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Improving Environmental Literacy in Experiential Learning E-Modules in Biology Subjects

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Abstract: Environmental problems have become an increasingly concerning global issue, including climate change, ecosystem damage, and the decline in natural resource quality. One major cause of low public environmental awareness is the lack of environmental literacy skills. This study aims to examine how experiential learning e-modules can empower students' environmental literacy. The research employed a quasi-experimental one-group pretest-posttest design. The sample was selected using purposive sampling based on class considerations and accessibility, involving 35 tenth-grade students. Data were collected through essay tests covering environmental literacy indicators. Data analysis used a t-test and N-Gain test to measure improvement in environmental literacy. The results showed an increase in the average pretest and posttest scores from 58 to 87, with an N-Gain value of 0.7 categorized as moderate. This indicates that the e-module is effective in enhancing students' environmental literacy. The study concludes that experiential learning-based e-modules effectively improve environmental literacy empowerment in biology learning. The approach not only strengthens cognitive understanding but also fosters positive attitudes and environmentally responsible behavior.

INTRODUCTION

Currently, environmental issues are a frequently discussed global issue. Environmental damage occurs due to climate change, natural resource extinction, and damage caused by human activities such as illegal logging and excessive use of natural resources (SDA), without sustainable conservation efforts. Rapid technological developments in various sectors have had an impact on the environment, both positive and negative. One negative impact is environmental damage, which ultimately leads to a decline in environmental quality. Low public awareness of environmental issues is caused by a lack of environmental literacy skills among the community. According to Handayanti (2020), one strategy that can be implemented to foster environmental awareness is to improve environmental

literacy, particularly by instilling these values in students as the nation's next generation. Environmental literacy is defined as an individual's ability to demonstrate responsiveness and concern for environmental conditions, as well as understanding the proper ways to protect and preserve it. Literacy also encompasses the understanding, interpretation, and application of relevant information and knowledge in various fields, such as numerical literacy (the ability to master mathematics), digital literacy (the ability to utilize digital technology), and scientific literacy (the ability to understand and apply scientific concepts) (Idris et al., 2020).

Environmental awareness can encourage individuals to take actions such as reducing energy consumption, using resources efficiently, supporting environmentally friendly practices, and participating in environmental conservation and protection efforts. With increased environmental awareness, it is hoped that individuals and society will collectively take steps to address environmental challenges and maintain the balance of the Earth's ecosystem (Noviyanti et al., 2017). A survey conducted at SMAN 1 Blitar, SMAN 2 Blitar, SMAN 4 Blitar, and SMAN 1 Kademangan with a total of 253 respondents revealed that environmental literacy indicators are still not optimally mastered by students. The environmental literacy indicators are knowledge (70.06%), skills (25.04%), character (35.02%), and environmental behavior (33.40%). Survey results indicate that environmental literacy levels among students are still relatively low. This is supported by preliminary analysis observations, where teachers only teach students conceptual knowledge (Perwitasari et al., 2025). However, environmental literacy empowerment lacks training that should be applied in daily life (Sari & Rosdiana, 2024).

Environmental literacy empowerment can be implemented in the learning process through activities based on experiential learning. Experiential learning is a method that emphasizes direct experience. The integration of experiential learning in environmental education aims to improve environmental literacy and integrate problem-solving practices into everyday life. This approach is aimed at increasing students' awareness and understanding of environmental issues and instilling a

mindset focused on sustainability in everyday life (Sidiq & Najwah, 2020). The application of experiential learning to empower environmental literacy requires supporting open materials, one of which is a systematically structured e-module containing activities that empower environmental literacy. The advantage of experiential learning e-modules lies in their ability to increase validity and student interaction through a learning structure based on real-life experiences. They have been proven to be suitable for use with media and material validity scores above 85%, and are effective in improving conceptual understanding and environmental literacy (Lastri et al., 2021). Therefore, this study aims to develop an experiential learning-based e-module that can empower environmental literacy.

RESEARCH METHODS

1. Design

   This research is an experimental study aimed at examining how experiential learning e-modules can empower students' environmental literacy. This developmental research employed a one-group pretest-posttest design. In this design, the dependent variable is measured at the beginning of the study. After treatment is administered, the dependent variable is measured again (a second time) using the same measuring instrument. This paradigm includes a pretest before treatment, allowing for more accurate results, allowing for comparisons between the pre-treatment and post-treatment conditions. The One-Group Pretest-Posttest Experimental Design is shown in Figure 1.

