# Environmental Teaching Using Creativity–Based Learning (CBL) for Undergraduate Students, Rajabhat Mahasarakham University

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**Abstract**

The purposes of this research were to investigate the efficiency of environmental teaching using Creativity–Based Learning (CBL), to compare the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of students before and after learning and to compare the environmental knowledge, attitude towards environmental conservation and the environmental problem-solving thinking ability of students of different genders and faculties after learning. The sample were 52 undergraduate students studying at Rajabhat Mahasarakham University and enrolling in the Natural Resources and Environmental Management in Thai Course. They were selected by a purposive sampling method. The research instruments were 7 lesson plans on the environmental teaching based on CBL**,** the environmental knowledge test, the environmental conservation attitude assessment and the environmental problem-solving thinking ability assessment. The statistics for data analysis were frequency, percentage, mean and standard deviation, t-test, F-test (One-Way MANOVA, One-Way MANCOVA and Univariate Test) were also employed for the hypothesis test.

The study results were as the efficiency of the environmental teaching using CBL was 80.90 /82.28, which was higher than the set criteria of 80/80, the mean scores of the students on the environmental knowledge, the attitudes towards environmental conservation, and after the studying, the environmental problem-solving thinking ability were significantly higher than those of before studying at the .05 level, the environmental knowledge, the attitudes towards environmental conservation, and the environmental problem-solving thinking ability of the students of different genders were not different ($p > .05$) and the environmental knowledge of the students of different faculties was significantly different at the .05 level. However, their attitudes towards environmental conservation and environmental problem-solving thinking ability were not different ($p > .05$).

**Keywords:** environmental teaching, creativity-based learning, environmental knowledge, attitudes towards environmental conservation, environmental problem-solving thinking ability

## 1. Introduction

Changes in the global environment are the phenomena affecting the quality of life of the entire world population. It may be caused by natural factors such as volcanic eruption, forest fires causing soot, ash and dust in the atmosphere, resulting in air pollution and floods causing the currents and dirt, leading to water pollution. In addition, human beings are also the causes of environmental changes, for example, they carry out activities for sustenance and survival in society which are all related to the environment (Chupan Chompuchan, 2016). These situations have forced all countries around the world to become more aware of environmental issues. Therefore, cooperation from all countries began in 1972 when the United Nations organized a meeting, called the "Conference on Human Environment" in Stockholm, Sweden. There were claims about the unlimited use of the world's resources. The concept of sustainable development has been recognized as being able to integrate the environment and development together. At the Rio de Janeiro Conference of 2012, developing countries proposed to the United Nations to establish a working group on Sustainable Development Goals (SDGs) to sustainably protect the global environment (Somporn Sangchai, 2018). Many countries have realized the ongoing environmental problems. They have studied and searched for approaches to protect, develop, restore and conserve the environment, which will be effective and sustainable ways to solve environmental problems. One of the most effective and sustainable solutions to

environmental problems is providing both formal and informal education on the environment and environmental problems that affect the quality of the environment and people's life (Vinai Veeravatnanond, 2012).

As the world has entered the 21st century, many changes have occured, especially in the field of education. It is considered the latest advancement in the field of education that the science of learning has applied to education, especially teaching at the higher education level (Wanvisa Ken, 2013). Learners in the new century have many ways to seek knowledge on their own both in the environment and on the Internet. In terms of the learning management challenges, modern teachers should have a correct way of thinking or paradigm of teaching and learning that promotes learners to really know what they have learned, focusing on taking actions and preparing to be workers with knowledge and persons who are ready to learn (Vicharn Panich, 2012). This is consistent with the National Education Act on Learning Process Management requesting educational institutes and related agencies to promote practice of skills, thinking processes, management, coping with situations and applying knowledge to prevent and solve problems (Ministry of Education, 2009). Creativity-based learning (CBL) is one of the most popular student-centered learning methods. It was developed from problem-based learning and Edward De Bono's creativity development approach. Its active learning, which is the management of teaching and learning that promotes students to be active in learning and have analytical thinking, creative thinking, communication and teamwork skills (Wiriya Ruchaipanit, 2015).

The Natural Resources and Environmental Management in Thai Course is one of the General Education Courses of Social Sciences, Rajabhat Mahasarakham University. The objective is to provide learners with the environmental knowledge and promote participation for sustainable environmental development for having consciousness in the environment protection and being able to apply the knowledge to appropriately manage the local environment (Rajabhat Mahasarakham University, 2017).

For this reason, this research focused on the environmental teaching development for undergraduate students at Rajabhat Mahasarakham University using CBL as an innovation in teaching and learning that promotes the environmental learning of learners and encourages learners to be aware of environmental conservation and have appropriate ideas for solving environmental problems as well as developing the characteristics of the 21st century learners so that they are ready to be valuable citizens of the world.

