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Environmental Education Lesson Study: A Practical Analysis in Science Learning and Its Impact on Students' Environmental Attitudes

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Abstract: Environmental Education Lesson Study: A Practical Analysis of Science Learning and Its Impact on Students' Environmental Attitudes. **Objective**: This study aimed to examine the implementation of an environmental education (EE) lesson study conducted by science teachers and to analyse its influence on students' environmental attitudes. **Method**: The methodology of research utilised a comprehensive approach that combined qualitative and quantitative from direct observations of the lesson study implementation in schools in the Serpong District from August 2023 to February 2024, a focused discussion group with six teachers, and environmental attitude online questionnaires with 406 students voluntarily participating in this survey. **Finding**: The findings indicate that the environmental education lesson study employs a framework of independent practice and open participation. While the planning and doing phases are managed independently by teachers from model schools, the observation and discussion phases actively involve educators from various schools, facilitating participation in hybrid formats. The students' environmental attitudes are not influenced by the activities of teachers within the lesson study. Instead, the type of school attended plays a critical role in shaping environmental attitudes. Students from eco-schools and those who prioritise environmental education as a distinct subject demonstrate considerably more positive environmental attitudes than those from institutions integrating environmental issues within their science learning. **Conclusion**: The environmental education lesson study has enhanced students' environmental attitudes. However, there is a need for a specific and holistic approach to environmental education to foster positive environmental attitudes among students effectively.

Keywords: attitude, environmental, education**,** lesson study, science learning.

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■ **INTRODUCTION**

The air quality in South Tangerang City is critically deficient, as evidenced by an Air Quality Index (AQI) categorised as very unhealthy, currently recorded at 248 US AQI according to visual air monitoring data (Waluyo, 2024). Since its establishment 11 years ago, South Tangerang has faced persistent challenges with waste management, primarily due to limited public awareness and the ongoing practice of indiscriminate waste disposal (Setiawan, 2019). In response, the local government has launched various programmes to reduce waste in collaboration with community organisations. These initiatives include the development of Integrated Waste Disposal Sites based on the 3R principles (Reuse, Reduce, Recycle) and the establishment of waste banks in each sub-district. Furthermore,

environmentally conscious schools known as "Adiwiyata schools" have been created, with 148 institutions ranging from nurseries to secondary schools (Tangerang, 2023a); (Tangerang, 2023b)). The South Tangerang Education Agency has partnered with the Indonesian Education Promoting Foundation, an international non-governmental organisation based in Toyama, Japan, and the Biology Education Programme at UIN Jakarta. This collaboration has enabled the development and integration of environmental education (EE) across various subjects, with particular emphasis on science curricula at the secondary school level. From 2017 to 2021, the IEPF developed an EE curriculum and accompanying textbooks for junior high schools in South Tangerang City. In response to the COVID-19 pandemic during the years 2020 to 2021, the implementation of EE lesson studies in all public junior high schools in Tangerang City transitioned from an in-person format to an online format. Unlike traditional offline lesson studies, which are conducted in person, online lesson studies require teachers to facilitate all stages planning, execution, observation, and discussion utilising Zoom meetings as the primary platform for engagement (Herlanti et al., 2022).

EE aims to achieve five primary objectives: the development of knowledge, enhancement of critical thinking skills, promotion of environmental awareness, fostering an understanding of the impact of behaviours on the environment, and encouraging active participation in conservation activities (Blatt, 2015; Heimlich & Ardoin, 2008). These objectives knowledge, awareness, attitudes, skills, and participation were outlined in the Tbilisi Declaration of 1977. However, achieving these goals within environmental education presents significant challenges.

The TIMSS & PIRLS 2023 assessment measures achievements in EE across educational institutions, focusing on two key objectives: environmental attitude and behaviour. Environmental attitude is prioritised, as it stems from awareness and considerably influences subsequent behaviour (Martin et al., 2023).

Integrating EE into subject lessons presents considerable challenges, particularly when changing students' environmental attitudes. Many educators face difficulties incorporating EE into their science curricula due to several factors, including inadequate training, limited teaching time, challenges in managing learning experiences outside the classroom, and low levels of environmental literacy (Cahyani & Djudin, 2024). Additionally, there is a need to improve teachers' ability to incorporate EE content within the current curriculum frameworks. Many educators have limited knowledge of environmental education principles and lack the pedagogical skills required for effective integration, especially in lesson planning and assessment strategies (Rambulangi et al., 2020).