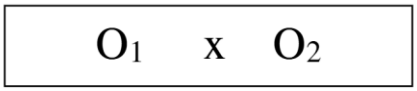

Figure 1. One Group Pretest-Posttest (Arikunto, 2006)

Description :

O1 : pretest

X : treatment

O2 : posttest

2. Participants (subjects)

The target participants in this study were grade 10 students at SMAN 1 Kademangan Blitar.

3. Treatment

In this One Group Pretest-Posttest design, observations were conducted twice: before and after the treatment. The syntax (steps) of the treatment in this study are as follows:

a) Conduct an initial observation/pre-test (pretest or O1) before applying the experiential learning method to the subjects (grade 10 students).
b) Implement the experiential learning method in Biology for grade 10 students at SMAN 1 Kademangan Blitar according to the specified time.
c) Conduct a final test (post-test or O2) to determine the improvement in students' environmental literacy that has been delivered through the application of the experiential learning method (after the treatment).
d) Analyze the research data to test whether the proposed hypothesis is accepted or rejected by comparing the pretest and posttest results. The difference between O1 and O2, O2 - O1, is assumed to be the effect of the treatment.

4. Instruments

The instruments used in this study were a single-group pretest and posttest to assess students' environmental literacy. The test outline can be seen in Table 1.

Table 1. Environmental Literacy Test Outline

<table>
<tr><th>No.</th><th colspan="2">Environmental Literacy Questions</th></tr>
<tr><td rowspan="4">1.</td><td colspan="2">Climate change is a phenomenon of changes in global temperature and weather patterns largely caused by human activity. The burning of fossil fuels such as oil, coal, and gas releases greenhouse gases into the atmosphere, causing Earth's temperature to rise, known as the greenhouse effect. As a result, many significant environmental changes occur, such as melting polar ice caps, rising sea levels, and changing rainfall patterns. The impacts of climate change are felt across various sectors of life. Therefore, it is crucial for every individual to play a role in protecting the environment, such as reducing energy use, recycling, and planting trees to absorb carbon dioxide.</td></tr>
<tr><td>Environmental Literacy Aspects</td><td>Question Indicator</td></tr>
<tr><td>Knowledge</td><td>a) Based on the reading above, explain what is meant by the greenhouse effect and how this process can affect the environment as a whole!</td></tr>
<tr><td>Competencies</td><td>b) What is your view on the importance of</td></tr>
</table>

		protecting the environment to reduce the impact of climate change? Explain your reasons!
	Dispotitions	c) If you lived in an urban area that frequently experienced flooding, what steps would you take to help reduce its impact? Explain the method you think would be most effective!
	Environmentally Responsible Behaviour	d) Are you willing to participate in a carbon emission reduction program, such as planting trees or reducing the use of single-use plastic? Explain your plans and motivations for participating!
2.	Environmental change in Indonesia is increasingly becoming a serious concern. One of the biggest problems is deforestation. Every year, millions of hectares of forest are lost due to illegal logging, land clearing for agriculture, and development. As a result, biodiversity is threatened, global temperatures are rising, and communities living near forests are losing their livelihoods. Furthermore, air, water, and soil pollution caused by human activities are also worsening environmental conditions. Addressing this problem requires the participation of all parties, from the government and companies to the general public. Reforestation programs, proper waste management, and the use of renewable energy can provide solutions.	
	Knowledge	a) What forms of environmental change are described in the reading? Name them and give a brief explanation!
	Competencies	b) What do you think about the statement in the reading that "all parties must participate in overcoming environmental problems"? Explain your reasons!
	Dispotitions	c) Based on the reading, imagine you were given the task of managing deforested land to make it environmentally productive again. What four steps would you take?
	Environmentally Responsible Behaviour	d) Have you ever participated in a reforestation activity or environmental campaign? If yes, please describe your experience. If not, what kind of activity would you like to participate in to contribute to environmental conservation?