## 2. Method

### *2.1 Research Conceptual Framework*

CBL is one of the most popular student-centered learning methods. It was developed from problem-based learning and Edward De Bono's creativity development approach. It is active learning, which is the management of teaching and learning that promotes students to be active in learning and have analytical thinking, creative thinking, communication and teamwork skills. The teaching process consists of 5 steps as follows: 1) stimulating interest, 2) identifying problems and grouping, 3) searching for information and thinking, 4) presentation and 5) evaluation (Wiriya Ruchaipanit, 2015). In the Natural Resources and Environmental Management in Thai Course, there are 7 environmental teaching plans used for teaching and learning activities: 1) environment and natural resources, 2) ecosystem, 3) geography of Thailand, 4) water resources 5) soil and mineral resources, 6) forest and wildlife resources, 7) natural resources and environmental management. The research instruments included 7 environmental teaching plans, the environmental knowledge test, the environmental conservation attitude assessment, and the environmental problem-solving thinking ability assessment. The quality of the instruments was verified by 5 experts. The instruments were also tried out with 35 students who were not the samples of the study to determine the difficulty index, the item discrimination power and the reliability. Then, the environmental teaching activities were organized using creativity-based learning for 52 undergraduate students at Rajabhat Mahasarakham University, who enrolled in the Natural Resources and Environmental Management in Thai Course in the first semester of the academic year 2019. These students were selected by a purposive sampling method. Environmental teaching aimed for students to have environmental knowledge, positive attitudes towards environmental conservation and environmental problem-solving thinking ability as shown in Figure 1.

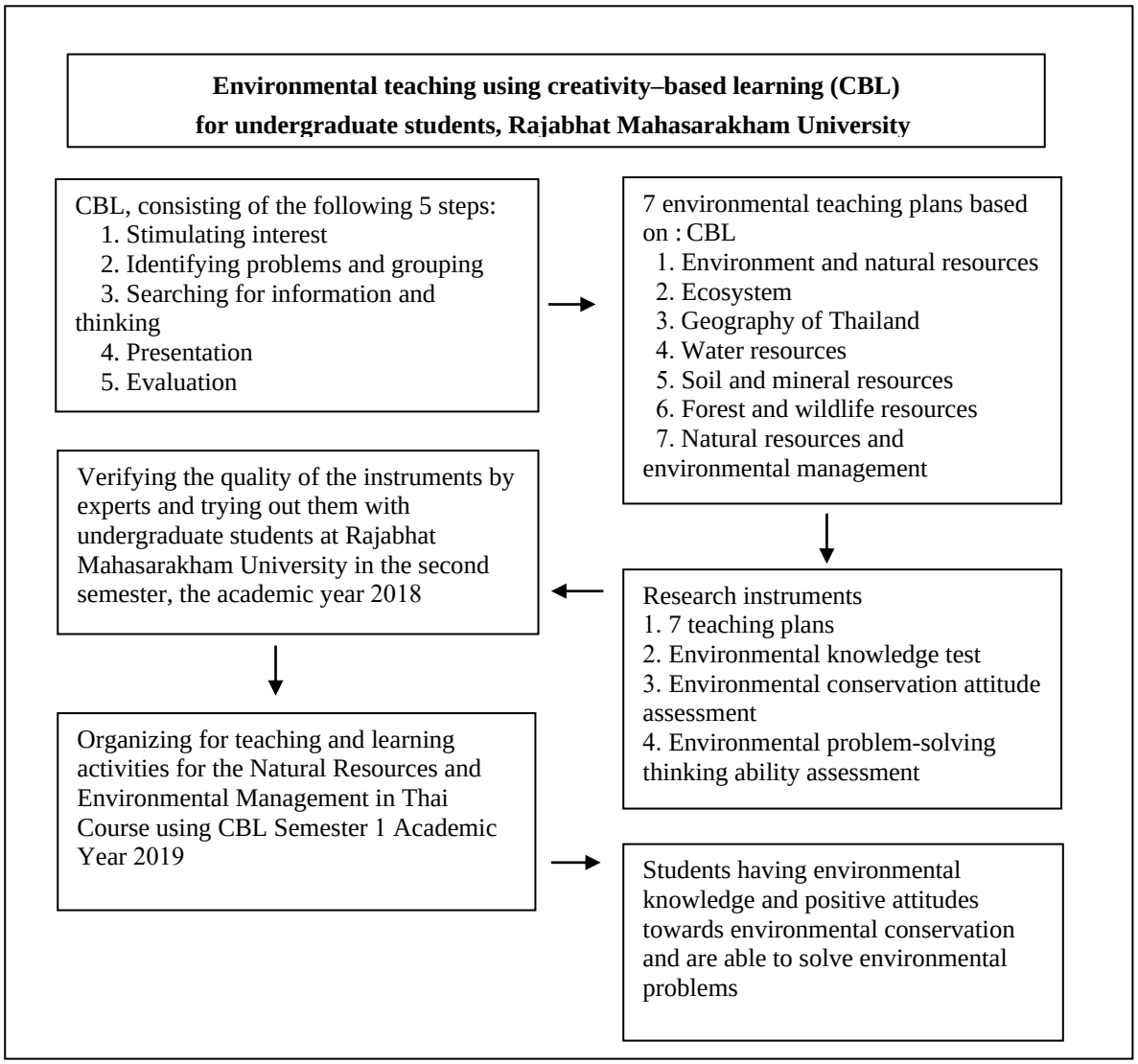


Figure 1. Research conceptual framework

*2.2 Population and Sample*

Population: 160 undergraduate students studying at Rajabhat Mahasarakham University in the first semester, the academic year 2019.

