Teaching of Environmental Education on Water Resource Management Using Team Work- Based Learning (TWBL)

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Abstract

The purposes of this research were to develop an effective and efficient environmental education lesson plan on water resource management using Team Work-Based Learning (TWBL), study and compare knowledge, attitude, and environmental ethics before and after the learning, and examine students of different genders. The study sample comprised 27 students in Primary 4/4 at Anubanmuangatsamat School, Roi Et Province, selected by simple random sampling. The research instruments include an environmental education lesson plan on water resource management using TWBL, a knowledge test, an attitude test, and an environmental ethics test. The statistical methods used for data analysis were frequency, percentage, mean, standard deviation, content validity, reliability, index of discrimination, difficulty, and Paired t-test, F-test (One-Way MANOVA). The research showed that 1) The environmental education lesson plan was an effectiveness score of 81.23/86.91. The effectiveness index (E.I.) was 0.5283. This indicates that students gained more knowledge, leading to an improvement in their academic progress after the learning 52.83%. 2) After the learning, students' average scores on knowledge, attitudes, and environmental ethics were higher than before the learning, statistically significant ($p > .05$). 3) There was no difference between the scores of knowledge, attitude, and environmental ethics of students with different genders.

Keywords: water resource management, team work- based learning, knowledge, attitude, environmental ethics

1. Introduction

Water is life, being a vital component of the body and essential for survival. The primary drinking water sources for Thais are surface water and groundwater. However, these water sources are contaminated by household wastewater, agricultural wastewater using chemicals, and industrial wastewater containing chemicals and heavy metals. It is estimated that 33.33% of Thailand's surface water sources are not of good quality for consumption or other uses. Thailand's major groundwater sources are located in the central plains surrounding Bangkok, and are used for consumption and other purposes. However, climate change and droughts caused by prolonged periods without rainfall have led to a decrease in both surface and groundwater volumes in the central plains. This also affects agricultural production, which uses a large amount of water, up to 70% of the total water supply, making it more dependent on water from dams in the lower northern region. Flooding, in particular, causes severe damage to livestock and crops, ultimately impacting economic growth, quality of life, and public health (Vichaisarn et al., 2021).

Severe water shortages are predicted in Thailand as a result of population growth and rapid industrial expansion. This affects water quality; the decrease in the amount of clean water and environmental problems leads to pollution and wastewater issues. Natural water sources are deteriorating, contaminated with waste and chemicals discharged from industrial plants and household wastewater. These are all problems that affect the health, quality of life, and living standards of all people. Solving water resource management problems is effectively and efficiently requires long-term planning combined with participatory water and environmental conservation from all sectors. This will lead to sustainable water management (Kongkaew, 2011).

Water management is a crucial science that supports the achievement of agricultural productivity goals. Proper and

appropriate water management, considering weather conditions, soil type, crop type, and available water resources, is not difficult, as numerous important factors must be considered. Many of these factors are variable due to natural influences; some can be controlled, while others, like drought or flooding, are uncontrollable. It is difficult to predict when and how severe such natural events will occur. Such natural influences are a major cause of production losses and consequently affect the country's economic standing, which is heavily reliant on agricultural output (Eiamprasertkun, 2020).

Environmental education includes teaching and learning activities that provide knowledge and skills in disseminating environmental knowledge. Students will be able to transfer this knowledge to others. The transfer of environmental education knowledge involves conveying information to a target population through any method that allows knowledge to flow freely, ensuring the target population receives a comprehensive understanding of the environment. They can think, act, and solve environmental problems, and there are various methods of environmental knowledge transfer (Wongchantra, 2011).

Team Work-Based Learning (TWBL) is a teaching methodology that can develop students' analytical thinking skills and self-directed learning abilities. This is a teaching and learning model that emphasizes collaborative and creative learning, working together in small teams based on individual differences, with clearly defined goals. Within the team, shared responsibilities and positive interactions contribute to the development of students' cognitive skills to a higher level. Social support for at-risk students fosters interpersonal development and teamwork skills, which are considered crucial for student growth (Suwannachada, 2019).

