The Development of Science Activity Packages Learning on *The Basic Household Wastewater Management Methods* for Mathayomsuksa 1 Students

Onanong Thongpan, Sriboonyanoon School, Thailand

The Southeast Asian Conference on Education 2026
Official Conference Proceedings

Abstract

There were three Purposes of the study: 1) to development and identify educational quality of science activity packages learning on "The Basic Household Wastewater Management Methods" for Mathayomsuksa 1. (Grade 7) students to attain the efficiency index of 80/80. 2) to study learning outcomes; knowledge and science process skills of MS 1. Students by science activity packages learning. 3) to study attitude toward water resources of MS. 1. Students by science activity packages learning. and 4) to study the MS. 1 students' toward satisfaction in the science activity packages learning. The study was accomplished through two stages of operation; 1) development and quality evaluation of science activity packages learning by specialist science and environment education experimentation with a group of three students nine students and thirty students successively. 2) performing experimental teaching by employing the science activity packages learning with the sampling coming up with a group in one class (from 4 class of 40 MS.1 in the first semester of 2025 academic year of Sriboonyanon school) for 16 periods (50 minutes a period) for the experimental teaching. The results were as follows: 1. The science activity packages learning were at higher educational quality and efficiency index 82.65/83.84. 2. Learning outcomes of students exposed to instruction utilizing the developed science activity packages learning were found to be positive: 1) students' post-test scores on knowledge were significantly higher than their pre-test scores, 2) The students' post-test scores on science process skills were significantly higher than their pre-test scores ($p < .05$). 3) Students' post-test scores on attitude toward water resources designated as "good level." 4) Students' toward satisfaction in science activity packages learning were of a "high level."

Keywords: science activity packages learning, wastewater management, water resources

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Introduction

The water resource crisis in Thailand has reached a critical threshold, particularly within the Lower Chao Phraya Basin. As the nation's primary arterial waterway, the Chao Phraya River faces severe degradation due to rapid urbanization and inadequate waste management. According to the Pollution Control Department (2023), domestic wastewater discharge from households remains the predominant source of organic contamination. Scientific monitoring reveals that water quality in densely populated areas, such as Nonthaburi and Bangkok, frequently fails to meet the Surface Water Quality Standards (Class 3-4). Key indicators of this "invisible crisis" include Biochemical Oxygen Demand (BOD) levels exceeding the 4.0 mg/L threshold and Dissolved Oxygen (DO) levels occasionally plummeting below 2.0 mg/L a state detrimental to aquatic life. Furthermore, the high concentration of Oil and Grease from kitchen discharge creates surface films that obstruct gas exchange, further exacerbating the depletion of oxygen in the river and its connected canal networks (Pollution Control Department, 2024).

In response to these environmental challenges, the Ministry of Education (2023) has mandated a shift toward Competency-Based Education and Active Learning. The national strategy emphasizes "Green Education," aimed at cultivating students who possess Scientific Literacy the ability to apply scientific knowledge to real-world contexts. This aligns with the Institute for the Promotion of Teaching Science and Technology (IPST, 2017) guidelines, which promote Inquiry-Based Learning and the BCG (Bio-Circular-Green) Economy Model. Education is no longer confined to theoretical memorization; it is now a vehicle for sustainable development, encouraging students to act as "Change Agents" within their communities to mitigate local environmental impacts.

Sriboonyanon School is strategically located on the banks of the Chao Phraya River, where the students' daily lives are inextricably linked to the water. Many students reside in households situated along canals that discharge directly into the river. Despite their proximity to the problem, there is a significant gap in the students' practical ability to manage household wastewater. Traditional science laboratories often lack the "Context-Based" approach necessary to make learning relevant. To address this, the researcher developed the Science Activity Packages titled "The Basic Household Wastewater Management Methods" specifically for Grade 7 (Mathayomsuksa 1) students. This innovation leverages the school's unique location as a living laboratory to study the properties of matter and separation techniques through the lens of environmental preservation.

The developed curriculum bridges the gap between the Basic Education Core Curriculum (2017) and practical environmental stewardship. It consists of five specialized modules:

- Module 1 Water Quality Testing – Empirical analysis of pH, DO, TDS, and Grease levels to identify local contamination.
- Module 2 Sedimentation Techniques – Applying the principles of chemical and physical separation to clarify domestic wastewater.
- Module 3 Grease Trap Construction – Engineering simple, low-cost solutions to intercept oils at the source.
- Module 4 Bio-composting from Food Waste – Utilizing microbial action to reduce organic loads in accordance with biological treatment principles.
- Module 5 Project-based Solutions – Synthesizing skills to design sustainable wastewater management plans for the students' own homes and riverside communities.