Sample: 52 undergraduate students studying at Rajabhat Mahasarakham University and enrolling in the Natural Resources and Environmental Management in Thai Course in the first semester of the academic year 2019, selected by a purposive sampling method.

*2.3 Variables*

Independent variables: 1) the environmental teaching plans based on creativity-based learning, 2) gender and 3) students in each faculties enroll in the Natural Resources and Environmental Management in Thai Course in the first semester of the academic year 2019**.**

Dependent variables: 1) environmental knowledge, 2) attitudes towards environmental conservation and 3) environmental problem-solving thinking ability.

*2.4 Construction and Quality Verification of the Research Instruments*

The construction and the quality verification of the research instruments for environmental teaching using CBL for undergraduate students at Rajabhat Mahasarakham University can be divided into two types.

2.4.1 The instruments used for knowledge transfer were the environmental teaching plans using CBL. The processes of construction and the quality verification of the instruments were as follows.

1) The details of the Natural Resources and Environmental Management in Thai Course which is one of the General Education Courses of Social Sciences, Rajabhat Mahasarakham University in Thailand were studied to analyze its goals, objectives and content.

2) The principles and the methods of preparing the lesson plans of the Natural Resources and Environmental Management in Thai Course were studied from documents, books and related research to determine the topics and the content matching the course descriptions of Natural Resources and Environmental Management in Thai (1300001).

3) The framework for the content of the Natural Resources and Environmental Management in Thai Course was developed. It was also examined and advised by experts. The course comprised 7 units: 1. environment and natural resources, 2. ecosystem, 3. geography of Thailand, 4. water resources, 5. soil and mineral resources, 6. forest and wildlife resources and 7. natural resources and environment management.

4) The appropriateness of the manual and the environmental lesson plans using creativity-based learning was evaluated by 5 experts.

5) The manual and the environmental lesson plans evaluated by the experts were analyzed. The mean scores of 3.50 or more were set as the criteria. It was found that the mean score ( ) of the appropriateness of the environment teaching manual was 4.67 with a standard deviation (S.D.) of 0.47, which was at the most appropriate level. The IOC was 0.85. The mean score ( ) of the appropriateness of the teaching plans using creativity-based learning was 4.64 with a standard deviation (S.D.) of 0.49, which was in the most appropriate level. The IOC was 0.90.

6) The environmental lesson plans using creativity-based learning were improved and tried out with the students who had studied this course before and were not the samples in this study. The students were divided into 3 groups: a small group of 5 people, a medium group of 10 people, and a large group of 20 people.

2.4.2 The instruments for assessment included the environmental knowledge test, the environmental conservation attitude assessment, and the environmental problem-solving thinking ability assessment. The processes of construction and the quality verification of the instruments were as follows.

1) The environmental knowledge tests

1.1) The basic information from textbooks and relevant research were studied to guide the construction of the environmental knowledge test.

1.2) The obtained information was used to construct the environmental knowledge test. It consisted of multiple-choice questions with 4 options: A, B, C and D. Only one correct answer must be chosen. The scoring criteria were as follows: 1 point was given for every correct answer and 0 point was given for every wrong answer. The test consisted of 70 questions.

1.3) The environmental knowledge test was reviewed by the advisor, and it was revised according to the recommendations.

1.4) The consistency of the environmental knowledge test with the objectives and teaching plans was verified by 5 experts. It was found that the IOC of the knowledge test was 0.92, which was higher than 0.50, indicating that all questions were consistent with the content and the objectives of the course. As a result, it can be used to collect data.

1.5) The environmental knowledge test was tried out with the students who had studied this course before and were not the samples in this study. The students were divided into 3 groups: a small group of 5 people, a medium group of 10 people, and a large group of 20 people for investigating the difficulty index, the item discrimination power and the reliability of the test. It was found that the difficulty index of all items in the knowledge test was at a fair level: the lowest value was 426 and the highest value was 0.766. For the item discrimination power, the criteria were set to measure the difference in item difficulty between groups of students with high and low marks to analyze and find out the item discrimination power with 0.20 or more. It was found that the item discrimination power of every question was at a fair level: the values of discrimination power were between 0.517 - 0.751. As for the reliability of the whole knowledge test, it was tested by $\alpha$ – Cronbach Coefficient. The reliability of the whole test was 0.984, indicating that all the items in the environmental knowledge test were acceptable with the value of higher than 0.70 (Kanlaya Vanichbuncha, 2017). Therefore, it can be used for data collection.

1.6) The environmental knowledge test was improved, and the complete version was presented to the advisor before it was used to collect data.

2) The environmental conservation attitude assessment. The processes of construction and the quality verification of the environmental conservation attitude assessment were as follows.

2.1) The principles and the approaches for constructing the environmental conservation attitude assessment were studied from documents, textbooks and related research.

2.2) The environmental conservation attitude assessment was constructed to ask about the students' feelings and opinions on environmental conservation using the 5-point Likert scale (Boonchom Srisa-ard, 2010). The criterias are as followed level 1: average score of 1.00-1.50 means that the least amount of environmental conservation attitude; level 2: average score of 1.51-2.50 means a low level of environmental conservation attitude; level 3: average score of 2.51-3.50 means a moderate environmental conservation attitude; level 4: average score of 3.51-4.50 means a high level of environmental conservation attitude; and level 5: average score of 4.51-5.00 means the highest level of environmental conservation attitude. There were 35 items in the environmental conservation attitude assessment.

