

Development of Integrated ESD PBL E-LKPD to Improve Critical Thinking Skills and Environmental Literacy of Phase E Students at SMA N 1 Seyegan

Saraswati^{1*}, Suhartini²

¹ Magister Pendidikan Biologi, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

² Pendidikan Biologi, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

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Corresponding Author:

Saraswati

sarasswati.25@gmail.com

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Abstract: This study aims to determine the feasibility, practicality, and effectiveness of E-LKPD Problem Based Learning (PBL) integrated with Education for Sustainable Development (ESD) in ecosystem material to improve critical thinking skills and environmental literacy of SMA phase E students. This study is a Research and Development (R&D) study with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). E-LKPD was evaluated by experts, practitioners, and tested for its effectiveness on SMA N 1 Seyegan phase E students. Data collection instruments used interviews, questionnaires, and test instruments. Instrument validity techniques involve content validation by experts and empirical validation using statistical programs based on the magnitude of the $R_{count} \geq R_{table}$ value or $Sig \text{ value} < 0.05$. Data analysis techniques use the manova test at a significance level of 0.05 and n-gain score. The results of this development research indicate that the development of E-LKPD is assessed from the feasibility of material experts and media experts to obtain a very good category; assessed from biology teacher practitioners and students to obtain a very practical category; and effectively improve critical thinking skills and environmental literacy of students. This result is supported by the average gain score results which show that there is an increase in critical thinking skills and environmental literacy of students in the fairly effective category of 0.60 and 0.72 whose learning uses E-LKPD PBL integrated with ESD.

Keywords: Critical thinking skills; Development; Education for Sustainable; E-LKPD; Environmental literacy; Problem based learning

Introduction

The 21st century brings rapid and complex changes in various aspects of life, driven by technological advances that replace many human roles. In this context, the skills needed by humans must develop to face new challenges (Pratiwi et al., 2019). These changes affect human life and demand improvements in the quality of human resources in various fields, including education. 21st-century education emphasizes the development of skills such as creativity, critical thinking, collaboration,

problem solving, communication skills, social skills, and character skills (Mardhiyah et al., 2021). According to Trilling et al. (2010) and Wijaya et al. (2016), 21st-century skills include life and career skills, learning and innovation skills, and information, media, and technology skills. Therefore, education is an effort to improve the standard of human welfare and is an important part of national development.

Partnership for 21st Century Skills emphasizes that 21st century learning must include four core competencies: communication, collaboration, critical

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thinking, and creativity. However, based on the analysis of the 2022 PISA study, Indonesia is ranked 67th out of 81 participating countries (Foster, 2023). These results show that Indonesian students only master low-level questions that are routine, simple computations, and measure factual knowledge in everyday contexts. They are less proficient in high-level questions that require analysis, creativity, and critical thinking. In fact, critical thinking skills are very important for carrying out various analyses, assessments, evaluations, reconstructions, and rational and logical decision-making (Mardhiyah et al., 2021). Wayudi et al. (2020) in their research revealed that the critical thinking skills of high school students in Indonesia are in the low category, as also stated by Hidayati et al. (2021).

The results of the initial assessment of phase E students at SMAN 1 Seyegan on ecosystem material showed low results, where 60% of students had not achieved the minimum passing grade. This is likely due to the lack of mindset in solving problems and understanding of each material presented. Istiqomah et al. (2019) reported that students' low critical thinking skills were caused by several factors, including teacher-centered learning and low mastery of analytical skills by students that require reasoning and problem solving. Therefore, it is necessary to apply a learning model that encourages students' critical thinking skills.

One of the learning models that can provide a learning environment to support critical thinking is problem-based learning (PBL). Research conducted by Anggraini et al. (2020) concluded that learning using the PBL model can improve cognitive learning outcomes in biology. Problem solving is related to critical thinking skills because critical thinking is a process used when generating new ideas by combining previously existing ideas (Gita et al., 2017). The problems presented in PBL can arouse students' curiosity, so that they are interested in investigating the problem (Occhipinti, 2019; Pozuelo-Muñoz et al., 2023; Rézio et al., 2022; Sukacké et al., 2022). When students conduct investigations, they use critical thinking stages to investigate problems, analyze evidence, and make decisions based on the results of the investigation. This can increase students' mental activity (N. Anggraini et al., 2021; Hernández-Barco et al., 2021; Lozano et al., 2022).

According to Yuliastri (2023), critical thinking skills are positively correlated with environmental problems. Various environmental problems such as pollution, air pollution, ozone layer depletion, global warming, and flooding disrupt the biogeochemical cycle, ecological changes, and animal habitats (N. Anggraini et al., 2022). This problem is likely to occur due to a person's low environmental literacy, which includes attitudes, responsibilities, concern, and awareness of the environment (Fitri et al., 2022). The

environmental literacy domain according to NAAEE (2011) in Nasution (2016) includes the knowledge domain (environmental knowledge), dispositions domain (attitudes towards the environment), competencies domain (environmental competencies), and environmentally responsible behavior (responsible behavior towards the environment). Environmental literacy can be built through understanding the conditions of the surrounding environment due to the interaction between humans and the environment.

