

# Teaching Environmental Education By Using Research-Based Learning For Undergraduate Students

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## Abstract

This research aims to find efficiency and effectiveness of learning activities teaching environmental education by using research-based learning for undergraduate students, to study and compare the environmental knowledge, environmental attitude and environmental ethics of students before and after learning, students with different gender and different grades. The sample used in the study were 50 the 3<sup>th</sup> Year undergraduate students in Environmental Education program, Faculty of Environment and Resource Studies, Mahasarakham University, which is obtained by purposive sampling. The research tools were the plans of teaching environmental education by using research-based learning, the environmental knowledge test, environmental attitude test and environmental ethics test. The statistics used for data analysis were frequency, percentage, mean, standard deviation and hypothesis testing using t-test, F-test (One-Way MANOVA, One-Way MANCOVA and Univariate Test. The results of the research showed that 1) Teaching environmental education by using research-based learning which developed by the researcher was found that the efficiency was 92.43/86.45 which set to 80/80 criteria and the effectiveness index was 0.7813 indicating that the students had progress in learning by 78.13%. 2) After learning, the students' average score of environmental knowledge, environmental attitude and environmental ethics was higher than before learning as the statistical significance level .05. 3) There was difference of environmental knowledge, environmental attitude and environmental ethics of the students with different gender as the statistical significance level .05. 4) There was no difference of environmental knowledge, environmental attitude and environmental ethics of the students with different grad ( $p > .05$ ).

**Keywords:** Teaching, Environmental education, Research-based learning, Environmental knowledge, Environmental attitude, Environmental ethics.

## Introduction

The development in various fields of academic of the world have affected Thai society in many sections, both of socio-economic aspect and politics which each section is very important to the lifestyle and thinking of Thai people. The guidelines of country development had brought problems to Thai people as appearing in the present which is caused by the imbalance of

development both of economy and society become to the capital dependency and technology from outside resulting in the destruction of natural resources and the environment, destroyed the culture and traditional wisdom of the local Thai people in the countryside whom less self-reliant. There are more labors fleeing poverty to find work in the big cities which is the cause of many problems, including deteriorating sources, prostitution

problem, child labor problem, drug problem, ecosystem and environmental issues; etc. It is the problematic situation of the country that has changed the society and lifestyle of Thai living for causing the deterioration of the family institution, society and community lack of transmission of education and culture within family and community. The worldview of people on the value of things had changed then focus on the competition for more self-interest and emphasis on materialism, especially when the country is faced with economic crises. The problems had intensified and had become more complex (Panya, 2006).

In the past, teaching and learning system was based on the teacher-centered teaching which unable to truly develop learners. In education reform, the concept has been changed to be learners-centered instruction (child-centered) with the principle that teaching and learning process have to support the learners who able to seek knowledge and develop their abilities naturally and full potential of one's own demand, including supporting practicing in real working conditions. There is a connection between what is learned and society. The learners had learned from many situations both of inside and outside the classroom. There are providing activities and processes for learners to analyze, synthesize, evaluate and create things not only focusing on memorizing only the content. Learners have more freedom to learn (Wichadee, 2011). The research process is not involved only the teacher, but the learner also. Learners in the era of educational reform should have skills in a systematic and sustainable learning process and able to take the research process to develop their own learning, such as creating the project, checking their knowledge, to seek new knowledge then to adapt the knowledge gained in daily life; etc. (Chompookham, 2001)

Education is the most important tool to develop the quality of the population because of education helps to reinforce knowledge, ideas, skills in living with quality and efficiency, bring to the progress of society and the nation finally. The most important development of a nation is the population development which providing both formal and informal education as a basis for development the country to progress in every

aspect (Amat, et al., 2017). At present, learning management in the classroom is thing which teachers should have carefully design and plan because students in Generation Z are creative, assertive, intelligent learners, because they grew up with all-round knowledge and can freely search for information on the Internet (Suprom, 2018).

Education is an important tool to make people, create society and to establish the nation. It is the main mechanism for developing quality manpower be able to live with others in society happily as the fast-changing trend of the 21<sup>st</sup> century world due to education plays an important role in building a country's advantage in order to compete and stand on the world stage under the economic and social system that is dynamics. The countries all around the world therefore attach great importance and dedication to the development of education in order to develop their human resources so that they can keep up with the changes in the economic and social systems of the country, region and the world under external pressure from globalization and domestic pressure that is a critical problem that the country has to face, in order for Thai people to have a good quality of life, Thai society is a moral, ethical society and the country of the world both in the present and in the future by making significant changes and affecting the education system. (Office of the Education Council Secretariat Ministry of Education, 2017-2036). These changes and theirs effects happened; as the result, the education system has to change the curriculum, methods of teaching and learning, development and preparation of teachers to produce new teachers with high performance according to professional standards in order to be able to transfer the learning process to the new generation of children and youth to be aware of the changes can think critically to prevent natural disasters, manage, develop and preserve the environment for a quality of life and an environmentally friendly society. (Office of the Education Council Secretariat Ministry of Education, 2017-2036). Providing education to develop the potential of all age people is the shared mission or responsibility of the state and all relevant sectors, all in setting goals for educational management, educational standards, curriculum