Lesson study represents an alternative training method within teacher-learning communities. This approach involves the collaboration of teachers, lecturers, and school supervisors who collaboratively engage in planning lessons (Plan), implementing and observing those lessons (Do and See), and subsequently discussing the outcomes (Talk). This comprehensive process serves as a valuable professional development tool for educators. Participation in lesson study activities has enhanced teachers' capacity to integrate EE into their curricula, expand their pedagogical knowledge, and improve classroom management skills. Research indicates that lesson study fosters the development of Technological Pedagogical and Content Knowledge (TPACK) among educators, thus rendering the learning process more responsive to the diverse needs of students (Norton, 2018); (Zhang & Liu, 2018).

Additionally, lesson study can increase teachers' confidence in their instructional

practices, leading to greater effectiveness in the learning process (Stokes et al., 2020); (Helmbold et al., 2021). A critical component of lesson study is the discussion phase (Talk), during which teachers reflect on the lessons that have been implemented and observed. This reflective phase allows educators to recognise their strengths and obtain constructive feedback, ultimately promoting the development of more effective teaching strategies and facilitating ongoing improvements in teaching and learning (Shimizu & Kang, 2022; Herlanti et al., 2024).

In addition to enhancing teachers' professionalism, lesson study significantly impacts student learning outcomes. Research shows that students whose teachers participate in lesson study demonstrate improvements in both cognitive skills and practical abilities (Özdemir, 2019). Teachers involved in lesson study activities can better recognise students' thinking processes. This insight enables them to develop more effective teaching strategies, enhancing students' understanding of key concepts (Vermunt et al., 2023). Moreover, lesson study encourages teacher innovation and the creation of more interactive lessons, which boosts student motivation throughout the learning process (Helmbold et al., 2021). In addition to improving cognitive skills and abilities, lesson study can positively influence students' attitudes, including their scientific and social dispositions (Muslim, 2011; Suparya, 2020).

In light of the numerous advantages associated with lesson study particularly its beneficial effects on teachers' professional development and its enhancement of student learning outcomes this approach has been adopted as a vehicle for the advancement of environmental education in South Tangerang City. Within this jurisdiction, environmental education has been established as a component of the local curriculum, seamlessly integrated into various subjects and the Pancasila Pupils Profile Powering Project (P5). This study aims to examine the implementation of lesson study within science instruction related to EE and to assess its influence on students' environmental attitudes.

◼ METHOD

Research Design and Procedure

The research method used is a mixed-method, combining qualitative and quantitative methods. Qualitative methodologies were employed to investigate the implementation of environmental education lesson study practices carried out by junior high schools in South Tangerang City for one year. Quantitative methods investigated the relationship between teacher participation in lesson study programmes and the environmental attitudes expressed by students. The quantitative method used a quasi-experimental with a static group comparison design (Gall et al., 2003). Figure 1 illustrates the research process that was conducted.