Therefore, environmental education is extremely important today due to the increasingly severe environmental problems. Teamwork is an effective learning method for raising awareness and enhancing collaborative skills. This plays a crucial role in environmental education and can be applied in teaching to help students understand environmental issues from various perspectives and develop problem-solving abilities through collaborative work.

2. Method

2.1 Objective

1) To develop an environmental education lesson plan on water resource management using Team Work-Based Learning (TWBL), based on established efficiency and effectiveness criteria.

2) To study and compare the knowledge, attitudes, and environmental ethics regarding water resource management using TWBL before and after the learning.

3) To study and compare the knowledge, attitudes, and environmental ethics of students with different genders.

2.2 Population and sample

1) The population used in this study consisted of 130 students in the fourth grade at Anubanmuangatsamat school, Roi Et province, comprising 58 males and 72 females.

2) The sample were 27 students from class 4/4 at Anubanmuangatsamat school, Roi Et province, selected by simple random sampling.

2.3 Variables Studied

1) Independent variables: teaching environmental education on water resource management using TWBL and gender.

2) Dependent variables: knowledge about water resource management, attitudes towards water resource management, and environmental ethics.

2.4 Research Tools

1) Tools for dissemination: an environmental education lesson plan on water resource management using TWBL.

2) Tools for measurement and evaluation: knowledge test on water resource management, attitude test towards water resource management, and environmental ethics test.

2.5 Construction and Evaluation of Learning Tools

1) Reviewing research documents related to teaching and the creation of a test on water resource management using TWBL.

2) Defining the scope and structure of the content for environmental education teaching and creation of a test on water resource management using TWBL, with the following details:

2.1) TWBL involves planning the process from pre-teaching, where the instructor prepares and conducts the lesson, and finally evaluates the learning process by having students assess their teammates. In TWBL, the teacher's role is that of a facilitator of student learning (Sinthuchai et al., 2020), as detailed below:

- Pre-teaching preparation phase includes: 1) writing learning objectives, 2) forming teams, and 3) preparing learning resources.

- Teaching phase includes: 1) assigning self-study tasks, 2) ensuring students' readiness, and 3) applying knowledge to solve problems from real-world situations.

- Evaluation phase: Peer evaluation within the team.

2.2) Environmental education lesson plans on water resource management using TWBL consist of 5 plans, with a total of 5 teaching sessions, each lasting 3 hours, for a total of 15 hours. Using TWBL, there are a total of 5 lesson plans, consisting of 5 lessons, each lasting 3 hours, for a total of 15 hours. These include:

Lesson Plan 1: Constructing check dams

Lesson Plan 2: Constructing retention ponds

Lesson Plan 3: Constructing dams

Lesson Plan 4: Excavating water storage ponds

Lesson Plan 5: Wastewater treatment using water hyacinth

2.3) The knowledge test consists of 30 multiple-choice questions (A, B, C, and D) with a total of 30 points.

2.4) The attitude test consists of 20 multiple-choice questions (Agree, Unsure, and Disagree) requiring students to mark a check mark in a table according to their opinion.

2.5) The environmental ethics test consists of 20 multiple-choice questions (A, B, C, and D) with the following four options: for myself = 1 point, for relatives and friends = 2 points, for society = 3 points, and for correctness and goodness = 4 points.

3) They were presented to three experts. Upon reviewing the content validity (IOC) of them, the average value was 1.00, indicating their suitability for use.

4) Conduct a try-out of it and test with students in Grade 4/3 at Anubanmuangatsamat school, Roi Et province. The results can be analyzed as follows:

4.1) The knowledge test was evaluated for difficulty index, finding values ranging from 0.60 to 0.80. The discrimination index for each item ranged from 0.31 to 0.85. The reliability index of the entire test, calculated using Cronbach's alpha coefficient, was 0.915, which means the knowledge test meets the criteria.

4.2) The attitude test was evaluated for item discrimination index, finding values between 0.30–0.67. The reliability index of the entire scale, using Cronbach's alpha coefficient, was 0.744, which means the attitude test meets the criteria.