2.3) The consistency of the environmental conservation attitude assessment with the objectives and teaching plans was verified by 5 experts. It was found that the IOC of the knowledge test was 0.91, which was higher than 0.50, indicating that all questions were relevant to the content and the objectives. Therefore, it can be used for data collection.

2.4) The item discrimination power of the environmental conservation attitude assessment was investigated. The items with the item discrimination power of 0.20 or more were selected. It was found that the item discrimination power of the environmental conservation attitude assessment was at a fair level: the values of discrimination power were between 0.374 – 0.746. The reliability of the environmental conservation attitude assessment was examined using α – Cronbach Coefficient. It was found that the reliability of environmental conservation attitude assessment was 0.946, indicating that all the items in the environmental conservation attitude assessment were acceptable with the value of higher than 0.70 (Kanlaya Vanichbuncha, 2017). Therefore, it can be used for data collection.

2.5) The environmental conservation attitude assessment was improved, and the complete version was used to collect data with the samples.

3) The environmental problem-solving thinking ability assessment

3.1) The basic information from textbooks and relevant research were studied to be the guidelines for the construction of the environmental problem-solving thinking ability assessment.

3.2) The environmental problem-solving thinking ability assessment was constructed. It was comprised of multiple-choice questions with 4 options: A, B, C and D. Only one correct answer must be chosen. The scoring criteria were as follows: 1 point was given for every correct answer and 0 point was given for every wrong answer. There were 28 questions in the assessment.

3.3) The consistency of the environmental problem-solving thinking ability assessment with the objectives and teaching plans was verified by 5 experts. It was found that the IOC of the knowledge test was 0.89, which was higher than 0.50. This indicated that all questions were consistent with the content and the objectives of the course, so it can be used for data collection.

3.4) The item discrimination power of the environmental problem-solving thinking ability assessment was investigated. The items with the item discrimination power of 0.20 or more were selected. It was found that the item discrimination power of the environmental conservation attitude assessment was at a fair level. The values of discrimination power were between 0.523 – 0.707. The reliability of the environmental problem-solving thinking ability assessment was verified using α – Cronbach Coefficient. The reliability of the environmental problem-solving thinking ability assessment was 0.959, indicating that all the items in the environmental problem-solving thinking ability assessment were acceptable with the value of higher than 0.70 (Kanlaya Vanichbuncha, 2017). Therefore, it can be used for data collection.

3.5) The environmental problem-solving thinking ability assessment was improved, and the complete version was used to collect data.

*2.5 Data Collection*

The steps for organizing teaching activities for the development of the environmental teaching using creativity–based learning (CBL) were as follows.

2.5.1 The teaching activities, including the environmental teaching manual, the environmental lesson plans using creativity-based learning, the environmental knowledge test, the environmental conservation attitude assessment and the environmental problem-solving thinking ability assessment and the teaching materials were prepared.

2.5.2 The sample did the pretest on the environmental knowledge test, the environmental conservation attitude assessment and the environmental problem-solving thinking ability assessment.

2.5.3 The environmental teaching based on 7 lesson plans using creativity-based learning (as shown in Table 1) was administered with 52 samples who were the undergraduate students studying at Rajabhat Mahasarakham University and enrolling in the Natural Resources and Environmental Management in Thai Course in the first semester of the academic year 2019 for a period of one semester.

Table 1. The environmental teaching plans using creativity-based learning (CBL)

| **Week** | **Topics** | **Hours** |
|---|---|---|
| 1 | Introduction to the lesson plans and pretest | 3 |
| 2 – 3 | Lesson Plan 1: Environment and Natural Resources | 6 |
| 4 – 5 | Lesson Plan 2: Ecosystem | 6 |
| 6 - 7 | Lesson Plan 3: Geography of Thailand | 6 |
| 8 - 9 | Lesson Plan 4: Water Resources | 6 |
| 10 - 11 | Lesson Plan 5: Soil and Mineral Resources | 6 |
| 12 - 13 | Lesson Plan 6: Forest and Wildlife Resources | 6 |
| 14 - 15 | Lesson Plan 7: Natural Resources and Environment Management | 6 |
| 16 | Summary of the lesson plans and posttest | 3 |
| **Total number of hours per semester** | | **48** |

The process of the environmental teaching activities using CBL was as follows.

1) Stimulating interest

1.1) The researcher clarified the information about the teaching method, the roles of the students and the researcher, the research conceptual framework and the sources of information to the students.

1.2) The researcher presented media in various forms such as pictures, video clips, news and everyday events and raised questions about the situations of natural resources and the environment in Thailand to encourage the students to think critically and discuss together.

2) Identifying problems and grouping

2.1) The students expressed their opinions and discussed about the situations of natural resources and the environment in Thailand in order to observe the causes of environmental problems, leading to suggestions and guidelines for solving the problems.

2.2) After that, the researcher assigned the students to divide into groups. Each group was assigned to study the natural resource and environmental crises of Thailand and analyze them and create the mind map.

3) Searching for information and thinking

3.1) The students searched for information on natural resource and environmental crises in Thailand to support the preparation of the mind map from books, the Internet and libraries.