Population and Sample

The study was conducted in South Tangerang City, with 213 schools. The research focused on a target population of 24 public schools in South Tangerang City, distributed across seven sub-district level teacher working groups. Public schools were selected for the study due to their status under government intervention. The research sample was chosen based on the engagement of teacher working groups in lesson study activities on August 2023 – February 2024 within public schools. The Serpong and North Serpong groups demonstrated the highest activity level among these groups. Schools in the Serpong were categorised into four types: type I – schools with an actively engaged model teacher, type II – schools in which teachers participated in lesson study activity but were not model teachers, type
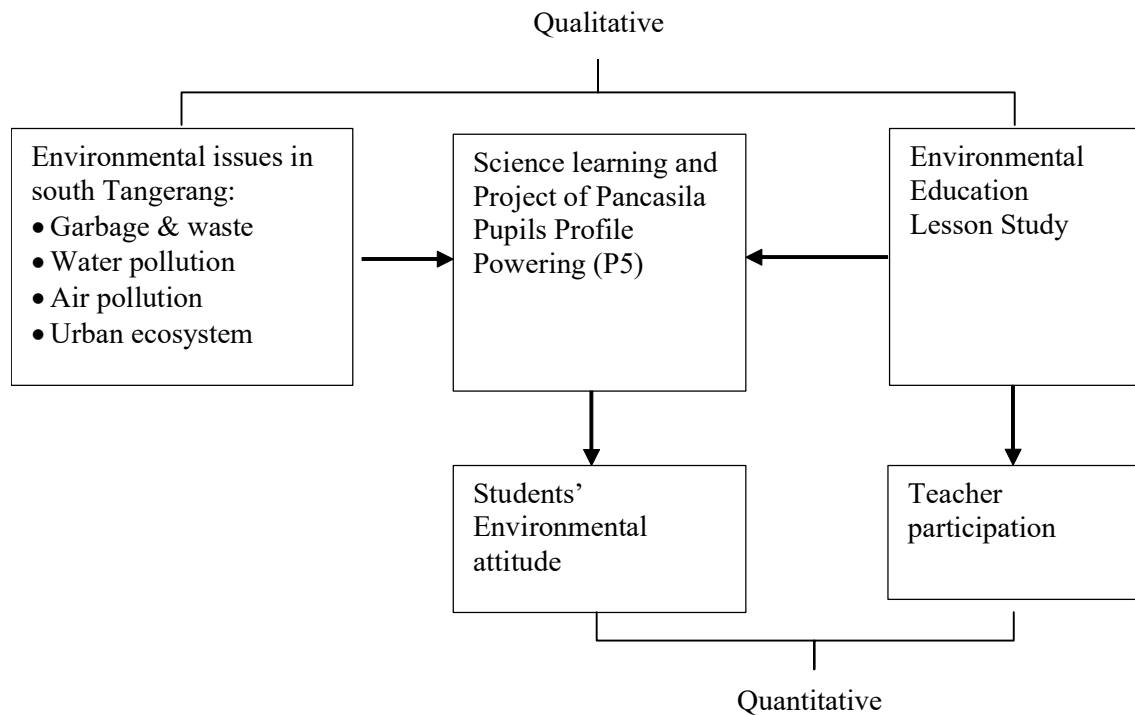
Qualitative

Figure 1. Research flow

III – schools that engaged in online lesson study activities, and type IV – schools that did not partake in either online or offline lesson study activities. After one year, the teachers will apply environmental education to science learning.

Teachers in each type of school were asked to distribute environmental attitude questionnaires to their students. The research sample was students who voluntarily filled out the questionnaire. The specifics research sample presented in Table 1.

Table 1. Research sample

Sub-district	Type I		Type II		Type III		Type IV	
	School	Sample	School	Sample	School	Sample	School	Sample
Serpong	A	111	C	53	E	40	-	
	B	39	-		F	62	-	
North Serpong	-		D	35	-		G	66
Sum	2	150	2	88	2	102	1	66

Instuments

The practical environmental education lesson study was analysed by gathering qualitative data through observations and semi-stuctured interviews. The observations took place during lesson study activities at SMP A and SMP B in the 2023/2024 academic year from August 2023 to February 2024. Semi-structured interview were conducted with schoolteachers A, B, C, D, E, and G through a forum discussion group (FGD) in October 2024 (https://tinyurl.com/fgdtbiouinjkt).

The environmental attitude instrument employed in this study was adapted from a prior investigation into high school students' environmental attitudes (Ugulu et al., 2013). It assessed four critical dimensions of environmental attitudes: environmental awareness, attitude toward recovery, attitude toward recycling, and environmental consciousness and behaviour. The Ugulu's instrument, comprising 36 question items, underwent testing on 40 students at a junior high school in South Tangerang City. The results of the instrument trial at the South Tangerang school revealed 25 valid items with a Cronbach's Alpha coefficient of 0.67 (See Table 2). Subsequently, 25 validated items (Table 2) were administered to a sample of 139 students from public and private junior schools in South Tangerang, Cronbach's alpha coefficient of 0,79, which is a high level of reliability for the instrument. Detailed information regarding the number of questions in the adapted instrument utilised at South Tangerang City Junior High School is presented in Table 2.