development, learning process, media, learning resources, the measurement and evaluation of learners at all educational levels for all target groups and all ages to create and develop qualified citizens with knowledge, abilities, skills and desirable characteristics, able to study, learn and develop their potential to the maximum according to their abilities. And improvement of the teacher's production system and development, instructors and educational personnel at all levels and types of education in order to obtain good teachers with knowledge, skills and ability to manage teaching and learning and having the spirit of being a teacher enter the education system of the country in order to develop learners to reach the maximum potential of each person. (Office of the Education Council Secretariat Ministry of Education, 2017-2036). Therefore, education is an important tool in providing quality and comprehensive education for people of all ages, all target groups. Be able to manage and develop the potential of all people around. Distribute opportunities and equality in the provision of quality education and lifelong learning without limitation of form, time and place, which will lead to the reduction of inequality in education and the development of people to have skills, characteristics, and competencies in accordance with the direction framework and national development goals (Office of the Education Council Secretariat Ministry of Education, 2017-2036). The important role in educating, skill, create attitude and awareness among learners and people of all ages on the importance of developing and growing up in an environmentally responsible society, be able to adapt in a world of rapid and drastic changes in nature, be ethical, having morals, ethics and take responsibility for their actions and adopting the concept of the Sufficiency Economy Philosophy into practice in daily life as well as enhancing the capacity of personnel in research and development of innovation and technology that can adapt to changing climates and grow on an environmentally friendly quality of life (Office of the Education Council Secretariat Ministry of Education, 2017-2036).

Research-based learning (RBL) teaching and learning that emphasize research (research-based approach) or research-based teaching

(research-based instruction) is a technique. In the creative teaching that focuses on developing learners to have more creative characteristics. (Sinlarat, 2004). Because research is a process of human development, especially to develop the researchers who known how to ask the questions and what they want to know and having been creative. Researching is seeking of knowledge or solving problems. The researcher must be creativity in considering issues or information. As a result of these doing made the researcher had a keen for learning was reasonable person who developed academic advancement because of the results of research or knowledge gained be able to understand, predict or control situations and increase the power of solving problems (Phithianuwat and Boonterm, 2004) which in teaching and learning emphasizes the research process or uses the research as part of general learning. Teachers often arrange for learners to follow the six steps of the research process, but the weaknesses they find are: Teachers often do not teach learners or practice the process skills necessary to perform them. For example, teachers often assign learners to search for knowledge or to collect or summarize information. without teaching or practicing the skills or things necessary to do it. Therefore, it can be said that it is instruction rather than teaching. Instructions are simply giving learners the opportunity to use those processes. which the learners will be able to do more or how well It depends mainly on the potential of the learners. Teachers do not teach because teaching means helping learners to increase their learning from the current level. Therefore, if teachers are to teach the research process, they must help learners learn about that process. Teachers need to help build the skills needed to perform each step. Most of these skills are known as process skills. This could be cognitive processing skills, such as cognitive skills, or social process skills, such as interaction skills. Collaboration skills It also addresses the role of teachers in learning management by the research process in each step of the research process (Khammani, 2004).

In this research, the researcher recognizes the importance of teaching environmental education using research- based learning for undergraduate students which the researcher wants to develop teaching and learning that is

suitable for students. Because it is one of the techniques in creative teaching, it is the heart of education because it really encourages students to build their own body of knowledge including supporting the concept of student-centered teaching and learning and in line with educational management principles that focus on using the research process as part of the learning process. There is also an emphasis on learning from actual experiences, knowledge, good attitude and ethics towards the environment will provide learners with tools for lifelong learning, specially to allow learners to gain hands-on experience in using the research process. This leads to deep learning and the application of knowledge to prevent and solve problems.

### Methods of study

Conceptual framework used in research

For teaching on RBL, there are 6 steps, step 1 identifying the problem, step 2 hypothesis, step 3 proving the hypothesis, step 4 collecting data, step 5 analyzing the data, and step 6 summarizing the results. RBL consists of 8 learning plans, which are plan 1: soil resources, plan 2: water resources, plan 3: air pollution, plan 4: forest resources, plan 5: wildlife resources, plan 6: conservation agriculture, plan 7: agriculture and plan 8: solid waste management. The tools used in the research were 8 learning plans, environmental knowledge test, environmental attitude test and environmental ethics test by bringing to find the quality of tools by 5 experts and try out with 4<sup>th</sup> year undergraduate students, the end of the academic year 2019, and then organize teaching activities on environmental education by using RBL to provide students with environmental knowledge, attitude and ethics (illustrated 1)



### Illustration 1 Conceptual framework used in research

#### Population and sample

Population used in the study were 372 undergraduate students in Environmental Education programme, Faculty of Environment and Resources Studies, Mahasarakham University.

The sample were 3<sup>rd</sup> year 50 undergraduate students in Environmental Education programme, Faculty of Environment and Resources Studies, Mahasarakham University, being selected by purposive sampling.

#### Variables studied

The independent variable is environmental education learning plan using research-based learning, gender, and grad.

The dependent variable is environmental knowledge, environmental attitude and environmental ethics.

#### Tools and tool quality

For teaching environmental education by using research-based learning for undergraduate students, the researcher has determined the creation and quality of the tools as follows.

1) Environmental education learning plan using research- based learning

1.1) Study research papers related to environmental education teaching plans.

1.2) Determine the scope and content structure of the environmental education learning plan.

1.3) To present an outline of the content of the environmental education learning plan and to improve it according to the recommendation.

1.4) Adopt an environmental education learning plan based on expert assessment. It was analyzed based on the average score of 3.50 or higher as the decision criterion. It was found that the appropriateness of the environmental education learning plan was a mean of 4.80 and the standard deviation (S.D.) was equal to 0.03, which was at the most appropriate level. and the Consistency Value (IOC) is 0.88.

1.5) Improve the environmental education learning plan and then used for a trial

(try out) with 30 undergraduate students in the fourth semester of the academic year 2019 in Environmental education programme, Faculty of Environment and Resources Studies, Mahasarakham University that is not the sample for a period of 1 semester.

1.7) Bring environment education learning plan using research-based learning to improve and make a complete version to collect data with the sample.