3.2) Each group of students discussed to find out the answers in a variety of ways. The researcher helped, advised and stimulated the discussion within the group so that the students can understand and analyze the problems to find out appropriate answers to create creative works, projects, or in any other form.

4) Presentation

4.1) The students presented the group work on natural resource and environmental crises in Thailand and shared and learned after finishing the presentation.

4.2) The researcher participated in the discussion, scored the presentation and shared lessons learned on the environment and natural resources.

5) Evaluation included the evaluation of the presentation of the work and end-of-unit exercises, and the evaluation of learning outcomes, including the environmental knowledge test, the environmental conservation attitude assessment and the environmental problem-solving thinking ability assessment.

2.5.4 After all 7 teaching plans were used, the students had to take the posttest, including the environmental knowledge test, the environmental conservation attitude assessment and the environmental problem-solving thinking ability assessment. These tests were the same as the pretest.

2.5.5 The posttest results were analyzed by statistical methods to test the hypothesis.

2.5.6 The results of the development of the environmental teaching revealed that the efficiency of the teaching plans using creativity-based learning was 80.9/82.28, which was higher than the set criteria of 80/80. The effectiveness index of the teaching plans using creativity-based learning was 0.6064 or 60.64%.

*2.6 Statistics for Data Analysis*

The statistics used for data analysis in this research were as follows.

1. The basic statistics included mean, percentage, frequency and standard deviation.

2. The statistics for testing the efficiency of the research instruments were as follows: 1) the appropriateness of the environmental teaching plans using creativity-based learning, 2) Index of Item Objective Congruence, 3) the difficulty index of the environmental knowledge test, 4) the item discrimination power of the questionnaire using item-total correlation, 5) the reliability using α – Cronbach Coefficient, 6) the efficiency of process (E1), 7) the efficiency of results (E2), and 8) the effectiveness index (E.I.).

3. The statistics used for testing results and hypothesis at the statistical significance level of .05 were 1) Paired t-test, 2) One-Way MANOVA, 3) One-Way MANCOVA, 4) Univariate Test and 5) multiple comparison by Scheffe's method in One-Way ANOVA.

**3. Results**

The development of the environmental teaching using CBL for undergraduate students at Rajabhat Mahasarakham University can be summarized as follows.

1. The investigation of the efficiency of the environmental teaching using CBL for undergraduate students at Rajabhat Mahasarakham University in accordance with the set criteria of 80/80 can be presented as follows.

According to the investigation of the efficiency of the environmental teaching plans using CBL, it was found that the mean score of the environmental knowledge assessed during the study using the 70-question test was 56.63 points (80.90%). In addition, the mean score of the posttest using the 70-question test was 57.59 points (82.28%). Therefore, the efficiency of the environmental teaching using CBL was 80.90 /82.28, which was higher than the set criteria of 80/80 (Table 2).

Table 2. The efficiency of the environmental teaching plans using creativity–based learning (CBL) ($E_1/E_2$)

| The efficiency of the teaching plans | Total score | $\bar{x}$ | S.D. | Percentage |
|---|---|---|---|---|
| The efficiency of process ($E_1$) | 70 | 56.63 | 6.30 | 80.9 |
| The efficiency of results ($E_2$) | 70 | 57.59 | 4.85 | 82.28 |
| The efficiency of the teaching plans: 82.52/83.27 | | | | |

2. The overall mean score on the environmental knowledge of the students before studying was at a moderate level ( =38.48). After studying, the overall mean score on the environmental knowledge of the students was at the highest level ( =57.59). When comparing the mean scores on the environmental knowledge before and after studying, it was found that the mean scores of the students after studying were significantly higher than those of before studying at the .05 level.

2.1 The overall mean score on the attitudes towards environmental conservation of the students before studying was at a high level ( =3.84). After studying, the overall mean score was at the highest level ( = 4.40). When comparing the mean scores on the attitudes towards environmental conservation before and after studying, it was found that the mean scores of the students on the attitudes towards environmental conservation after studying were significantly higher than those of before studying at the .05 level.

2.2 The overall mean score on the environmental problem-solving thinking ability of the students before studying using the 28-item test was 14.36 points (51.28%). After studying, the mean score was 23.26 points (83.07%). When comparing the mean scores on the environmental problem-solving thinking ability before and after studying, it was found that the mean scores of the students on the environmental problem-solving thinking ability after studying were significantly higher than those of before studying at the .05 level (Table 3).

Table 3. The results of the comparison of the mean scores of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability before and after studying

| List | Before studying | | | After studying | | | t | df | p |
|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S.D. | Knowledge level | $\bar{x}$ | S.D. | Knowledge level | | | |
| Environmental knowledge (N = 70) | 38.48 | 4.02 | Moderate | 57.59 | 4.85 | Highest | -34.950 | 51 | .000* |
| Attitudes towards environmental conservation (N = 5) | 3.84 | 0.33 | High | 4.40 | 0.46 | High | -12.141 | 51 | .000* |
| Environmental problem-solving thinking ability (N = 28) | 14.36 | 1.51 | Moderate | 23.26 | 1.16 | High | -39.53 | 51 | .000* |

* Statistically significant at the level of 0.05.

3. According to the comparison of the environmental knowledge, the attitudes towards environmental conservation, and the environmental problem-solving thinking ability of the students, it was found that the environmental knowledge, the attitudes towards environmental conservation, and the environmental problem-solving thinking ability of the students of different genders were not different ($p > .05$).