Table 2. Instrument of environmental attitude

No.	Questions
A.	**Factor I. Environmental Awareness**
1	The primary purpose of tree planting is to beautify the environment in terms of aesthetics
2	Since the environment can clean itself, human waste does not cause problems.
3	Instead of spending money on historical places, it is more advantageous for us to build luxurious roads
4	Some species are unnecessary for the environment.
5	The extinction of insects such as files is beneficial for the environment
6	Nature renews itself with the substance cycle. Therefore, recycling helps the economy only in terms of time.
7	The best way to build houses is to dry wetlands and build them there.
8	It is meaningless to buy paper bags instead of nylon, which are free in the markets.
9	People have the right to make changes in nature to meet their needs.
10	Money can be saved by buying plastic bottles since glass bottles of drinks are expensive.
B.	**Factor II. Attitudes towards recovery**
11	Using rechargeable batteries instead of disposable batteries supports recycling.
12	Shopping only as much as needed is essential for recycling.
13	I believe that we should be economical for the environment
14	We should use both sides of white paper to support recycling.
15	For savings, I turn off the lights when they are not used.
C.	**Factor III. Attitude toward recycling**
16	I can go from door to door to teach people recycling.
17	I separate waste materials in my house for recycling
18	I feel sad when I see people throwing away objects that can be recycled.
19	It makes me happy when people recycle used bottles, cans and paper.
D.	**Factor IV. Environmental consciousness and behaviour**
20	In a liveable environment, I can work voluntarily for a long time if needed.
21	I don't waste water while I am brushing my teeth.
22	I prefer environmentally harmless products even if they are more expensive.
23	I participate in environmental projects
24	My friends know me as a sensible person toward the environment.
25	I talk with people around about ecological matters.

Data Analysis

The Environmental attitude instrument comprises a ranking scale questionnaire with responses ranging from strongly disagree to agree (1-4). The minimum score achievable is 25, while the maximum is 100. Subsequently, the scores obtained by each student are categorised as reflecting a low to excellent attitude. Further details regarding these categories can be found in Table 3.

Table 3. Environmental attitude categories based on scores obtained from the environmental attitude questionnaire

Score of environmental attitudes	Description
<60	Low attitude toward the environment
61-74	Moderate attitude toward the environment
75-84	Good attitude toward the environment
>85	Excellent attitude toward the environment

The collected scores were subjected to statistical analysis to address the research hypotheses. The first hypothesis posited a correlation between teacher engagement in environmental education lesson study activities and students' environmental attitudes. This hypothesis was tested using the Chi-Square crosstab test. The second hypothesis aimed to determine the impact of teacher participation in environmental education lesson study activities on students' environmental attitudes. We employed the T-test and one-way ANOVA test to test this hypothesis, which necessitates normally distributed data. Additionally, we conducted a normality test on the data using the One-Sample Kolmogorov-Smirnov Normal Test.

■ **RESULT AND DISCUSSION**

Practical Analysis of Environmental Education (EE) Lesson Study in Science Learning

Based on the results of the observations, the EE lesson study model implemented in the Serpong and North Serpong sub-districts is represented in Figure 3. This figure illustrates that schools (A and B or type I) engaged in the planning (plan) and execution (do) of EE integrated within their science curricula. In contrast, type II schools (C and D) conducted direct observations (see). They facilitated classroom discussions (talk), while Type III schools (E and F) performed observations (see) and discussions (talk) via Zoom meetings.

According to the stages of the lesson study (LS), teachers A and B completed the 'plan' and 'do' stages by executing the lesson plan in the classroom setting. Teachers from schools C and D observed the lessons directly at schools A and B. Conversely, teachers from schools E and F participated by viewing lessons broadcast live through Zoom. Schools C, D, E, and F, categorised as Type II and Type III conducted the 'see' stage of the lesson study.

After implementing and observing the EE lessons, all participating teachers engaged in a reflection activity, wherein they discussed the positive outcomes derived from their observations, representing the 'talk' stage of the lesson study. Notably, teachers from School G (Type IV) did not participate in the activities associated with the lesson study.

In Figure 3, it is demonstrated that the lesson study practice is implemented in a hybrid format. During both the observation and discussion stages of learning, educators have the opportunity to participate either in person in classrooms conducting open lessons or remotely via Zoom meetings (details regarding hybrid lesson
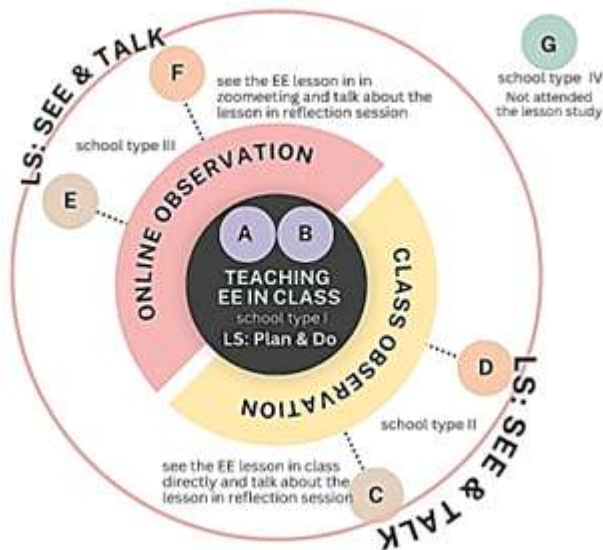
Figure 3. The practical of environmental lesson study