4.3) The environmental ethics test was evaluated for the item discrimination index, finding values between 0.30–0.58. The reliability index of the entire instrument, calculated using Cronbach's alpha coefficient, was 0.715, which means the environmental ethics test meets the criteria.

5) Improve and refine the tools to make them more complete, and then use them to collect data.

2.6 Data Collection for the Research

In TWBL, the instructor prepares before teaching, conducts the lesson, and finally, evaluates the students by having them assess their teammates. The steps are as follows:

- Pre-teaching preparation phase:

1) Writing learning objectives. The researcher defined the learning objectives as follows: (1) to enable students to know about water resource management. (2) To enable students to have an attitude towards water resource management. (3) To enable students to have environmental ethics.

2) Team formation: The students involved were 27 students from Grade 4/4, Anubanmuangatsamat school, Roi Et province. They were divided into 5 teams: 3 teams of 5 students each and 2 teams of 6 students each.

3) Preparation of learning resources, including a lesson plan, knowledge tests, attitude test, and environmental ethics test.

- Teaching phase:

4) Assigning independent study tasks: the instructor assigned students to conduct independent research on the topic of water resource management in assigned teams. A lesson plan was distributed, and students were assigned to research the content related to water resource management independently, along with completing a pre-test.

5) Guaranteeing student readiness: students take individual mid-course tests and complete group worksheets, along with discussing and exchanging ideas with team members. The instructor summarizes key concepts related to water resource management.

6) Applying knowledge to solve problems from real-world situations: each team completes a worksheet, and their answers are discussed within the team and presented to all teams. The instructor poses questions about water resource problems and their solutions, encouraging each team to discuss and find answers, then present their findings to the class. The instructor then summarizes the key concepts for the students.

- Evaluation phase:

7) Peer evaluation: each team will evaluate their own performance by giving each other equal scores, and also take a post-test.

2.7 The Data Analysis Statistics

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

2) Statistics used to test instrument effectiveness: content validity (IOC), reliability index, discrimination index, difficulty index, process efficiency index (E_1), outcome efficiency index (E_2), and effectiveness index (E.I.)

3) Hypothesis testing statistics: Paired t-test, F-test (One-Way MANOVA) statistically significant ($p > .05$).

3. Results

3.1 The Results of the Performance Study Based on the 80/80 Criterion and the Effectiveness Index

The analysis of the environmental education lesson plan on water resource management using TWBL revealed that the students' mid-test score was 658; mean = 23.37 (81.23%), and a post-test score was 704; mean = 24.92 (86.91%). (As shown in Table 1.)

The E.I. of the environmental education lesson plan was 0.5283, meaning that students' knowledge increased, resulting in a 52.83% improvement in learning after the instruction. (As shown in Table 2.)

Table 1. Effectiveness Values of the Environmental Education Lesson Plan on Water Resource Management Using Team Work-Based Learning (E_1/E_2)

Activity	Full Score	Mean	S.D.	Percentage of Average Score	Criterion
E_1	30	23.37	1.77	81.23	It meets the criteria
E_2	30	24.92	1.59	86.91	It meets the criteria
The effectiveness of the lesson plan was 81.23/86.91					

Table 2. The Effectiveness Index of the Environmental Education Lesson Plan on Water Resource Management Using Team Work-Based Learning

Pre-test	Post-test	Number of students	Maximum	E.I.
648	704	27	30	0.5283

3.2 Results of the Study and Comparison of Average Scores on Knowledge, Attitudes, and Environmental Ethics

The results and comparison of average knowledge scores revealed that students' average scores of knowledge regarding water resource management before the intervention were at a moderate level ($\bar{x}$ = 19.35), and after the learning, their average scores of knowledge were at a high level ($\bar{x}$ = 24.92). Comparison of average knowledge scores before and after the learning showed that after the learning, students' average scores were statistically significantly higher than before the learning ($p > .05$). (As shown in Table 3.)