2. The tools used for measurement and evaluation include the environmental knowledge test, environmental attitude test and environmental ethics test which the details are as follows:

2.1) Study basic information from textbooks related research papers to guide the creation of research tools.

2.2) Use the data to create tools used for measurement and evaluation, including:

2.2.1) Environmental knowledge test which is a multiple choice with 4 options, namely A, B, C, D, 80 items, choose only the cheapest answer. The criterion for a correct answer was to be given 1 point, the wrong answer was to be given 0 points. The interpretation of the score was as follows; an average score of 0.00-16.00 means that the student had knowledge at the lowest level, a mean score of 16.01-32.00 means that the student had the knowledge at a low level mean score of 32.01-48.00 means that the student's knowledge is at a moderate level mean score 48.01-64.00 means that the student's knowledge is at a high level and a mean score of 64.01–80.00, meaning that the students were knowledgeable at the highest level.

2.2.2) The assessment of environmental attitudes consisted of 80 items. The assessment was divided into 5 levels: strongly agree, agree, not sure, disagree, and strongly disagree. The scoring criteria for the attitude scale were as follows: a mean score of 1.00-1.80 means strongly disagree, a mean score of 1.81-2.60 means disagrees, a mean score of 2.61-3.40 means not sure, a mean score of 3.41-4.20 means agrees, and a mean score of 4.21-5.00 means strongly agree.

2.2.3) Environmental ethics test, multiple-choice type, 4 choices, namely a, b, c, d, 35 items divided into 4 levels, as follows: For self, average score 1.00–1.75 for comrades, average score 1.76–2.50 for society, average score 2.51–3.25 and for the sake of fairness average score 3.26–4.00.

2.3) Bring the instrument used for measurement and evaluation to 5 experts to consider the consistency of the instrument used in the research with the objectives. It was found that the environmental knowledge test was an IOC value of 0.92. The environmental attitude test was an IOC value is equal to 0.92 and the environmental ethics test was an IOC value of 0.90 which is greater than 0.50 indicates that all questions are relevant to the content and objectives can be used for data collection.

2.4) Bring the instrument used for measurement and evaluation to 5 experts to consider the consistency of the instrument used in the research with the objectives. It was found that the environmental knowledge test was an IOC value of 0.92. The environmental attitude test was an IOC value equal to 0.92 and the environmental ethics test was an IOC value of 0.90 which is greater than 0.50 indicates that all questions are relevant to the content and objectives can be used for data collection.

2.4.1) Each item of the environmental knowledge test was a level of difficulty at the usable level, with the lowest value of 0.43 and the highest of 0.80 for each item's power of discrimination by using criteria to distinguish between high and low groups. Analyzing the power to discriminate each item with a value of 0.20 or more, it was found that all questions was the power to discriminate each item at the usable level the power to discriminate between 0.532-0.947.  $\alpha$ -Cronbach Coefficient

was found to have a confidence value of 0.990, indicating that all knowledge tests were acceptable with values greater than 0.80 that could be used to can be used to collect information.

2.4.2) All items of the environmental attitude test was a valid discrimination power of each item, i.e., the discriminant power was between 0.393 – 0.854, and the overall environmental attitude test was used to determine the confidence value by using the  $\alpha$ -Cronbach Coefficient was found to have a confidence value of 0.983, indicating that the environmental attitude test was in accordance with acceptable values of 0.80 or higher, can be used to collect data.

2.4.3) the environmental ethics test was a valid discriminant power value for each item, i.e., they had discrimination powers between 0.391–0.886, and the entire environmental ethics test was used to determine the confidence values using  $\alpha$ -Cronbach Coefficient was found that there was a confidence value of 0.981, indicating that the environmental ethics test met acceptable values of 0.80 and above could be used for data collection.

2.5) Bring the tools used for measurement and evaluation to improve and make a complete version to collect data with the sample.

#### Data collection

1) Teaching environmental education using research-based learning for undergraduate students is quasi experimental research by one group pretest-posttest design to compare environmental knowledge, attitudes and ethics before and after class and construct a trial (Srisa-at,2000) (Table 1).

Table 1. Research plan one-group pretest-posttest design

| Group | Before         | Test | After          |
|-------|----------------|------|----------------|
| E     | O <sub>1</sub> | X    | O <sub>2</sub> |

Symbols used in research plans was

E instead Experimental group

O<sub>1</sub> instead Testing knowledge, attitudes, and environmental ethics before teaching

O<sub>2</sub> instead Test of knowledge, attitude, environmental ethics after teaching

X instead Teaching environmental studies using research-based learning

2) Preparation before teaching, the researcher has prepared teaching documents, namely an environmental education learning plan, environmental knowledge test, environmental attitude test and environmental ethics test.

3) Take the pre-test with the environmental knowledge test, environmental attitude test and environmental ethics test created by the researcher.

4) The teaching was conducted using a environmental education learning plan with 6

steps, which were applied from the theory of Khammani (2004) as follows: Step 1: identifying the problem, Step 2: forming a hypothesis step, Step 3: prove and test the hypothesis, Step 4: gathered the data, step 5: analyzed the data, and step 6 summarized the results. The sample was 50 undergraduate students in the first semester of the 2020 academic year in Environmental Education program, Faculty of Environment and Resources studies, Mahasarakham University for a period of 1 semester (Table 2).