study practices can be found at https://www.youtube.com/watch?v=j0qAsdTDeUo). Before the COVID-19 pandemic, lesson study activities were conducted in face-to-face setting (Elliott, 2019; Hendayana, 2016). However, a significant shift occurred during the pandemic towards online modalities, utilising various digital learning models (Gao et al., 2024; Herlanti et al., 2022; Holden, 2023; R. Huang et al., 2021; X. Huang et al., 2021; Mynott & O'Reilly, 2023; Tanujaya et al., 2023). After the pandemic, integrating in-person and online approaches termed hybrid lesson study has emerged as an effective strategy to enhance teachers' access to professional development and collaboration with colleagues. Hybrid lesson study presents several advantages, particularly in mitigating time and geographic location constraints. Educators frequently face demanding schedules filled with daily responsibilities, hindering their ability to engage in lesson study activities outside of school. This challenge is exacerbated when the lesson study's location is a considerable distance from the school (D. Nickerson et al., 2014).

Based on the semi-structured interview results in forum discussion group, the findings are presented in Table 4. This table indicates that teachers experienced enhancements in their professional, pedagogical, and social competencies while implementing EE lesson study activities. The positive influence of the lesson study on students' enthusiasm for learning was primarily evident in Type I schools, where teachers served as model teachers in the lesson study; however, this effect was not observed in the other types of schools.

Table 4. Semi-structured interview result on forum discussion group

Question	Type 1	Type II	Type III	Type IV
Effect of environmental education lesson study on professionalism	Teacher A: Content knowledge (How to integrate	Teacher C. Absent Teacher D. Content knowledge	Teacher E. Pedagogy knowledge (Method of teaching)	Teacher G. Pedagogy knowledge (Method of teaching)

development	environmental issues in science learning) Teacher B. Social competency (from collaboration activity, got some insight to make better in teaching)	(How to integrate environmental issues in science learning)	Teacher F. Content knowledge (How to integrate environmental issues in science learning)	
Effect of environmental education lesson study on students	Teachers A & B: Students are happy when they try to integrate environmental issues into science learning			
Method to integrate environmental education in school	Teacher A: take some environmental issues and incorporate them into science learning Teacher B: integrate some environmental issues into P5 and environmental habits in class (Cleaning the class).	Teacher C. Absent Teacher D. Environmental education is a monolithic subject, one hour a week.	Teer E: environmental education habitual in eco-school (3R lifestyle, Adiwiyata school) Teacher F: take some environmental issues and integrate them into science learning and environmental education habitual in eco-school (adiwiyata school)	Teacher G: take some environmental issues and integrate them into P5.

Table 4 demonstrates that the implementation of EE varied across Types I, II, III, and IV schools. Type III schools exhibited a more comprehensive approach by integrating environmental issues into science lessons and promoting eco-friendly practices within the school environment through the eco-school or green-school programme (Adiwiyata School). This initiative is regulated under the Regulation of the Minister of Environment of the Republic of Indonesia Number 05 of 2013, which provides comprehensive guidelines for implementing the Adiwiyata Programme. The Adiwiyata Programme aims to establish educational institutions committed to environmental stewardship and foster a culture of sustainability. The core principles of the Adiwiyata Programme encompass education, participation, and sustainability (Indahri, 2020).

Type II schools specifically dedicated one hour per week to EE, distinct from science lessons, although it continued to be delivered by science teachers. Types I and IV schools employed similar methodologies, incorporating environmental issues into science lessons and the P5 (Project of Pancasila Pupils Profile Powering). Other researchers have emphasized the findings presented in Table 4. An option for integrating environmental education (EE) into the school curriculum involves establishing it as an independent subject. This traditional approach has been utilized in various countries, allowing EE to have its syllabus, a designated time slot on the timetable, and instruction similar to that of other conventional subjects, such as the science and social sciences. Alternatively, EE is incorporated as a cross-curricular element by integrating environmental topics into all subject disciplines, particularly within science learning. This integrative approach to learning is grounded in both philosophical and practical frameworks. It pertains to a methodology combining knowledge, skills, attitudes, and values from various subject areas to cultivate a deeper understanding of fundamental concepts and their interconnections (Damoah et al., 2024).