Table 3. The Results of the Analysis and Comparison of the Average Scores of Knowledge about Water Resource Management Using Team Work-Based Learning, Using a Paired t-test (n = 27).

Item	Before		Level	After		Level	t	df	P
	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Knowledge (N=30)	19.35	2.89	Moderate	24.92	1.59	High	-7.427	26	.000*

* statistically significant level of .05

The results and comparison of average attitude scores toward water resource management revealed that students' overall average attitude scores found that before the learning, it was in the agree level ($\bar{x}$ = 2.55), and after the learning, it was in the agree level ($\bar{x}$ = 2.95). Comparing the average attitude scores before and after the learning, it was found that after the learning, students' average scores of attitudes were statistically significantly higher than before the learning (p > .05). (As shown in Table 4.)

Table 4. The Results of the Analysis and Comparison of the Average Scores of Attitude Scores Towards Water Resource Management using Team Work-Based Learning, Using a Paired T-Test Before and After the Learning (n = 27)

Item	Before		Level	After		Level	t	df	P
	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Attitude (N=3)	2.55	0.82	Agree	2.95	0.20	Agree	-12.788	26	.003*

* statistically significant level of .05

The results and comparison of average environmental ethics scores revealed that before the learning, students' overall average scores of environmental ethics were at the level of for society ($\bar{x}$ = 2.56), and after the learning, their overall average scores of environmental ethics were at the level of for correctness and goodness ($\bar{x}$ = 3.95). Comparing the average scores of environmental ethics before and after the learning, it was found that after the learning, students' average scores of environmental ethics were statistically significantly higher than before the learning (p > .05). (As shown in Table 5.)

Table 5. The Results of the Analysis and Comparison of the Average Scores of Environmental Ethics Using Team Work-Based Learning, Using a Paired T-Test Before and After the Learning (n = 27)

Item	Before learning		Level	After learning		Level	t	df	P
	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Environmental ethics (N=4)	2.56	0.25	for society	3.95	0.17	for correctness and goodness	-8.140	26	.000*

* statistically significant level of .05

3.3 Results of Knowledge, Attitudes, and Environmental Ethics Among Students of Different Genders

Table 6. The Results of a Multivariate Analysis of Knowledge, Attitudes, and Environmental Ethics between Students of Different Genders Using a One-Way MANOVA

Test statistics	Value	Hypothesis df	Error df	F	P
Pillai's Trace	.114	3.000	23.000	.986	.417
Wilks' Lambda	.886	3.000	23.000	.986	.417
Hotelling's Trace	.129	3.000	23.000	.986	.417
Roy's Largest Root	.129	3.000	23.000	.986	.417

The study of knowledge, attitudes, and environmental ethics among students of different genders revealed no significant differences. (As shown in Tables 6 and 7.)

Table 7. The Results of a One-Way Comparison of Knowledge, Attitudes, and Environmental Ethics Between Students of Different Genders Using a Univariate Test

Independent variables	Dependent variables	ss	df	MS	F	P
Genders	Knowledge	.053	26	.002	.039	.846
	Attitudes	.154	26	.006	1.571	.222
	Environmental ethics	6.807	26	.259	1.260	.272

4. Discussion

4.1 The Results of Developing an Environmental Education Lesson Plan on Water Resource Management Using Team Work-Based Learning (TWBL)