The objective of this research is to develop and evaluate the efficiency of these Science Activity Packages to meet the 80/80 standard criterion. Beyond improving academic achievement, the study aims to enhance students' Scientific Process Skills and foster a deep sense of Environmental Awareness. By integrating the Ministry of Education's vision with the urgent need for Chao Phraya River conservation, this research provides a scalable model for community-based science education that promotes a sustainable future for Thailand's water resources

Research Goals

1. To development and identify educational quality of science activity packages learning on "*The Basic Household Wastewater Management Methods*" for Mathayomsuksa 1. (Grade 7) students to attain the efficiency index of 80/80.
2. To study learning outcomes; knowledge and science process skills of MS 1. Students by science activity packages learning.
3. To study attitude toward water resources of MS. 1. Students by science activity packages learning.
4. To study the MS. 1 students' toward satisfaction in the science activity packages learning.

Figure1

Students Measuring Dissolved Oxygen (Do) Levels in Canal Water

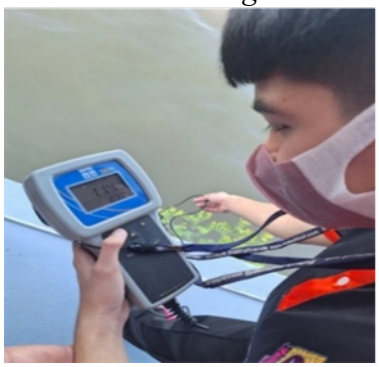

Figure 2

Students Measuring Tds, and PH Levels From Various Water Sources

Figure 3
Students Performing a Laboratory Activity Focused on Removing Suspended Substances From Water Through Physical Separation Techniques

Figure 4
Students Practicing the Construction of a Household Grease Trap Prototype

Figure 5
Students Engaged in a Collaborative Design Process for Domestic Wastewater Management

Methods

The study was accomplished in 8 steps: Development of the science activity packages learning on "*The Basic Household Wastewater Management Methods*" were divided into 5 Modules: 1) Water Quality Testing (DO, Oil and Grease, TDS, and pH), 2) Sedimentation Techniques, 3) Grease Trap Construction, 4) Bio-composting from Food Waste and 5) Project-based Solutions. The details are as follows:

1. Determination of the quality of the science activity packages learning by specialist science and environment education. A total of 3 people evaluated six areas: 1) Learning Outcomes, Contents 3) Using Language and Illustrations ,4) Learning Activities, 5) Experimental kit, and 6) Post-test. Each area was evaluated with one of the following ratings:

1.00–1.50 = very low
1.51–2.50 = low
2.51–3.50 = medium
3.51–4.50 = good
4.51–5.00 = very good.

2. The evaluation results of the science activity package were utilized to revise and enhance its quality. This iterative process incorporated expert feedback and recommendations until the evaluation scores reached a minimum threshold of "Good." Subsequently, the refined activity set was implemented for pilot testing with small groups of 3 and 9 students, respectively.
3. The developed science activity package underwent a field trial to determine its efficiency according to the established criteria prior to formal implementation. The procedure is outlined as follows:

   Participants and Setting – The efficiency test was conducted with 30 MS. 1 students at Sriboonyanon School during the first semester of the 2025 academic year.