Table 2. Environment education learning plan using research-based learning

| Week                                                 | Topic                                          | Hours     |
|------------------------------------------------------|------------------------------------------------|-----------|
| 1                                                    | Recommended lesson plans and test before class | 2         |
| 2 – 3                                                | Learning Plan 1: soil resources                | 4         |
| 4 – 5                                                | Learning Plan 2: water resources               | 4         |
| 6 - 7                                                | Learning Plan 3: air pollution                 | 4         |
| 8 - 9                                                | Learning Plan 4: forest resources              | 4         |
| 10 - 11                                              | Learning Plan 5: wildlife resources            | 4         |
| 12                                                   | Learning Plan 6: conservation agriculture      | 2         |
| 13                                                   | Learning Plan 7: agriculture                   | 2         |
| 14-15                                                | Learning Plan 8: solid waste                   | 4         |
| 16                                                   | learning plan summary and test after class     | 2         |
| <b>Total number of hours throughout the semester</b> |                                                | <b>32</b> |

4.1) Have students observe the problem, ask questions, gather information, and analyze the problem and identify the real problem so that students can clearly identify environmental problems.

4.2) Let students make assumptions Identify the root cause and guess the answer to the problem and have evidence to support and make appropriate assumptions about the environment.

4.3) Have students prove and test the hypothesis, implemented processes and methods in design proving or testing appropriate hypotheses about the environment.

4.4) Have students collect information search for resources data collection methods and how create tools that are suitable for the environment.

4.5) Have students analyze the data. use of statistics determination of environmental measurement and assessment criteria.

4.6) Let students summarize the results along with presenting information from teaching and learning environment education.

5) Upon completion of the scheduled coursework take the post-test with the environmental education knowledge test, environmental attitude test and environmental ethics test which is the same set as the pre-test.

6) Analyzing the test after class by statistical methods to test the hypothesis.

7) The results of the development of teaching-learning activities in environmental education by using research-based learning revealed that the efficiency of environmental education learning plan was 92.43/86.45, which was higher than the 80/80 criterion set, and the effective index was 0.7813, indicating that the students had increased learning progress. 78.13%.

### Statistics used in research

Statistics were used in data analysis in this research. The details are as follows:

1) Basic statistics are frequency, percentage, mean, and standard deviation.

2) Statistics for testing the effectiveness of the tools were: the suitability of the environmental education lesson plan was Conformity Index Value, the difficulty of the environmental knowledge tests, the power to discriminate each item of the questionnaire, confidence value process efficiency values ( $E_1$ ), result efficiency values ( $E_2$ ), and effectiveness index (EI) values.

3) Statistics for testing results and hypotheses the statistical significance level of .05 for were Paired t-test, One-Way MANOVA, One-Way MANCOVA, Univariate Test and pairwise comparison according to the LSD method.

### Results

Teaching environmental education using research-based learning for undergraduate students can be summarized as follows:

1) Comparison of environmental knowledge, attitudes ethics of students before and after school, it was found that

1.1) The students had average scores on their knowledge of the environment. The overall pre-test level was at a moderate level ( $\bar{x}$ =30.44) and after studying, the students had

average knowledge scores at the highest level ( $\bar{x}$  =69.16). When comparing the average scores of environmental knowledges before and after school, it was found that after school, the students had higher average scores of knowledge than before school as statistically significance .05 ( $P<.05$ ).

1.2) The students had average scores on their environmental attitude found that before studying, the overall level was at the agreed level ( $\bar{x}$  =3.41) and after studying, the students had an overall average score at the highly agree level ( $\bar{x}$  =4.34). And after studying, the students had an overall average score at the highly agree level. It was found that after studying, the students had a average score on environmental attitude higher than before studying statistically significant .05 ( $P<.05$ ). (Table 3)

1.3) The students had average scores on environmental ethics before studying at the social level ( $\bar{x}$  =2.59). And after studying, the students had overall average scores at the level for goodness ( $\bar{x}$  =3.33). When comparing the average environmental ethics scores before and after studying, it was found that after studying, the students had average scores on environmental ethics higher than before studying statistically significant .05 ( $P<.05$ ). (Table3)

Table 3. The results of the comparison of the mean scores of environmental knowledge, environmental attitudes and environmental ethics of students before and after studying

| Menu                           | Pre-test  |      |            | Posttest  |      |                | t       | df | p     |
|--------------------------------|-----------|------|------------|-----------|------|----------------|---------|----|-------|
|                                | $\bar{x}$ | S.D. | Level      | $\bar{x}$ | S.D. | Level          |         |    |       |
| Environmental knowledge (N=80) | 30.44     | 6.41 | Moderate   | 69.16     | 2.68 | Highest        | -40.172 | 49 | .000* |
| Environmental attitude (N=5)   | 3.41      | 0.13 | Agree      | 4.34      | 0.12 | Strongly agree | -38.789 | 49 | .000* |
| Environmental ethics (N=4)     | 2.59      | 0.12 | For Social | 3.33      | 0.11 | For goodness   | -35.432 | 49 | .000* |

\* Statistically significant .05

2) The results of the comparison of environmental knowledge, attitude and ethics of students of different gender (Tables 4-6).

2.1) There were difference of the environmental knowledge, attitude and different environmental ethics of students of different gender statistically significant .05 (Table4).

Table 4. Results of the study of multiple variances in environmental knowledge, environmental attitude and environmental ethics of students of different gender using One-Way MANOVA

| Test statistics    | Value | Hypothesis df | Error df | F     | P     |
|--------------------|-------|---------------|----------|-------|-------|
| Pillai's Trace     | 0.163 | 3.000         | 46.000   | 2.979 | .041* |
| Wilks' Lambda      | 0.837 | 3.000         | 46.000   | 2.979 | .041* |
| Hotelling's Trace  | 0.194 | 3.000         | 46.000   | 2.979 | .041* |
| Roy's Largest Root | 0.194 | 3.000         | 46.000   | 2.979 | .041* |

\* Statistically significance .05

2.2) The results of the study revealed that there were no different of environmental knowledge and ethics students of different gender ( $p > .05$ ). There

was different of environmental attitudes of students of different statistical significance .05 (Table 5)