Students' Environmental Attitude

The environmental attitude scores of students across different school types have been analysed, with the following results: a minimum score of 49, a maximum score of 96, an average score of 78.60, and a standard deviation of 7.66. These findings indicate that the average environmental attitude of students is classified as "good." A detailed breakdown of students' environmental attitude scores by school type is presented in Table 5.

Table 5 shows outstanding environmental attitudes are more prevalent among Type I and Type III schools. Students' environmental attitudes in Type II schools are lower than in Type IV schools. The Chi-Square test results in Table 6 indicate a significant relationship between school type and students' environmental attitudes.

Table 5. Environmental attitude of students

Environmental Attitude	Type I		Type II		Type III		Type IV		Total	
	N	%	N	%	N	%	N	%	N	%
Low	2	1	2	2	0		3	4	7	2
Moderate	40	27	34	39	11	11	23	35	108	27
Good	79	53	43	49	49	48	31	47	202	49
Excellent	29	19	9	10	42	41	9	14	89	22
	150	100	88	100	102	100	66	100	406	100

N=Number of students
%=percentage

Table 6. Chi-square tests

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-Square	42.003[a]	9	<.001
Likelihood Ratio	44.007	9	<.001
Linear-by-Linear Association	1.073	1	.300
N of Valid Cases	405		

Four cells (25.0%) have an expected number of not less than 5. The minimum expected count is .96.

The environmental attitudes of students in various types of schools reveal distinct patterns. The average score for Type I schools is 78.24, with a standard deviation of 7.09. In Type II schools, the average score is 82, with a standard deviation of 7.05. Type III schools report an average score of 82.74, with a standard deviation of 2.12. Conversely, Type IV schools have an average score of 76.22 and a standard deviation of 8.49. These statistics suggest that schools whose teachers did not engage in the lesson study demonstrated lower scores compared to those teachers were actively involved in the lesson study.

The findings of the normality test presented in Figure 4 showed a normal data-distributing curve, and Table 7 indicates that the normal test is significant (Sig. 0.019). The quantitative data collected adheres to a normal distribution, thereby permitting the implementation of a t-test and one-way ANOVA test.
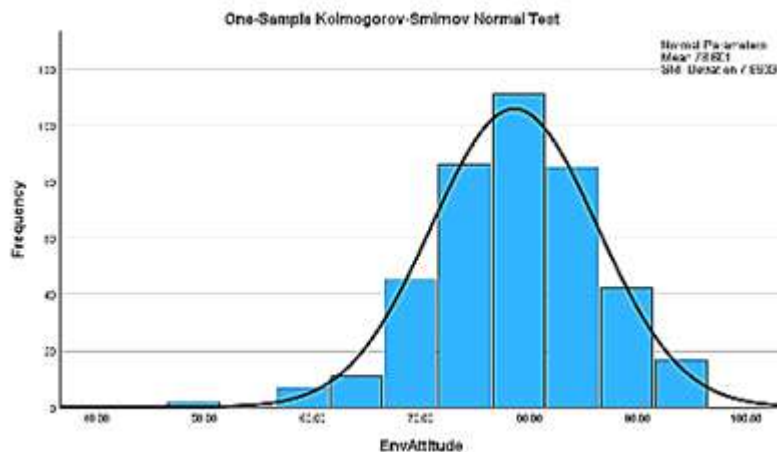
Figure 4. Students' environmental attitude distribution curve showed normal distribution

Table 7. One-sample kolmogorov-smirnov normal test summary

Total N		406
Most Extreme Differences	Absolute	.049
	Positive	.028
	Negative	-.049
Test Statistic		.049
Asymptotic Sig.(2-sided test)[a]		.019
a. Lilliefors Corrected		

The t-test results illustrated in Table 8 indicate a statistically significant difference in the environmental attitudes of students at schools that participated in lesson study compared to those that did not. Specifically, students in institutions that implemented lesson study exhibited more positive environmental attitudes than their counterparts in schools without such engagement, as evidenced by a mean difference of 2.83.

Table 8. T-test for independent sample tes

	Levene's Test for Equality of Variances		t-test for Equality of Means		Significance		Mean Difference	Std. Error Difference
	F	**Sig.**	**t**	**df**	**One-Sided p**	**Two-Sided p**		
Equal variances assumed	.431	.512	2.774	404	.003	.006	2.83	1.02
Equal variances not assumed			2.646	88.32	.005	.010	2.83	1.07

The results from the ANOVA, displayed in Table 9, reveal significant differences in the mean scores across various school types ($F=16,75$. Sig. <0.01). This indicates a substantial effect of teachers' participation in environmental education lesson study activities on students' environmental attitudes.