RESULTS AND DISCUSSION

Based on the results of the learning analysis, curriculum analysis, and analysis of educator and student needs, the development of e-modules is still expected to address issues related to the limited availability of printed media, such as student textbooks. This is also supported by efforts to promote effective use and open opportunities for integrating supplementary teaching materials with the latest information technology to support the achievement of 21st-century skills (Kimianti & Prasetyo, 2019). Furthermore, the background of the school studied also supports

the concept analysis, as it is an environmentally conscious school. For educators, this research is expected to serve as a reference for improving teaching skills, the ability to utilize teaching materials or learning media, and students' environmental literacy, allowing teachers to more easily and with greater variety in delivering learning materials to students, both in the classroom and from home. Furthermore, the diversity of Indonesia's natural resources can support the development of e-modules, so that the material presented can enhance students' understanding of the potential of the surrounding environment (Anjarwati, 2021).

The effectiveness of the e-module is determined based on the students' environmental literacy test scores that have been conducted in line with the experiential learning-based e-module. This study continues the effectiveness test phase of the experiential learning-based e-module to improve environmental literacy skills in the field by using instruments in the form of environmental literacy essay pretests and posttests which can be seen in Table 2 and in Figure 2. The environmental literacy essay test was conducted in class X-2 of SMAN 1 Kademangan as part of a controlled experiment to test the research hypothesis. Data analysis using normality tests, homogeneity tests, and paired sample t-tests. The prerequisite tests can be seen in Table 3 and Table 4, while the hypothesis tests can be seen in Table 5.

Table 2. Results of the Environmental Literacy Indicator Analysis Essay

Treatment	Indicator	Results
Pretest	*Knowledge*	17.5%
	Disposition	20.0%
	Competencies	18.0%
	Environmentaly Responsible Behavior	18.5%
posttest	*Knowledge*	24.7%
	Disposition	24.5 %
	Competencies	25.5%
	Environmentaly Responsible Behavior	25.3%

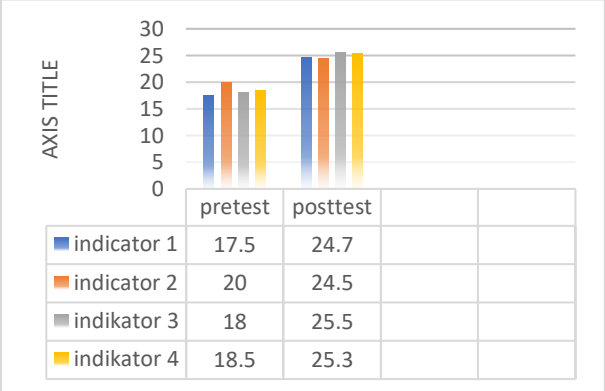

Figure 2. Results of the Environmental Literacy Indicator Analysis Essay

Prerequisite Test

This test was conducted as a prerequisite before the hypothesis tests, which involved normality and homogeneity analysis.

Table 3. Normality Test Analysis Results

Treatment	Sig.	Decision
Pretest	0.241	Normal
posttest	0.124	Normal

Based on the results of the normality test above, it can be seen that each treatment data is normally distributed. The pretest obtained a significance value of 0.131, which is greater than 0.05, thus concluding that the values are normally distributed. The posttest also obtained a value of 0.200, which is greater than 0.05, indicating a normal distribution, as can be seen in Figure 2. To determine the hypothesis test that will be used next, the data will be tested for homogeneity.

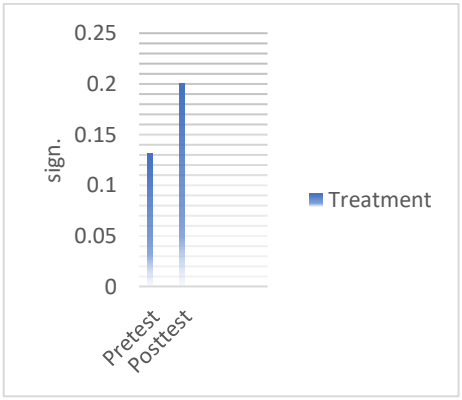

Figure 3. Normality Test Graph

Table 4. Results of the Homogeneity Test Analysis

Sig.	Decision
0.118	Homogen

Based on the results of the homogeneity test, the sig. value was 0.118, which is greater than 0.05. Thus, it can be concluded that the data have homogeneous variance. After the data were declared normally distributed and had homogeneous variance,

Hypothesis Testing

After the data were declared to meet the requirements for normality and homogeneity, the next step was to conduct a hypothesis test. The test used in this study was the Paired Sample T-Test, because the data being compared came from two different conditions (pretest and posttest).