The study on the effectiveness and efficiency of environmental education lesson plans on water resource management using TWBL, consisting of 5 lesson plans: constructing check dams, constructing retention ponds, constructing dams, excavating water storage ponds, and wastewater treatment using water hyacinth, found that the effectiveness was 81.23/86.91, which met the set criteria of 80/80. The effectiveness index was 52.83, meaning that students gained more knowledge and showed a 52.83% improvement in their learning after the instruction. This is with the concept of Munkham (2007), who states that it is a process that enables trainees to acquire knowledge, understanding, skills, and appropriate attitudes regarding the training subject, until the trainees learn and can change their thinking and effectiveness. Furthermore, using the E1/E2 criterion to evaluate a teaching package enables measurement of its overall effectiveness and specific aspects for each objective. This results in clear measurement results, and the data obtained can be used to make decisions without needing to use other methods that would cause duplication. And Chombodin (2001) said that in the social sciences, performance efficiency refers to the inputs that consider the effort, readiness, ability, and fluency of the performer in a task, compared to the outputs, which are satisfaction or the achievement of set objectives. And Kunmuangnoi (2004) said that it has been explained that efficiency is similar to effectiveness, but effectiveness considers any method or alternative in terms of its ability and success in achieving results, unlike efficiency, which is a comparison between the inputs or resources used and the achievement of the goal of that alternative. In addition to being assessed by comparing the inputs or resources used to the achievement of the goal of the method or alternative, efficiency can also be considered solely in terms of the quantity or quality of the output or result, or it can consider both the quantity and quality of the resources used. This is consistent with the research by Photibuatong & Boonsom (2021), who studied the development of health education activities with team-based learning for health promotion of ninth-grade students, found that the effectiveness of health education activities combined with team-based learning to promote well-being was 83.80/82.10. And Panngoen et al. (2012) studied the development of a blended instructional model on soil water and forestry conservation, found that the lesson plans using the blended learning approach are of the highest quality and have an effectiveness rating of 87.31/92.08. And Waenpetch & Rattanasilchai (2022) studied the development of lesson plans about the environment in the province by using the 4MAT teaching technique for students in grade 4 at Banthaluksansai School, found that the lesson plan was 90.10/82.58 effective, exceeding the set standard (80/80). The learning achievement was an E.I. of 0.67, indicating that students' knowledge increased after learning about the environment in the province using the 4MAT teaching technique. And Wongchantra et al. (2022) studied the effect of environmental education learning for enhancing rivers management in the northeast of Thailand using community-based learning found that plans were the efficiency of 81.08/85.43, the efficiency index was 0.7709. This showed that the students could increase their knowledge, resulting in the students progressing from their studies, which accounted 77.09%.

4.2 The Study Compared Knowledge, Attitudes, and Environmental Ethics Regarding Water Resource Management Using Team Work-Based Learning (TWBL) Before and After the Learning

4.2.1) The study, which compared knowledge about water resource management using TWBL approach, found that students' average scores on overall knowledge about water resource management before the lesson were at a moderate level, and after the lesson, their average scores on overall knowledge about water resource management were at a high level. A comparison of the average knowledge scores before and after the lesson revealed that students

had significantly higher average scores after the lesson than before the lesson, at a statistically significant level of .05. This is consistent with the concept of Suwan (1999), who explained that knowledge is a basic behavior that students possess simply by understanding it. This may be achieved through thinking, seeing, hearing, or remembering. Knowledge at this level includes understanding definitions, meanings, facts, rules, structures, and problem-solving methods. Understanding, on the other hand, may manifest as translation skills, which refer to the ability to write, describe, and express meaning using one's own words, as well as the ability to predict or anticipate what might happen. And Yotyingyong, K. (2006) said that knowledge is an individual's thought process that involves thinking, analyzing, and synthesizing until it leads to understanding and the ability to apply it to draw conclusions and make decisions in various situations. And Sawatdee (2018) said that it has been stated that knowledge is a basic behavior in which students only know how to define facts, rules, structures, and solutions. Understanding, on the other hand, may manifest as translation skills, meaning the ability to write, describe, and interpret, as well as the ability to predict what will happen. And Chailuecha et al. (2017) said that it has been stated that measuring knowledge involves assessing memory, interpretation, understanding, application, and analysis. There are many types of knowledge measurement tools, the most commonly used being content-based tests that vary in content, designed to be observable or quantifiable. These tests are used to rank or assign characteristics to individuals. Written test formats are widely used. Multiple-choice tests must have high validity and reliability, effectively distinguishing knowledgeable from those who lack knowledge, regardless of whether the test is subjective or objective. This is consistent with the research by Pichai et al. (2018) studied the boosting morale for youth using cooperative and team-based learning found that the experimental group demonstrated a statistically significant improvement in their knowledge and understanding of moral values for youth after the experiment compared to before the experiment ($p < .05$). And Arthan (2021) studied the development of the science model on evolution under an additional biology course (Wor 31242) of the science learning group for Matthayom Suksa IV found that the students who learned about evolution in the advanced biology course using the SCIENCE Model in the science learning area showed significantly higher post-test scores compared to pre-test scores at the statistically significant level of .05. And Chuto & Prathum (2015) studied the perception of students in upper secondary school on environmental issues and management found that the students' average awareness of environmental problems and management was significantly higher after receiving education on environmental problems and management ($p< 0.05$). And Paço & Lavrador (2017) studied the environmental knowledge, attitudes, and behaviours towards energy consumption. The results also found that males, older students, and those studying engineering and the social and human sciences are those reporting higher levels of environmental knowledge. And Coracero et al. (2022) studied the knowledge and perspective of students towards biodiversity and its conservation and protection. The students' knowledge was a moderate level on biodiversity (mean score = 6.65). Their perspective on biodiversity was leaning toward its protection and conservation (mean score = 7.2).