The follow-up ANOVA test, conducted using Tukey's method as presented in Table 10, reveals that significant differences regarding

Table 9. One-way analysis of varian (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2640.238	3	880.079	16.747	<.001
Within Groups	21125.122	402	52.550		
Total	23765.360	405			

participation in the environmental education lesson study were identified exclusively among Type III schools. Conversely, Type I and Type II schools exhibited no significant differences from Type IV schools, which did not engage in the lesson study. Furthermore, students' environmental attitudes in Type III schools, where teachers participated in an online lesson study, demonstrated significant differences compared to those in Type I and Type II schools, where teachers were involved in traditional in-class lesson studies.

The key findings from the research are presented in Tables 5,6 and 8, illustrating the significant impact of teacher involvement in environmental education lesson studies on students' environmental attitudes. However, Tables 9 and 10 indicate that this substantial influence is attributed explicitly to Type III schools. Students' environmental attitudes in Type III schools differ from those in Types I, II, and IV schools. Type III schools consist of Schools C and D, participating in online lesson study

Table 10. Multiple comparisons tukey HSD

School type	School-type	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
I	II	2.03545	.97339	.158	-.4757	4.5466
	III	-4.49529*	.93034	<.001	-6.8954	-2.0952
	IV	2.01273	1.07077	.238	-.7497	4.7751
II	III	-6.53075*	1.05468	<.001	-9.2516	-3.8099
	IV	-.02273	1.18041	1.000	-3.0680	3.0225
III	IV	6.50802*	1.14517	<.001	3.5537	9.4623
*. The mean difference is significant at the 0.05 level.						

activities. Based on interviews summarised in Table 4 and the document of eco-schools (adiwiyata) news in South Tangerang, school C has been designated as an Adiwiyata model school since 2018, while School D received official recognition as an Adiwiyata school in 2023. The enhancement of students' environmental attitudes is not a result of the environmental education lesson study itself but rather stems from the schools' green programme, the eco-schools initiative.

Numerous studies have indicated a significant disparity in environmental attitudes between eco-schools and non-eco-schools (Nieminen, 2022). Eco-schools, also known as green schools, considerably influence environmental attitudes, with a reported effect size of 9.3% (de Pauw & van Petegem, 2011; Saprodi et al., 2019). The improvement in environmental attitudes within eco-schools (Adiwiyata) can be ascribed to their EE curriculum, which is seamlessly integrated into various subjects, particularly in the realm of science education, along with engaging in participatory environmental activities (Larashati et al., 2022). Figure 5 demonstrates that an eco-school represents a comprehensive initiative and that the lesson study approach supports the curriculum and learning development within eco-schools.

Figure 5. Eco-school and lesson study

An intriguing finding pertains to the outcomes observed in type II schools. Based on the interview results (refer to Table 4), EE is delivered as a distinct subject, with one hour of instruction allocated each week. The average environmental attitude score among students in type II schools (82±7.05) surpasses those in type I schools (78.24±7.09), where EE is integrated into science learning. Nevertheless, this observed difference lacks statistical significance (see Table 10, Sig. 0.158). These findings corroborate previous research, suggesting that delivering EE as a standalone subject yields (monolithic) more favourable environmental attitudes than integrating it into other subjects (Istiqomah, Suwondo, 2020). The monolithic approach to teaching EE offers the advantage of concentrating specifically on environmental issues while consistently dedicating one hour per week to student learning.

The environmental attitudes of students attending type I schools demonstrated an average score of 78.24±7.09, higher than the average score of 76.22±8.49 recorded for students in type IV schools. Nevertheless, the analysis of statistical test results revealed that this difference was not statistically significant (refer to Table 10, Sig, 0.238). Based on the interview findings outlined in Table 4, type IV schools engaged in online lesson studies during the 2020-2021 academic year (Herlanti et al., 2022) and continued incorporating EE within their science learning and P5 curricula.

The environmental attitudes of students regarding each question are illustrated in Figure 6. A score of three signifies a "good" environmental attitude, whereas scores below three indicate a low environmental attitude. According to the data presented for questions 1–10, classified under the environmental awareness factors category (refer to Table 2), Type III schools demonstrated superior performance compared to other school types.