Table 5. Results of the Paired Sample T-Test

Test Statistic	**Sig. *2-Tailed***	**Decision**
Paired Sample T-Test	0.000	There is an effect of using experiential learning-based e-modules on improving environmental literacy skills in biology for grade 10 of high school.

Based on the results of the hypothesis test using the Paired Sample T-Test, the 2-Tailed significant value is 0.000, which is less than 0.05, indicating that H_a is accepted and H_0 is rejected. If H_a is accepted and H_0 is rejected, then the experiential learning-based e-module is effective in improving environmental literacy skills in biology for grade 10 of high school. The results of the Paired Sample T-Test analysis show a 2-Tailed significant value of 0.000, indicating that the experiential learning-based e-module is effective in empowering environmental literacy skills in biology for grade 10 of high school. The activities in the experiential learning-based e-module that were developed address environmental issues, thus providing meaningful learning experiences because they utilize everyday problems. Students are equipped with environmental literacy skills to address environmental issues around them. This is supported by research by Mauludah et al. (2018) that incorporates experiential learning models, or learning materials based on direct experience, using real-life problems in students' daily lives.

In addition to the t-test results, the analysis of students' environmental literacy improvement was also calculated using N-Gain. The calculation results

showed an N-Gain value of 0.7, which falls into the moderate category, as seen in Table 6.

Table 6. N-Gain Results

N-Gain	Description
0.7	Moderate

This indicates that the use of experiential learning-based e-modules significantly improved students' environmental literacy, although there is still room for learning optimization to achieve a high level. These results align with research conducted by Hake (1999), which stated that N-Gain values between 0.3 and 0.7 are categorized as moderate, while values above 0.7 are categorized as high. These findings are supported by previous research, such as that by Yuliani et al. (2018), which demonstrated that experiential learning through innovative teaching materials can improve students' understanding of science concepts and environmental literacy, with N-Gain results in the moderate to high category. This confirms that the presence of experiential learning-based e-modules not only helps students understand concepts but also instills environmental awareness through active involvement in everyday problems. Therefore, the developed e-modules have the potential to be an effective learning medium for environmental literacy empowerment.

The indicator for the ability to identify local environmental issues can be developed. The reflection stage provides space for students to reflect on the causes and impacts of these issues, in line with the indicator for the ability to analyze environmental information from various sources. In the abstract conceptualization stage, students begin to develop ideas or solutions based on theoretical understanding and data, in line with the indicator for the ability to formulate solutions to environmental problems. Finally, in the active experimentation stage, students implement the designed solutions by creating a cleanliness campaign or a simple waste sorting system, in line with the indicator for the ability to actively participate in concrete actions to protect the environment (Arvanitis et al., 2020).

The experiential learning approach not only equips students with knowledge but also develops attitudes and skills for environmental sustainability. Based on all learning activities conducted using experiential learning-based e-modules, it has

been shown to empower students' environmental literacy, with percentages in each domain of knowledge reaching 24.7%, disposition reaching 24.5%, competencies reaching 25.5%, and environmentally responsible behavior reaching 25.3%. Of these four domains, competencies achieved the highest percentage, at 25.5%. This indicates that students not only acquire knowledge but also develop critical thinking skills, problem-solving skills, and the ability to take concrete action on environmental issues. Improvements in this domain are likely influenced by the direct experiences provided in experiential learning. Students are actively involved in exploring and solving environmental problems contextually (Afrianda et al., 2019).

Experiential learning-based e-modules can improve environmental literacy because they are supported and complemented by images, videos, and articles explaining environmental issues, indirectly training students in solving environmental changes occurring in their surroundings. Supported by research conducted by Tivani et al., (2016) that learning using experiential learning-based worksheets can improve problem-solving skills and environmental character. This is in accordance with the syntax of experiential learning built from constructivist learning theory, which builds students' knowledge in a personally meaningful way from the problems presented and the actions they will take, thus presenting learning by analyzing an environmental problem. The goal of experiential-based learning is to solve a specific problem (Eggen et al., 2012). One of the characteristics of experiential learning is using everyday problems in the real world as a starting point for learning.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of increasing environmental literacy in the experiential learning e-module in biology subjects, namely a significant increase in environmental literacy test scores with normality tests and paired sample t-tests, namely pretest and posttest data are normally distributed and homogeneous, proven effective in increasing students' environmental literacy. The results of the N-Gain test showed a score of 0.7 which is included in the medium category, so it can be

interpreted that the use of experiential learning-based e-modules is quite effective in increasing students' environmental literacy. Although it has not reached the high category, this value confirms a consistent and significant increase compared to before the treatment. This medium category also indicates that most students are able to link biological concepts with everyday environmental problems, but more varied learning activities are still needed so that literacy improvements can reach the high category.