   Efficiency Criteria (E_1/E_2) – The package was evaluated based on the 80/80 efficiency standard. Upon achieving this standard, the validated package was subsequently implemented for experimental instruction with the research sample.
4. Performance of experimental teaching by inviting a single sample group (sampled from 4 classes of 40 MS. 1 students, from Sriboonyanoon school during the first semester of the 2025 academic year, Nonthaburi, Thailand) for 16 periods (50 minutes a period).
5. Assessment of students' knowledge gained from learning in the science activity packages, which divides the assessment of the desired behavior into 4 areas: 1) knowledge (8 points), 2) comprehension (10 points), 3) Process of scientific inquiry (12 points), and 4) Application of scientific knowledge (10 points), total 40 points.
6. The assessment of students' scientific process skills acquired through the use of science activity packages. The evaluation is categorized into eight key areas, totaling 40 points: 1) Observation (3 points), 2) Measurement (4 points), 3) Using numbers/Calculation (5 points), 4) Classification (8 points), 5) Formulating hypotheses (6 points), 6) Data organization and communication (3 points), 7) Experimental skills (8 points), and 8) Data interpretation and conclusion (3 points).
7. The evaluation of students' attitudes toward the environment, acquired through science activity packages, is categorized into three key domains: 1) Environmental conservation awareness, 2) Environmental conservation behavior, and 3) Efficient resource utilization behavior. The assessment utilizes a 3-point scale (0 = Low, 1 = Moderate, 2 = High). The mastery criterion is established at a mean score of 2.00, representing the "High" level of environmental responsibility.
8. The assessment of student satisfaction toward the science activity packages is categorized into four key dimensions:1) Content Quality: Accuracy, clarity, and appropriateness of the subject matter,2) Learning Activities: Engagement, instructional flow, and student participation,3) Explanations and Illustrations: Clarity of instructions and the quality of visual aids ,and 4) Practical Application: The usefulness and real-world relevance of the knowledge gained. The satisfaction level is measured using a 5-point Likert Scale questionnaire is employed to measure satisfaction levels as follows: Evaluation of students' toward satisfaction in the science activity packages, through studying the in the science activity packages on "The Basic Household Wastewater Management Methods." Tests to measure toward satisfaction of the science activity packages used five levels, as follows:

   1.00 –1.50 = very low
   1.51–2.50 = low

2.51–3.50 = medium
3.51–4.50 = high
4.51–5.00 = highest

Results

The results of the research were as follows:

The quality of the science activity packages learning on "*The Basic Household Wastewater Management Methods*" were divided into five units: 1) Water Quality Testing (DO, Oil and Grease TDS, and pH) 2) Sedimentation Techniques 3) Grease Trap Construction 4) Bio-composting from Food Waste and 5) Project-based Solutions, by a total of three specialist science and environment education, who evaluated five areas: 1) contents, 2) using language and illustrations, 3) learning activities, 4) experimental kit and 5) post-test. The details are shows in Table 1.

Table 1
The Quality of the Science Activity Packages Learning on "The Basic Household Wastewater Management Methods," Evaluated by a Total of Three Specialist Science and Environment Education

Areas / **Units**	contents	using language and illustrations	learning activities	experimental kit	post-test	$\overline{X}$	Levels
Water Quality Testing	4.53	4.48	4.54	4.39	4.49	4.48	good
Sedimentation Techniques	4.53	4.46	4.56	4.61	4.49	4.53	very good
Grease Trap Construction	4.54	4.48	4.49	4.55	4.50	4.51	very good
Bio-composting from Food Waste	4.48	4.47	4.52	4.49	4.47	4.48	good
Project-based Solutions	4.50	4.52	4.49	4.50	4.49	4.50	good
Total average	very good 4.51	good 4.48	very good 4.52	good 4.50	good 4.48	**4.50**	**good**

Table 1 shows the average quality of the science activity packages learning on "*The Basic Household Wastewater Management Methods,*" evaluated by a total of three specialist science

and environment education. Quality was evaluated across five areas: contents, using language and illustrations, learning activities, experimental kit and post-test. The respective averages of each area were as follows: 4.51 very good, 4.48 good, 4.52 very good, 4.50 good, 4.48 good, while the total average across all areas was 4.50 good.

The efficiency of the science activity packages learning on "*The Basic Household Wastewater Management Methods*" were divided into 5 Modules: 1) Water Quality Testing (DO, Oil and Grease TDS, and pH) 2) Sedimentation Techniques 3) Grease Trap Construction 4) Bio-composting from Food Waste and 5) Project-based Solutions was evaluated based on the 80/80 criterion. The details are shows in Table 2.

Table 2
The Efficiency of the Science Activity Was Evaluated Based on the 80/80 Criterion

Testing	Module 1	Module 2	Module 3	Module 4	Module 5	Process Efficiency (E_1)	Product Efficiency (E_2)
During learning	83.24	81.54	83.21	82.83	82.43	82.65%	
Post-learning							83.84%

Table 2 shows the efficiency of the science activity packages was evaluated based on the 80/80 criterion. The results revealed that the process efficiency (E_1), derived from the average scores of the exercises within the packages, was 82.65%. The product efficiency (E_2), obtained from the post-learning achievement test, was 83.84%. Consequently, it can be concluded that the science activity packages met the established 82.65/83.84 efficiency standard, which exceeded the defined 80/80 criterion.