Table 4. The results of One–Way MANOVA analysis of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different genders

| Statistics | Value | Hypothesis df | Error df | F | p |
|---|---|---|---|---|---|
| Pillai's Trace | .087 | 3.000 | 48.000 | 1.521 | .221 |
| Wilks' Lambda | .913 | 3.000 | 48.000 | 1.521 | .221 |
| Hotelling's Trace | .095 | 3.000 | 48.000 | 1.521 | .221 |
| Roy's Largest Root | .095 | 3.000 | 48.000 | 1.521 | .221 |

Table 5. The results of One–Way MANCOVA analysis of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different genders using pretest as the covariate

| Independent variable | Dependent variables | SS | df | MS | F | p |
|---|---|---|---|---|---|---|
| Gender | Environmental knowledge | 21.358 | 1 | 21.358 | 1.454 | .234 |
| | Attitudes towards environmental conservation | .000 | 1 | .000 | 0.104 | .748 |
| | Environmental problem-solving thinking ability | 1.561 | 1 | 1.561 | 1.213 | .276 |

4. The results of the comparison of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different faculties can be summarized as follows (Tables 6-9).

4.1 The environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different faculties were significantly different at the .05 level. Therefore, the univariate tests on the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability were performed. It was found that the environmental knowledge of the students of different faculties was significantly different at the .05 level, but their attitudes towards environmental conservation and environmental problem-solving thinking ability were not different.

4.2 The environmental knowledge of the students of different faculties that was significantly different at the .05 level can be presented as follows.

The environmental knowledge of the students of the Faculty of Engineering was different from the environmental knowledge of the students of the Faculty of Education, the Faculty of Science and the Faculty of Management Sciences.

The environmental knowledge of the students of the Faculty of Humanities and Social Sciences was different from the environmental knowledge of the students of the Faculty of Education, the Faculty of Science and the Faculty of Management Sciences.

The environmental knowledge of the students of the Faculty of Education was different from the environmental knowledge of the students of the Faculty of Engineering, the Faculty of Humanities and Social Sciences, the Faculty of Law and the Faculty of Management Sciences.

The environmental knowledge of the students of the Faculty of Science was different from the environmental knowledge of the students of the Faculty of Engineering, the Faculty of Humanities and Social Sciences, the Faculty of Law and the Faculty of Management Sciences.

4.3 The environmental knowledge of the students of different faculties based on the teaching plans, namely ecosystem, soil and mineral resources, forest and wildlife resources and natural resources and environmental management, was significantly different at the .05 level. However, their attitudes towards environmental conservation and environmental problem-solving thinking ability were not different.

Table 6. The results of One–Way MANOVA analysis of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different faculties

| Statistics | Value | Hypothesis df | Error df | F | p |
|---|---|---|---|---|---|
| Pillai's Trace | .817 | 15.000 | 138.000 | 3.443 | .000* |
| Wilks' Lambda | .309 | 15.000 | 121.866 | 4.308 | .000* |
| Hotelling's Trace | 1.832 | 15.000 | 128.000 | 5.210 | .000* |
| Roy's Largest Root | 1.577 | 5.000 | 46.000 | 14.513 | .000* |

* Statistically significant at the level of 0.05

Table 7. The results of One–Way MANCOVA analysis of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different faculties using pretest as the covariate

| Independent variables | Dependent variables | SS | df | MS | F | p |
|---|---|---|---|---|---|---|
| Different faculties | Environmental knowledge | 357.088 | 5 | 71.418 | 8.373 | .000* |
| | Attitudes towards environmental conservation | .013 | 5 | .003 | .714 | .616 |
| | Environmental problem-solving thinking ability | 10.084 | 5 | 2.017 | 1.664 | .163 |

* Statistically significant at the level of 0.05

Table 8. The results of a one-way analysis of variance of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of students with different faculties using Univariate Test

| Dependent variables | Source of variance | SS | df | MS | F | p |
|---|---|---|---|---|---|---|
| Environmental knowledge | Contrast | 357.088 | 5 | 71.418 | 8.373 | .000* |
| | Error | 383.835 | 45 | 8.530 | | |
| Attitudes towards environmental conservation | Contrast | .049 | 5 | .010 | 2.191 | .192 |
| | Error | .204 | 46 | .004 | | |
| Environmental problem-solving thinking ability | Contrast | 32.758 | 5 | 6.552 | 4.338 | .320 |
| | Error | 69.473 | 46 | 1.510 | | |

* Statistically significant at the level of 0.05

Table 9. The results on the environmental knowledge of students with different faculties using multiple comparison of Scheffe's method

| Faculty | | Engineering | Humanities and Social Sciences | Education | Science | Law | Management Science |
|---|---|---|---|---|---|---|---|
| | | 55.25 | 56.20 | 60.92 | 60.83 | 52.66 | 50.20 |
| Engineering | 55.25 | - | - | .036* | .037* | - | .032* |
| Humanities and Social Sciences | 56.20 | - | - | .034* | .039* | - | .029* |
| Education | 60.92 | .036* | .034* | - | - | .025* | .000* |
| Science | 60.83 | .037* | .039* | - | - | .030* | .000* |
| Law | 52.66 | - | - | .025* | .030* | - | - |
| Management Science | 50.20 | .032* | .029* | .000* | .000* | - | - |

* Statistically significant at the level of 0.05

## 4. Discussion

The results of the environmental teaching using CBL for undergraduate students at Rajabhat Mahasarakham University can be discussed as follows.