The environmental attitudes needed to be more profound for questions 1 and 9. The scores for questions 2, 4, 5, 6, 7, 8, and 10 ranged from 2.5 to 3, suggesting a general need for more awareness regarding environmental issues within this category. A significant number of students appear to lack understanding of the broader benefits of tree planting beyond aesthetic value, the detrimental impact of human activities on nature, the ecological roles of all species, including insects such as flies, as well as the necessity for environmental considerations to take precedence over economic or personal interests when making decisions.
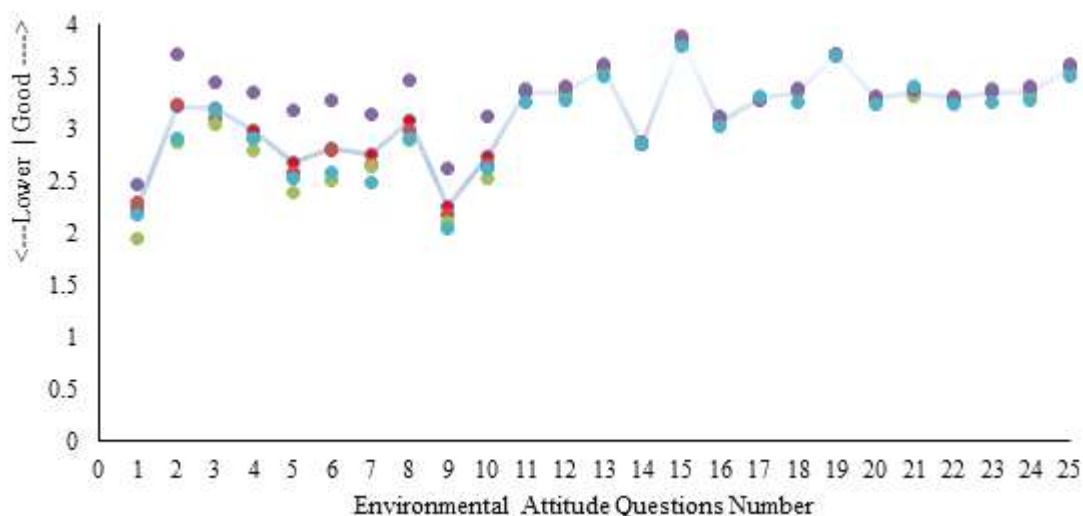

Figure 6. The average achievement of students' environmental attitudes for each question item

As Table 4 suggest that environmental attitudes are cultivated as habitual behaviours through school policies implemented in Schools C and D (School Type III). Figure 6 further underscores the effectiveness of the eco-schools (Adiwiyata) programme in promoting students' environmental awareness. The differences between EE lesson studies and the Adiwiyata programme are delineated in Figure 5. According to Figure 5, the eco-schools programme excels due to its holistic approach, which is integrated across all aspects of the school, including policies, curriculum, participatory activities involving the entire school community, and the management of facilities and infrastructure. In contrast, lesson studies constitute only a minor component of the curriculum, focusing predominantly on integrating environmental education into teaching practices.

■ **CONCLUSION**

The implementation of lesson study in environmental education was executed in a hybrid format. Type I schools executed all four stages of the lesson study process: planning, doing, seeing, and discussing. In contrast, type II and III schools conducted the seeing and discussing stages in person within classrooms and through online platforms.

Environmental education was integrated into the science curriculum and the P5 in type I and IV schools. Conversely, in type II schools, science teachers allocated one hour each week specifically to deliver environmental education as a separate subject. Type III schools integrated environmental education into the science curriculum and the P5 while incorporating participatory environmental activities into the eco-school (Adiwiyata) program.

The average environmental attitude of students in schools where teachers actively participated in lesson study both in-person and online was significantly higher (79.06±7.78) than that of students in schools that did not engage in lesson study (76.22±8.49). A notable difference in environmental attitudes was particularly evident in type III schools, which participated in lesson study online and implemented the eco-school (Adiwiyata) programme. Furthermore, type II schools that engaged in the seeing and discussing stages exhibited more excellent average environmental attitudes among their students than type I schools that participated in all four stages. Within type II schools, science teachers consistently delivered one hour of environmental education each week in a monolithic format rather than integrating it into the science subjects.

Lesson study has predominantly concentrated on intracurricular activities, encompassing online, offline, and hybrid classroom learning. For future research, an opportunity to expand environmental education lesson study to include co-curricular activities (habituation activities) and extracurricular activities (participation activities). This progression aims to enhance students' environmental attitudes.

■ **ACKNOWLEDGEMENT**

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