Achievement of learning outcomes among students who used the science activity packages learning on "*The Basic Household Wastewater Management Methods*" was assessed using the average pretest and post-test scores. The details of the results are shows in Table 3.

Table 3
The Comparison of the Achievement of Learning Outcomes Among Students Who Used the Science Activity Packages Learning on "The Basic Household Wastewater Management Methods," Assessed by Pre-test and Post-test

average score	n	$\bar{X}$	SD	df	t
pre-test	40	19.20	1.29	39	
post-test	40	21.82	1.48	39	10.36*

Table 3 shows the comparison of the average learning achievement scores of students who utilized the science activity packages on "*The Basic Household Wastewater Management Methods"* revealed a significant improvement. The analysis of pre-test and post-test data indicates that the post-test scores were higher than the pre-test scores at a statistical significance level of .05.

The achievement of learning outcomes with regard to science process skills in the science activity packages learning on "*The Basic Household Wastewater Management Methods*" was

assessed by comparing the average pretest and post-test scores. The details are shows in Table 4.

Table 4
The Comparison of the Average Achievement of Learning Outcomes, With Regard to Science Process Skills, Among Students in the Science Activity Packages Learning on "The Basic Household Wastewater Management Methods." This Was Assessed Using Pre-test and Post-test

average score	n	$\bar{X}$	SD	df	t
pre-test	40	21.28	3.89	39	
post-test	40	23.34	4.68	39	3.58*

Table 4 shows the study compared the average achievement of students' science process skills before and after the implementation of the science activity packages titled "The Basic Household Wastewater Management Methods." The statistical analysis revealed that the post-test scores were significantly higher than the pre-test scores at a .05 level of significance, indicating a substantial improvement in students' scientific competencies.

Evaluation of attitudes toward water resources among students learning in the science activity packages learning on "*The Basic Household Wastewater Management Methods.*" The details are shown in Table 5.

Table 5
The Average Post-test Score on Attitude Toward Environment Among Students Learning in the Science Activity Packages Learning on "The Basic Household Wastewater Management Methods"

average score	n	$\bar{X}$	SD	$\mu = 2$	df	t
post-test	40	2.48	0.89	2.00	39	2.26*

Table 5 shows the evaluation of students' attitudes toward the environment after engaging with the "*The Basic Household Wastewater Management Methods*" activity packages yielded a mean score of 2.48. This result is classified at a "high level," significantly exceeding the pre-determined criterion of 2.00 at a .05 level of significance. These findings suggest that the curriculum effectively fostered a positive environmental mindset among the learners.

Evaluation of students' satisfaction in the science activity packages learning on "*The Basic Household Wastewater Management Methods.*" The details are shown in Table 6.

Table 6
The Average Posttest Score of Students' Toward Satisfaction in the in the Science Activity Packages Learning on "The Basic Household Wastewater Management Methods"

average score	n	$\bar{X}$	SD	μ = 4	df	t	*p*
post-test	40	4.21	0.39	4.00	39	4.28*	.000

Table 6 shows the analysis of student satisfaction toward the "*The Basic Household Wastewater Management Methods*" activity packages revealed an average post-test score of 4.21, which is classified at a "high Level." This score significantly exceeded the pre-established criterion of 4.00 at a .05 level of significance, indicating that the instructional materials were well-received by the learners.

Conclusions

The results were as follows:

1. The science activity packages learning were at higher educational quality and efficiency index 82.65/83.84.
2. Learning outcomes of students exposed to instruction utilizing the developed science activity packages learning were found to be positive: 1) students' post-test scores on knowledge were significantly higher than their pre-test scores, 2) The students' post-test scores on science process skills were significantly higher than their pre-test scores ($p < .05$).
3. Students' post-test scores on attitude toward water resources designated as "good level."
4. Students' toward satisfaction in science activity packages learning were of a "high level."

Acknowledgments

Acknowledgement is gratefully made to S.T. Biotech & Consultant Co., Ltd. for providing the water quality testing equipment (DO, TDS, and pH meters) and the microbial cultures used in the bio-composting experiments.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The author declares that Grammarly, an AI-assisted writing software, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from Grammarly, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures, findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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Contact email: onanongfakanong@gmail.com