1. The efficiency of the teaching plans using creativity-based learning was in accordance with the set criteria of 80/80. The students' mean score on the environmental knowledge assessed during the study was 80.90% and that of

the posttest was 82.28%. It is consistent with Amporn Lertnaronk (2016) who developed a Thai learning model by using CBL on writing and found that the efficiency of Thai learning using creativity-based learning was 87.62/81.90. It is also consistent with a study by Prayoon Wongchantra et al. (2017), studying teaching environmental education using flipped classroom. It was found that the efficiency of the teaching was 84.67/90.33. Mehmet ERDOĞAN (2011) investigated the effects of ecology-based summer nature education program and found that the knowledge scores of the posttest were higher than those of the pretest without significant significance. Wutthisak Bunnaen (2015) developed the biology and biological laboratory handbook integrated learning. The efficiency of each learning unit was 80.55/81.85 because the lesson plans were developed in a systematic way based on the concept of Boonchom Srisa-ard (2010). This indicates that the teaching plans systematically developed can result in good academic achievement of students in accordance with the specified criteria.

2. The results of the comparison of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability using creativity-based learning.

2.1 The mean scores on the environmental knowledge of the students using creativity-based learning after studying were significantly higher than those of before studying at the .05 level. This is consistent with a study by Mongkon Riangnarong & Ladda Silanoi (2015), investigating the learning achievement using creativity - based learning (CBL). The learning achievement of the students was higher after using creativity - based learning (CBL). Abdulrahman M Al-Zahrani (2015) and Setthachotsombut, N. (2018), and Evrim Ural & Guzide Dadli (2020) also investigated the effects of creativity promotion and active learning based on CBL and PBL, which positively affected the learning outcomes of learners. Therefore, teaching by the lesson plans based on creativity-based learning (CBL) allowed the students to understand the content about the environment from identifying problems and studying from various learning sources, leading to creative group presentations. As a result, their academic achievement can be developed. For this reason, the mean scores on the environmental knowledge of the students after studying were significantly higher than those of before studying at the .05 level.

2.2 The mean scores of the students on the attitudes towards environmental conservation after studying were significantly higher than those of before studying at the .05 level. This is consistent with the study on learning management model development and teaching environment process conducted by Prayoon Wongchantra et al. (2017), Thakorn Sittichok & Orapin Sirisamphan (2017), Prayoon Wongchantra et al. (2008) and Bradley et al. (2010). It was found that the attitudes towards environmental conservation after learning activities were better than before learning. This is consistent with a study by Prayoon Wongchantra et al. (2017), studying the environmental science teaching to promote the national qualifications framework for higher education. It was found that after doing learning activities, the environmental knowledge, the attitudes towards the environment and the environmental ethics were higher than those of before doing learning activities and in accordance with the learning assessment standards according to the Thai Qualifications Framework for Higher Education. This points out that the lesson plans of the environmental teaching using creativity-based learning, and students' participation in activities through various experiences consistent with real life allowed students to link their attitudes towards environmental conservation to protect the environment. As a result, the mean scores of the students on the attitudes towards environmental conservation after studying were significantly higher than those of before studying at the .05 level.

2.3 The mean scores of the students on the environmental problem-solving thinking ability after studying were significantly higher than those of before studying at the .05 level. This is consistent with (Coschman, 1996) cited in Smaksmorn Phakdeeteva (2010), which stated that there is not a single solution to the problem. The learning of problem-solving thinking from case studies contributes to the development of problem-solving abilities. This is in line with the results of the study on the environmental problem-solving ability conducted by Saranya Wongaiam et al. (2016) and Onanong Detyothin et al. (2018), which revealed that after doing learning activities, the environmental problem-solving ability of the students was higher than before doing the activities. Woods, D.R. (2012) also found that authentic problem-based learning can lead to higher academic achievement. Khachakrit Liumthaisomg (2011) developed a teaching and learning model using a creative problem-solving process. It was found that the learning achievement of the students after learning was higher than before learning at the statistical significance level of .01. Therefore, the organization of learning activities by using or giving examples of current environmental situations can enable students to understand the environment and participate in discussions on questionable issues and find ways to solve the problems systematically. As a result, the mean scores of the students on the environmental problem-solving thinking ability after studying were significantly higher than those of before studying at the .05 level.

3. The results of the comparison of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different genders.

3.1 The environmental knowledge of the students of different genders was not different. It is consistent with a study by Kongporn Nimcharoenchaikul et al. (2015), which developed the lesson plans and training manual on the environment and found that the students' academic achievement was significantly increased from before studying. Also, the environmental knowledge of the students of different genders was not different. It is also consistent with a study by Anastasia Goulgouti et al. (2019), titled "Environmental Literacy: Evaluating Knowledge, Affect, and Behavior of Pre-service Teachers in Greece", which indicated that the environmental knowledge and environmental behaviors of the pre-service teachers with different sexes were not different. However, it is not consistent with a study by Prayoon Wongchantra (2009) developed the environmental education teaching process by an ethics infusion method for undergraduate students. The findings revealed that the female students had higher environmental knowledge and environmental ethics than the male students with statistical significance at the .05 level. Therefore, the environment knowledge of the students of different genders was not different. This may be because gender did not affect the environmental knowledge. The learning activities based on creativity-based learning were organized with gender equality in group activities. All students studied and searched for information together to practice analyzing and solving problems. They also had collaboration and exchanged opinions together.