Further research is recommended to develop experiential learning-based e-modules with interactive content and implementation at different school levels to further test their effectiveness. Combining them with collaborative or project-based learning models can also strengthen student engagement. Furthermore, measurement should focus not only on environmental literacy but also on environmental awareness and critical thinking skills, so that the learning impact is more comprehensive.

REFERENCES

Afrianda, R., Yolida, B., & Rita, M. R. T. (2019). The Effect of the Adiwiyata Program on Environmental Literacy and Environmental Care. Bioterdidik Journal, 7(1), 32–42.

Anjarwati, A. A. (2021). Developing an Immune System E-Module for Grade XI Based on Local Natural Resources Using the Book Creator Application in Online Learning. Proceedings of the 11th SNST 2021, Faculty of Engineering, Wahid Hasyim University, 115–121.

Arvanitis, A., et al. (2020). Experiential learning in higher education. Journal of Educational Psychology.

Eggen, P., & Kauchak, D. (2012). Learning strategies and models (teaching content and thinking skills). Jakarta: Indeks.

Hake, R. R. (1999). Analyzing change/gain scores. American Educational Research Association. Retrieved from http://www.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf

Handayanti, S. (2020). Comparison of Environmental Literacy Skills of 11th-Grade Students at Adiwiyata and Non-Adiwiyata Schools in South Tangerang City. Thesis. UIN Syarif Hidayatullah Jakarta. https://doi.org/10.31219/osf.io/3v248

Idris, M., Mokodenseho, S., Willya, E., & Otta, Y. A. (2020). Integration of Environmental-Based Education by Improving Nutritional Knowledge and Attitudes, 3(3), 69–70.

Kimianti, F., & Prasetyo, Z. K. (2019). Development of a Science E-Module Based on Problem-Based Learning to Improve Students' Science Literacy. Kwangsan: Journal of Educational Technology, 7(2), 91. https://doi.org/10.31800/jtp.kw.v7n2.p91--103

Lastri, N., Hamidah, A., & Effendi, M. H. (2021). Development of an experiential learning-based e-module on environmental pollution for seventh-grade junior high school students. Edu-Sains: Journal of Mathematics and Natural Sciences Education, 10(2), 43–50. https://doi.org/10.22437/jmpmipa.v10i2.10343

Mauludah, N., Roshayanti, N., & Sumarno. (2018). The effect of a problem-solving-based learning model on improving students' environmental literacy skills at SMA Negeri 1 Batangan. Journal of Biology and Its Learning, 5(2), 15–20.

Noviyanti, L. A., Rachmawati, D. A., & Sutejo, I. R. (2017). Digital Repository, University of Jember Digital

Perwitasari, N., Septikasari, Z., & Prihandoko, Y. (2025). Teaching Eco-Literacy: What is the Challenge in Indonesian Elementary Schools. Scientific Journal of Educational Professions, 10(1), 84–93. https://doi.org/10.29303/jipp.v10i1.3142

Sari, I. J., & Rosdiana, R. (2024). Analysis of high school students' scientific literacy on the concept of environmental pollution. Journal of Science and Education Research (JPSP), 4(1). https://doi.org/10.23971/jpsp.v4i1.7862

Sidiq, R., & Najwah. (2020). Development of an Android-Based Interactive E-Module for the Teaching and Learning Strategies Course. Journal of History Education. 9(1).

Tivani, I., & Paidi. (2016). Development of a Problem-Based Biology Student Worksheet to Improve Problem-Solving Skills and Environmentally-Careful Character. Journal of Science Education Innovation, 2(1), 35. https://doi.org/10.21831/jipi.v2i1.8804

Yuliani, E., Sutopo, & Indriwati, S. E. (2018). Development of a Problem-Based Biology Learning Tool to Improve High School Students' Environmental Literacy. Indonesian Journal of Biology Education, 4(2), 123–132. https://doi.org/10.22219/jpbi.v4i2.5947