Table 5. The results of a one-way multiple covariance study of overall environmental knowledge, environmental attitude and environmental ethics after learning about students of different gender by pre-test is a common variable (One-Way MANCOVA)

| Early variable | Dependent variable      | SS    | df | MS    | F     | p     |
|----------------|-------------------------|-------|----|-------|-------|-------|
| Gender         | Environmental knowledge | 6.735 | 1  | 6.735 | .934  | .339  |
|                | Environmental attitude  | .091  | 1  | .091  | 7.270 | .010* |
|                | Environmental ethics    | .015  | 1  | .015  | 1.314 | .257  |

\* Statistically significant .05

2.3) The results of the study revealed that the results of the data analysis comparing the differences in environmental knowledge, attitude and ethics of the students with different gender, it was found that there was no different

of environmental knowledge and ethics of the students of different gender ( $p > .05$ ). There was different of environmental attitude of students of different gender statistically significantly .05 ( $p > .05$ ) (Table 6).

Table 6. The results of the comparison of environmental knowledge, environmental attitude and environmental ethics of students of different gender using by (One-way ANOVA)

| Dependent variable      | Gender | Quantity | One-way ANOVA |      |      |       |
|-------------------------|--------|----------|---------------|------|------|-------|
|                         |        |          | $\bar{x}$     | S.D. | F    | P     |
| Environmental knowledge | Male   | 16       | 68.63         | 2.73 | .934 | .339  |
|                         | Female | 34       | 69.41         | 2.66 |      |       |
| Environmental attitude  | Male   | 16       | 4.41          | .12  | 7.27 | .010* |
|                         | Female | 34       | 4.31          | .11  |      |       |

|                      |        |    |      |     |      |      |
|----------------------|--------|----|------|-----|------|------|
| Environmental ethics | Male   | 16 | 3.36 | .12 | 1.31 | .257 |
|                      | Female | 34 | 3.32 | .10 | 4    |      |

\* Statistically significant .05

3) Results of the study of multiple variances in environmental knowledge, attitude and ethics of students with different grades using by One-Way MANOVA. It was found that there

were no different of environmental knowledge attitude and ethics of the students with different grades  
( $p > .05$ ) (Tables 7-8).

Table 7. Results of the study of multiple variances in environmental knowledge, attitude and ethics of students with different grades using One-Way MANOVA

| Test statistics    | Value | Hypothesis df | Error df | F     | p    |
|--------------------|-------|---------------|----------|-------|------|
| Pillai's Trace     | 0.175 | 6.000         | 92.000   | 1.417 | .196 |
| Wilks' Lambda      | 0.829 | 6.000         | 90.000   | 1.417 | .198 |
| Hotelling's Trace  | 0.200 | 6.000         | 88.000   | 1.416 | .199 |
| Roy's Largest Root | 0.166 | 3.000         | 46.000   | 2.538 | .068 |

Table 8. The results of a one-way variance study in environmental knowledge, attitude and ethics of students with different grades using by Univariate Test

| Dependent variable      | Source of variance | SS      | df | MS     | F     | p    |
|-------------------------|--------------------|---------|----|--------|-------|------|
| Environmental knowledge | Contrast           | 40.285  | 2  | 20.143 | 3.030 | .058 |
|                         | Error              | 312.435 | 47 | 6.648  |       |      |
| Environmental attitude  | Contrast           | .024    | 2  | .012   | .840  | .438 |
|                         | Error              | .669    | 47 | .014   |       |      |
| Environmental ethics    | Contrast           | .024    | 2  | .012   | 1.059 | .355 |
|                         | Error              | .541    | 47 | .012   |       |      |

## Discussion

Teaching environmental education using research-based learning(RBL) for undergraduate students found that there were issues to discuss the following results:

1) Teaching environmental education using research – based learning has been developed by emphasizing the insertion of environmental knowledge through teaching and learning activities in environmental education, starting from observing problems, asking questions, collecting data, analyzing problems, identify the real problem clearly hypothesized, identify the root cause and guess the answer to the problem. There is evidence to support and make appropriate assumptions, proof test

hypothesis, apply the process and method to the design, proving or testing a suitable hypothesis search for resources, data collection method and how to create the right tools analyze data use of statistics, determination of measurement and evaluation criteria, summarizing results and presenting information from teaching and learning environment education. using research based learning which is consistent with the concept of Sinlarat (2012) said that research-based learnig is a teaching method that supports the concept of student-centered learning management, encourage learners to seek knowledge by themselves the nature of research-based learning management emphasizes on promoting learners with basic skills necessary

for conducting research by applying the research content along with teaching the research process step-by-step sequentially until learners develop skills in conducting research properly. Saiyot and Saiyot (1995) said that it was a systematic process of investigating the truth about natural phenomena. There is a recording observation control, organizing information analysis and interpretation to obtain facts that can be used to draw conclusions linking the relationship of that phenomenon and use the results to develop or create rules theories that allow controlling or predicting events. Suwanwela (2003) said that it is the acquisition of knowledge that creates new knowledge in each field and research process also allows the researcher to plan, prepare and operate systematically until the truth is discovered create new, accurate and useful knowledge. This is consistent with the research of Chumsukon and Pitak (2016) found that the results of the research-based learning activities (RBL) in teaching the course of education for environmental development. As a result, the students had more knowledge about the environment. Viphatphumiprathes (2014) found that the effect of research-based learning on knowledge regarding the students' ASEAN culture, the students had more knowledge. Dejamonchai and Dansawat (2012) found that the results of using integrated learning units based on research in intermediate French 1 course for undergraduate students Thammasat University having more knowledge. Thongaim (2018) found that knowledge development understanding and research skills of students in organizing research-based learning activities and the librarian. Khumraksa and Rakbumrung (2020) found that the study of behavioral patterns of learning by using scientific process skills to learn through research-based learning activities was the base of science teacher students: hypothesis and experimental skills. Therefore, the transfer process with the use of an environmental education lesson plan using research as a learning base effective and effective, the students will be more knowledge about the environment.