4.2.2) The study, which compared attitudes toward water resource management using TWBL, found that students' average scores of attitudes before the learning were generally in the agree level, and after the learning were also generally in the agree level. A comparison of the average scores of attitudes before and after the instruction revealed that students had significantly higher average scores of attitudes after the intervention than before, at statistically significant level of .05. This is with the concept of Surakitboworn (2002) said that attitude is a state of mental readiness related to an individual's thoughts, feelings, and behavioral tendencies toward people, things, and situations in a particular direction, and this state of mental readiness must last for a sufficient period of time. And Tiwanon (1998) said that attitude is the combination of a person's thoughts, beliefs, opinions, knowledge, and feelings toward something, a person, or a situation. This results in an evaluation that may be either acceptance or rejection, and these feelings tend to shape certain behaviors. And Serirat et al. (1995) said that attitude refers to a person's feelings or thoughts towards something, which consumers learn from past experiences and use as a link between thoughts and behavior. This is consistent with the research by Phosarat & Boonsearm (2017), who studied the promotion of environmental landscape design in Ban Mad Municipal School, Talat Sub-district, Mueang District, Maha Sarakham Province. Following the promotion of environmental landscaping at Ban Maed Municipal School, students' attitudes towards environmental landscaping were at a level of agreement. And Weeranakin et al. (2022) studied the knowledge, understanding, and attitudes towards natural resources management of students in secondary school, and found that the attitudes towards natural resources management with post-workshop questionnaire scores were higher than pre-workshop scores. When exploring the attitude towards each specific resource management, land, forest, and water management showed the highest to lowest mean score, respectively. And Fytopoulou et al. (2023) studied the effects of curriculum on environmental attitudes: a comparative analysis of environmental and non-environmental disciplines. The results showed that students from both disciplines had positive environmental attitudes, but forestry students exhibited a discernibly higher level of environmental awareness.

4.2.3) The study, which compared environmental ethics related to water resource management using TWBL, found that students' overall average score in environmental ethics before the lesson was at the level of for society, and after the lesson, their overall average score was at the level of for correctness and goodness. A comparison of the average scores in environmental ethics before and after the lesson revealed that students had significantly higher average scores after the lesson than before the lesson, at statistically significant level of .05. This is with the concept of Veerawatnanond (2003) said that environmental ethics refers to the principles of environmental conduct for humans, based on righteousness, morality, and compassion. These principles impact both human life and fellow human beings. Therefore, human actions towards the environment are based on fundamental moral beliefs, which vary in degree, leading to different levels of environmental impact. And Wongchantra (2011) said that environmental ethics are essential in creating and instilling in individuals a good awareness of nature and the environment. This will result in reducing or minimizing environmental problems to the point where environmental development achieves a balance between humans, society, and the environment sustainably, without disrupting that balance. And the Integrated Curriculum Committee, General Education Subject Category (2004) said that environmental ethics refers to the principles of conduct toward the environment that result in the maintenance of ecological balance and benefit all living things that depend on the environment for survival, without disrupting the relationship between themselves and the environment. This is consistent with the research by Seetee et al. (2025), who studied the effect of 'why forest is important' activities on students' environmental literacy and ethics in Nan province. The study found that the average scores of students in environmental literacy and environmental ethics after learning through activities were higher than before learning. And Khrualit & Sutthirat (2016) studied the effect of co-curricular activities from the environmental camp towards the environmental morality of Mathayom Suksa 1 students. It was found that first-year secondary school students who participated in the extracurricular environmental camp had higher environmental ethics scores after participating in the activity than before participating. And Wongchantra et al. (2022) studied the effect of environmental education learning for enhancing dam management in the Northeast of Thailand using case study-based learning. After the learning, the mean score of environmental ethics of students was significantly higher than before the learning at the .05.