3.2 The attitudes towards environmental conservation of the students of different genders were not different. Attitude is an important element that leads to environmentally responsible behavior. Dillon, P. J. & Gayford, C. G. (1997) and Thapa, B. (1999) agreed that effective conservation and solutions to environmental problems require positive attitudes of the individual and having good attitudes will be a sustainable driving force for environmentally friendly behavior. This is consistent with a study by Sakorn Phromkot (2012), investigating the moral behavior of Loei Rajabhat University. It was found that the students of each gender and from different faculties did not differ in their moral behavior. Guricin, C., & Joy, O. S. (2020) and Demirali Yaşar Ergin (2019) found that male and female teacher applicants had no difference in attitudes towards environmental conservation. Therefore, when students of different genders learned about the environment using creativity-based learning, there was no difference in the attitudes towards environmental conservation. It is because to achieve attitudes towards environmental conservation, it depends on positive attitudes of each individual. It is not related to gender. Also, the drive of participation in preserving the environment through group activities enables individuals to sustainably exhibit environmentally friendly behaviors.

3.3 The environmental problem-solving thinking ability of the students of different genders was not different. This is consistent with the study results of the use of problem-solving skills conducted by Nasasiusa Bussabokkaew et al. (2018), Suwannaprut & Siriwan (2019), Anawat Khongprasert et al. (2018), which found that the problem-solving thinking abilities of different genders were not different. Pedaste, M., & Sarapuu, T. (2006) investigated the factors influencing the outcome of solving story problems in a web-based learning environment. It was found that the main factors determining the skills in environmental problem-solving were the initial skills in problem-solving, the complexity and difficulty of the problems and gender. Therefore, the students of different genders had no difference in environmental problem-solving thinking skills. This may be because females and males are equally interested in conserving natural resources and the environment.

4. The results of the comparison of the environmental knowledge, the attitudes towards environmental conservation and the environmental problem-solving thinking ability of the students of different faculties.

4.1 The environmental knowledge of the students of different faculties was significantly different at the .05 level. This is in line with Sara, P. et al. (2007), exploring attitudes, knowledge and environmental behavior of the students in teacher-training colleges in Israel. The findings revealed that the overall environmental knowledge of the students of different faculties was significantly different at the .01 level. It is also in accordance with the study results of Niramon Cha-um (2016) and Chatsakorn Kongcheewasakul et al. (2014), which revealed that the students of different faculties had different knowledge. This indicates that students of different faculties had different learning experiences or different basics of the courses and skills. Therefore, it is the factor affecting the assessment of knowledge that the students of different faculties would have different environmental knowledge.

4.2 The attitudes towards environmental conservation of the students of different faculties were not different. This is consistent with Thapa, B. (1999) and Pe'er, S., Goldman, D., & Yavetz, B. (2007), which found that university students had higher levels of environmental attitudes than environmental behavior. It is also in line with the results of the comparison of attitudes and ethics of students of different faculties conducted by Saran Wongkhamchantra (2018), Witsanu Suttiwan (2022), Milutin Maravić, Stanko Cvjetićanin & Sonja Ivković (2014) and Emine Zehra Turan (2019) which revealed that ethics and attitudes of the students of different faculties were not different. The students of different faculties had no different attitudes towards environmental conservation because the case studies

about the local environment were used in the teaching and learning activities. For this reason, the students can understand the current environmental problems or situations. In addition, most students have the same domicile, so their attitudes towards environmental conservation are in the same direction.

4.3 The environmental problem-solving thinking ability of the students of different faculties was not different. Bitter, Hatfield & Edward (1989) cited in Nutanong Tudbuakhum (1997) stated that that learning management allowing learners to solve problems together in small groups will encourage students to exchange ideas with each other in finding ways and thinking of helping each other to make the work successful. A collaborative learning atmosphere promotes problem-solving thinking abilities. This is consistent with a study by Bunjongparu N. et al. (2020) which developed an instructional package promoting high-order thinking skills in general education at Srinakharinwirot University and found that the high-order thinking skills of the students of different faculties were not significantly different at the 0.05 level. Therefore, organizing teaching and learning activities with a variety of activities together with giving examples of current environmental situations and working in groups encouraging everyone to participate in discussions to assess the situations and find out conclusions and ways to solve problems systematically made the concepts or approaches to environmental problem-solving in the same direction. As a result, the environmental problem-solving thinking ability of the students of different faculties was not different.

Conclusion and Recommendation: Therefore, environmental teaching using creativity–based learning (CBL) for undergraduate students, Rajabhat Mahasarakham University. It is an innovation in teaching and learning that supports the environmental learning of learners and encourages learners to be aware of environmental conservation and have appropriate ideas for solving environmental problems. In the future research on environmental teaching can be study other variables, such as environmental behavior, environmental management participation, and should study the modern learning activities that are suitable for environmental situations, etc.

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