2) The results of the comparison of environmental knowledge, attitude and ethics of students before and after studying by using

research based learning for undergraduate students, it was found that

2.1) After studying, students have higher average scores on environmental knowledge than before studying. As a result of teaching and learning activities, there is research-based learning. The procedure developed by the researcher is as follows: 1) study environmental problems, 2) establish a learning hypothesis, 3) prove and test the learning hypothesis, 4) collect data from the learning, 5) analyze the data, and 6) summarize the learning results. According to the curriculum content, linked to research-based learning, this learning encourages learners are more interested in the subject they are learning, resulting in higher academic achievement in that subject. Because it is a study that is not boring and monotonous have fun showing students' potential, but most importantly, it's a change in personality. Change a person's point of view to think which is different from other types of learning this kind of learning leads to change which is consistent with the concept of Khammanee (2009) said that it is a situation of learning management that allows learners to use the research process or research results as a tool for learning various content, which may be used to process research (research review) to accompany the teaching of content use the research results as the content in learning; use the research process to study the content or let students do research directly or help practice various research skills for learners. Sitichinda (2017) said that applying the research process or research results as a basis for management learn or use the research process as a tool for acquiring knowledge to enable students to develop their research process skills and self-study by teachers or teachers using a variety of teaching methods leading to the creation of desirable characteristics to occur to learners. Phukiat (2009) said that it is the process of developing learners to be able to use the research process as a tool for acquiring knowledge. They come up with answers and make their own learning decisions and provide learners with the ability to learn and use the scientific process to seek new knowledge or search for words. It is reliable answer by relying on the investigative process in the sciences related to the subject being studied

to conduct a search, prove, test, collect and analyze data. This is consistent with the research of Chumsukon and Pitak (2016); Ramsiri and Nillapun (2015); Kittheerawutwong and Saeta (2014); Wangkaewhiran (2019); Jiraro et al. (2020); Art-in (2014); Ittichinnapat, et al (2016) found that after teaching by research-based learning (RBL) students have higher knowledge than before teaching. And some are consistent with research by Theeranut, et al (2019) and Dejamonchai (2013) using research – based learning for students found that after teaching students have knowledge more than before teaching, so it shows that students who study using research - based learning as a result, they have more environment knowledge.

2.2) After studying, students had higher average scores on attitude towards environment than before studying. This is a result of teaching and learning environment education using research – based learning. The students practiced doing research. It is teaching by having students participate in a research project with an instructor or as an assistant in a research project. So, they will participate in collecting information and analyze data how to set up a problem-solving method, findings, and applying the findings for further study. It makes students understand the research process more and the teachers as well as make the teachers not bored of having to teach the same content which is consistent with the concept of Phithiyanuwat and Boonterm (1997) said that the guidelines for teaching and learning by emphasizing the research process that the research process is a research method for obtaining research results and research results. It is the result of the operation. Therefore, it is guideline for using research in teaching and learning. Therefore, it consists of using research results and using research processes in teaching and learning. The RBL educational management model has a teaching and learning management model consisting of learning the research results. Royal (1999) said that the tendency that a person acquires or learns and become a role model for showing support or hostility towards something or someone. The posture or attitude seen in the behavior is either an approach or a withdrawal, and therefore the object of the reaction may have a positive or a negative value in its individual

sense person. Allport and Gordon. (1967) said that this state of mental readiness determines the direction of a person's response to a person's thing or related situations and Sothanasathien (1990) said that it is an index of how a person thinks and feels about people around him, objects or environments and situations. Attitude is based on beliefs that may influence future behavior. Therefore attitude is merely readiness to respond to stimuli and it is a dimension of evaluation to show whether you like it or not to an issue, which is considered in-person communication (Interpersonal Communication). That is the effect of exposure that will affect behavior further. This is in line with research by Wongchantra (2015); Champapho, Wongchantra and Sali (2016); Anuwongnawarat (2008); Tigam (2014); Hsin and Larry (2005); Ozgu, et al. (2004); Wongchantra, et al. (2016); Pronyusri, Boonserm and Junkaew (2021); Phakeewai and Wongchantra (2020); Natphong, Boonserm and Paimmee (2021) found that after learning, their attitudes towards environmental conservation were higher than before learning. It shows that students who learn by using research - based learning having resulted in an increased attitude towards the environment.

2.3) After learning, the students had higher average scores on environmental ethics than before learning. This is a result of teaching and learning environment education using research - based learning. The researcher developed 8 plans: soil resources, water resources, air pollution, forest resources, wildlife resources, conservation agriculture, agriculture and solid waste management. Environmental education learning is also a process that leads to creating opportunities for students to participate in activities in creating knowledge, attitudes, attitudes, values, skills, and participation in solving environmental problems. It starts from the opportunity to jointly find problems, jointly decide, jointly plan, jointly solve problems through the process of environmental education, it will result in the implementation of various activities related to the environment. This make students accept and pay attention from the development to have sustainability, which is consistent with the concept of Saiyot (1999) said that the content of ethics set by school or society and these content that is considered good