4.3 The Study Compared Knowledge, Attitudes, and Environmental Ethics Regarding Water Resource Management Using Team Work-Based Learning (TWBL) Among Students of Different Genders

A study comparing knowledge, attitudes, and environmental ethics regarding water resource management, using TWBL, among students of different genders, found that there were no differences in knowledge, attitudes, and environmental ethics among students of different genders. This is a result of structuring the teaching to include comprehensive content aligned with the objectives set out in the environmental education curriculum, using teamwork as an effective learning base and a medium for transmitting knowledge to students. The instructor uses a teaching process that emphasizes group work, allowing students to exchange knowledge within their groups, think critically, analyze, and discuss together. Techniques for creating a positive and appropriate group atmosphere are also employed. This strategy effectively reveals the thoughts, feelings, and experiences of group members by using teamwork to stimulate interest and create an appreciation, awareness, and understanding of environmental issues and their solutions among students. This includes increased environmental conservation efforts, leading to improved environmental knowledge, attitudes towards the environment, and environmental ethics among both male and female students. In this knowledge transfer process, students receive knowledge in the same format, methods, processes, and learning materials to demonstrate equality. As a result, male and female students will have no difference in knowledge, attitudes, and environmental ethics. This is with the concept of Veerawatnanond & Siphanphong (1996), said that environmental education is described as an educational process that emphasizes knowledge about the physical and social environment, both tangible and intangible factors that cause environmental changes, and their impact on humans. The aim is to cultivate attitudes, behaviors, and values that promote the preservation or improvement of environmental quality, personal quality of life, and human well-being. And Wongchantra (2011) said that environmental knowledge transfer refers to bringing knowledge from a source of knowledge to a target population through media, tools, and equipment using specific processes and methods. This is consistent with the research by Sittipon & Chansuriya (2023), who studied the attitudes analysis of students towards the activities of student clubs, faculty of science, energy and environment, King Mongkut's University of Technology North Bangkok (Rayong Campus). The study found that male and female students showed no differences in their attitudes towards the format of student club activities overall. And Praimee et al. (2022) studied the environmental education learning for enhancing wetlands management in the Northeast of Thailand using cooperative-based learning. There was no difference in the knowledge score of wetland management in the Northeast of Thailand and attitudes of undergraduate students of different genders ($p > .05$). And Ongon et al. (2021) studied the effect of integrated

instructional activities of environmental education by using community - based learning and active learning. There was no significant difference between the average scores of the environmental knowledge, environmental ethics, and environmental volunteers of undergraduate students with different genders ($p > .05$).

5. Conclusion

The findings showed that

1. The environmental education lesson plan on water resource management using TWBL was an effectiveness score of 81.23/86.91. The effectiveness index (E.I.) was 0.5283. This indicates that students gained more knowledge, leading to an improvement in their academic progress after the learning 52.83%. It can be used in instruction for developing students.

2) After the learning, students' average scores of knowledge on water resource management, attitudes towards water resource management, and environmental ethics were higher than before the learning, statistically significant at the level of .05.

3) There was no difference between the scores of knowledge on water resource management, attitude towards water resource management, and environmental ethics of students with different genders.

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