teaching to learners or people in society to behave and when practiced, it will make the society live happily both oneself and others what society teaches is the content that should be known first. Teaching this knowledge schools or colleges will use the most because they have subjects with a lot of ethical content involved creating this kind of exam is a measure of learning achievement. Tests may be explanatory, complete, matching, and answer choices depending on the purpose of the exam. Lawrence (1981) said the focus was on learning that leads to environmental appreciation, altruism and conservation of natural resources known as environmental ethics. Weerawattananon (2003) said that to lead to guidelines for creating environmental ethics by teaching and teaching to appreciate the importance of the natural environment to know that the environment is very important to the existence of human life. Wongchantra (2011) said that to lead to guidelines for creating environmental ethics by teaching and teaching to appreciate the importance of the natural environment to know that the environment is very important for the existence of human life. This is consistent with the study results of Wongchantra, et al. (2017) in order to conduct a search, prove, test; Lauprasert (2019); Sithichok, T. and Sirisamphan (2017); Shouchupon (2014); Yasa, et al. (2015); Chaisantaow, Boonserm and Sookngam (2021); Ritsumdaeng, Boonserm and Sookngam (2021) found that after learning, undergraduate students environmental ethics environmental ethics higher than before learning. Therefore, it was shown that the students who learned using research - based learning resulted in the students having more environmental ethics.

3) The results of the comparison of environment knowledge, attitude and ethics of students of different gender, it was found that

3.1) There was no difference of score of environmental knowledge of the students of different gender. This may be because gender factors do not affect the environmental knowledge which teaching environmental education using research- based learning. Knowledge is transferred with equality whether male or female including the process used in teaching and learning. There are a variety of activities and is a process that enables students to

learn about the environment surrounding all aspects to develop knowledge until it becomes learning Which is consistent with the concept of Wongchantra et al. (2016) said that the transfer of knowledge on the environment is the introduction of knowledge from the knowledge source to the target population through media, tools and equipment with thematic processes and methods as the main focus. Pornkul (2009) said that the learning management plan is a guideline for pre-written teaching and learning activities make teachers ready and ensure that the teaching can achieve the goals set and the teaching process is smooth. Soonthornwirot (2010) said that the learning management plan is a plan for learning activities learning management using learning management media assessment. So, assessments are consistent with the content and objectives set out in the curriculum or in other words. The learning management plan is a map created from the teacher's manual or learning management guidelines of the Department of Academic Affairs let learning managers know which content to manage for what purpose how to manage learning, what media to use, and how to measure results. This is consistent with the research by Sutthiboon, Thamsenanupap and Wongchantra (2015); Kim, et al. (2016) found that both males and females were knowledgeable so there was no difference in understanding of household waste segregation. Qutami (2005) found that the there was no difference of the relationship between cognitive thinking methods of students of different gender. Suksringarm, Singseewo and Appamraka (2019) found that there was no difference of knowledge about social and environmental issues of the students of different gender. Sripuna, SeKhao and Sananworakiat (2015) found that there was no difference of knowledge about tourist attractions and conservation of the environment of students of different gender. Chitkaew (2016) found that there was no difference of the organization of the environment conducive to learning of students of different gender. Amphaphon and Chanrungruang (2018) found that there was no difference of the basic factors affecting the level of need for self-development of knowledge of students of different gender. Waichalad, and Phoklang (2014) found that there was no difference of teaching and learning management

of students of different gender in the Bachelor of Science program in the Faculty of Environment and Mahidol University Resources. Pronyusri, T., Boonserm and Junkaew (2021) found that there was no difference of environmental of students of different gender. So, it shows males and females when learning through research - based learning as a result, there was no difference of the environmental knowledge.

3.2) There was different of different attitudes towards environment of students of different gender. This may be because attitude is a matter of the mind, attitude, and thoughts and individual inclinations. This can be both positive and negative. Attitudes affect behaviors. It can be seen that attitudes consist of thoughts that affect emotions and that feeling out through different behaviors which is consistent with the idea of Sothanasathien (1990) said that it is an index of how a person thinks and feels about people around him, objects or environments and situations. Attitude is based on beliefs that may influence future behaviors. Attitude is therefore merely readiness to respond to stimuli and is a dimension of assessment to show that you like or dislike a point which is considered in-person communication. Interpersonal communication is the effect of exposure to further behavior. Thurstone (1928) said that attitude is the whole category of human beings about feelings, prejudices, thoughts, fears of something, oral expression is an opinion, and this thought is a symbol of attitude. It states that attitudes linked to a person's behavior are the complexity of a person's feelings or biases to create readiness to do something. according to the experience of that person and the propensity to react to something positively or anti-environment in one way or another. This is consistent with the study results of Wongphimsorn and Wongchantra (2021) found that there was difference of attitudes towards the environment of students of different gender. Tuengsuk, Sangarwut and Vichaidit (2021) found that there was difference of attitudes towards solid waste management of family members of different gender. Lertwisutphaiboon (1993) found that that there was difference of attitudes about the environment of students of different gender Mareyam (2013) Therefore, it is shown that males and females when undergoing research-

based learning, this results in different attitudes towards the environment.

3.3) There was no difference of score of environmental ethics of students of different gender. This may be because environmental conservation and environmental protection are practicable for all genders on an individual level which can be practiced by any gender, so there is no gender difference in relation to environmental ethics. It is a research-based learning management mode. It is learning from research and discover facts in self-study subjects. The results of the research were tools for learning the subject matter by using research processing and using the investigation process in the sciences related to the research subject in the conduct of searching, proving, testing, collecting data and analyze the data. This is consistent with the concept of Lawrence (1981) said that ethics is the basis of justice which adheres to the equitable distribution of rights and duties. The activities consist of tasks and obstacles that must be coordinated by everyone in the group in carrying out the activity. Including competitions in which all groups must do missions under pressure that will motivate their enthusiasm in doing activities and add fun and interest in learning committee activities where the area will be the medium. As a result, students have environmental ethics. Banjongchit (2008) said that it is an instructional model that encourages learners to participate in learning to solve problems including the arrangement of the environment. It is learning that allows and gives learners the opportunity to seek and build their own knowledge through activities with the goal of learning activities for students to have an ethical environment. This is consistent with the results of a study by Guricin and Omer (2020) found that there was no difference of the level of awareness of environmental ethics of teacher candidates with different gender. Keles and Ozer (2016) found that there are no different levels of environmental ethics of teacher students from 12 universities in the 3<sup>rd</sup> year and 4<sup>th</sup> year science with different gender. Anastasia Goulgouti Aikaterini Plakitsi and Georgios Stylos (2019) found that there was no difference of environmental behaviors of pre-employment teachers of different gender. Jaiyen (2013) found that there was not difference of the behavior of

environmental ethics of students with different heterosexual. Thinkhamchoet, Wongchantra and Bunnaen (2021) found that there was no difference of score of environmental ethics of male and female students. Therefore, it shows that the teaching and learning activities of environmental education using research-based learning is effective in developing environmental ethics of students participating in learning activities. The learning process is in accordance with the principles and processes of environmental education and students of different gender affecting the level of environmental ethics being not different.

4) The results of the comparison of knowledge about the environment environmental attitude and environmental ethics of students with different grades, it was found that

4.1) There was no difference of score of environmental knowledge of students with different grades. It is an activity that focuses on allowing students to learn by using research-based learning. All students participated in activities equally and equally along with exchanging knowledge has been learned or has gained past experience have the ability to remember and recall the subject matter in accordance with the educational environment which is consistent with the concept of Wangpanich (1983) said that when people have been told stories from learning, practice, training and that have been seen through various senses. This will let you know the facts or details of the story that will be the experience of a person which will be accumulated and passed on for generations to become knowledge memorization measures. Therefore, it needs to measure the ability to recall stories, facts, or experiences or measure recollection by experience. Bloom, et al. (1971) said that matters relating to the recall of a particular thing methods and processes, including the model of the knowledge objective program focusing on the psychological processes of memory. Which is a process that is connected to the organization. Suwan (2001) said that it is the primary behavior that learners remember either by seeing or by seeing, hearing and remembering. Knowledge is at this stage includes knowledge of definitions, facts, theories, structural rules, methods of solving these problems, etc. This is consistent with the

results of a study by Petchsom (2016) found that there was no difference of score knowledge of environmental processes of the students with difference grade. Sripuna, SeKhao and Sananworakiat (2015) found that there was no difference of score of environmental conservation of students with difference grade. Waichalad and Phoklang (2014) found that there was no difference of knowledge of resource management, facilities and environment of students in the Bachelor of Science program in the Faculty of Environment and Resources, Mahidol University with different grades. It showed that when undergoing research-based learning as a result, there is no difference in environmental knowledge.

4.2) There was no difference of score of environmental attitude of students with different grades. It is a result of the teaching style to have complete content and in accordance with the objectives set according to the teaching plan of environmental education by using research-based learning for transferring knowledge to students. In which the teacher has a teaching process that focuses on the learners to collect information and analyze data, how to set up a problem, methods for solving research problems, and applying the research results for good and appropriate benefits causing students to receive learning differently. It is consistent with the notion of Thurstone (1928) said that attitude is the whole human category of feelings, prejudices, thoughts, fears of something, oral expression of thought (opinion). This idea is a symbol of attitude, so if you want to measure attitude. This can be done by measuring how a person thinks of things. Murphy, Murphy and Newcomb (1937) and Kretch and Crutchfield (1937) said that attitude is the sum of processes that produce the motivating, emotional, accepting and cognitive states of which these processes are part of the experience of person. This is consistent with the study of Warasunan (2013) found that there was no difference of attitude of students being developed of indicators of knowledge in measuring and evaluating with difference grade. Alkharusi, Kazem, and Al-Musawai (2011) found that there was no difference of attitude of students who practiced teaching profession with difference grade. Yanderm (2009) found that there was no

difference in the attitudes towards teaching and learning social composing of students with difference grade. Janha, and Prabaripai (2015) found that there was no difference of attitudes of master's degree students study at the level at Kasetsart University with difference grade. Hsin-Ping and Larry (2005) found that there was no difference of attitudes of students with difference grade. Ozgul, et al. (2004) found that there was no difference of environmental attitudes of students who have different grades. It showed that when undergoing research-based learning as a result, there are no difference environment al attitude.

4.3) There was no difference of environmental ethics of students with different grades. This may be because students studying in the same course with similar cumulative grades would have environmental ethics in the same direction which is designed for students to create experiences from learning from real space. Along with inserting the concept of environmental ethics through learning activities about the environment, which is consistent with Sorasuchat (2015) said that behavioral qualities that society expects people in society to behave. It is correct in behavior having freedom within the boundaries of conscience which is a duty that members of society should conduct themselves, others, and society in order to create a prosperous society. Practice must know what is right and what is wrong. Integrated Management Committee General Education Section (2004) stated that one of the principles of behavior towards the environment that contributes to the existence of ecological equilibrium in the environment and contributing to all things that rely on the environment to survive without losing the relationship between oneself and the environment which environmental ethics are indistinguishable from the ethics of life, society and community by its own potential. It is the main factor in connecting life, community, society and the environment for sustainable and integrated existence. Wongchantra (2011) said that to create and instill in people a good consciousness of the natural environment. This will result in less environmental problems or less until reaching a level of balanced environmental development between humans, sustainable society and environment and not losing balance

which in part corresponds to the results of the study of Trongsitthirak (2003); Frederique (2007) and Netwong (2012) found that there was no different of environmental ethics of students with different grades. Inthongpan and Suhajcho (2015) found that there was no different of moral principles of students with different grades. Suwanpradit, et al. (2018) found that there was no difference in ethics of the students with different grades. It showed when undergoing research-based learning as a result, there is no difference in environmental ethics.

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