Awareness of environmental issues must also be directed towards sustainability. UNESCO officially introduced the concept of Education for Sustainable Development (ESD) which aims to improve the quality of life and improve the quality of human life with the principle of sustainability through education (UNESCO, 2012). Sustainable education aims to educate the next generation of the nation who contribute to sustainable development activities. This goal is formulated in the Sustainable Development Goals (SDGs) which contain 17 goals (United Nations, 2017). The concept of sustainable development prioritizes environmental protection and economic development simultaneously, so that the implementation of development must consider the sustainability of natural resources and the environment for the benefit of future generations.

Research conducted by Anggraini et al. (2021) concluded that students' environmental literacy skills were in the moderate category for the knowledge and competence aspects, and the high category for environmental attitudes. Research by Maulidya et al. (2014) found that students' knowledge was in the high category, while environmental attitudes and behavior were in the moderate category. Rohweder in Nasution (2016) stated that low environmental literacy was caused by a lack of intention to study environmental issues. Initial assessments of phase E students at SMAN 1 Seyegan showed that their environmental literacy was moderate, with only 40% showing an attitude of caring for the environment. This shows that environmental care practices are still rare.

The low critical thinking skills and environmental literacy of students require an appropriate learning model. The problem-based learning (PBL) model oriented towards sustainable education (ESD) can be an effective solution. The application of PBL in the learning process teaches students to solve problems with investigative skills in the real world (Hanifa et al., 2018), while the ESD framework provides comprehensive education on social, economic, and environmental issues related to sustainability (Saribas, 2015). Therefore, the use of the PBL model integrated with ESD can train students' critical thinking skills to solve problems and provide comprehensive education on sustainable issues.

Learning materials related to environmental issues are ecosystem materials. This material is found in the second semester phase E biology lesson which discusses components, food chains, and material cycles. Ecosystem materials are very relevant to everyday events, so learning should be done by presenting ecosystem problems that occur in the student's environment. Problem-based learning involving everyday natural phenomena can help students gain a more meaningful understanding and construct knowledge independently. According to Muthmainah et al. (2016), students who understand the concept of ecosystems will experience a more positive change in attitude towards the environment.

However, the results of interviews with biology teachers at SMAN 1 Seyegan showed that learning ecosystem material is still done through lectures and practice questions, without linking natural phenomena that occur, so that learning is theoretical. The questions given only test the level of remembering (C1), understanding (C2), and applying (C3), which do not hone students' critical thinking skills and environmental literacy. The LKPD used is still in printed form and is less interesting for students. The classroom atmosphere feels boring, with one-way learning and a lack of active student involvement. Many students do not pay attention to the teacher and some even open their cellphones secretly. The lack of variation in learning makes students less interested and active in learning. Research by Handayani et al. (2022) shows that learning variations are positively correlated with student activity. Learning also does not utilize the internet facilities available at school.

To overcome this problem, a solution is needed that can add variety to learning and make it more interesting for students. One solution is to develop electronic learning materials or E-LKPD. Learning materials that utilize technology can help the teaching and learning process become more interesting, effective, and efficient. According to Maghfiroh et al. (2022), the use of E-LKPD can improve cognitive, affective, and psychomotor learning outcomes. This is because PBL-based E-LKPD provides opportunities for students to learn independently, find their own concepts, and develop critical thinking skills.

Based on this background, research on "Development of Integrated PBL E-LKPD ESD on Ecosystem Material to Improve Environmental Literacy and Critical Thinking Skills of Students of SMAN 1 Seyegan Phase E" needs to be conducted. This study aims to develop effective and interesting electronic teaching materials to improve environmental literacy and critical thinking skills of students. By utilizing technology and integrating PBL learning models with ESD, it is expected to improve the quality of learning and

learning outcomes of students, as well as contribute to supporting sustainable education in Indonesia.

Method

This research is included in the type of development research, known as Research and Development (R&D), which aims to create a product that is feasible, practical and has value (Harefa et al., 2023). This development research refers to the ADDIE model. This development research approach refers to the ADDIE model. In this model, the E-LKPD development process based on integrated ESD PBL is carefully designed, allowing the development of products that are in accordance with learning, needs, and objectives. ADDIE is an acronym that explains the five basic steps of development design, namely Analysis, Design, Development, Implementation, and Evaluation. The following is a summary of the ADDIE model design in this development research.

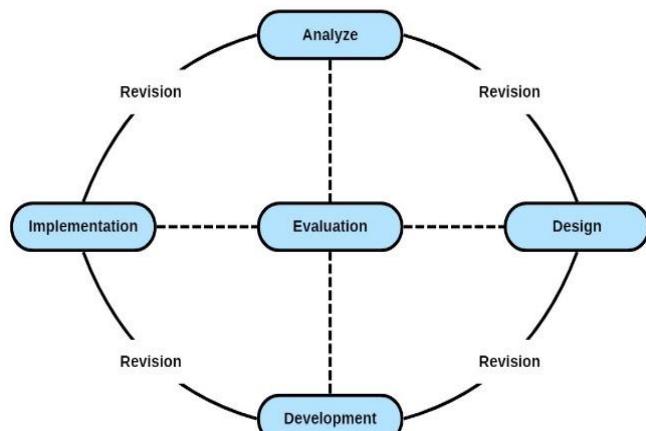


Figure 1. ADDIE design model

The first stage is the analysis stage, which is the identification and analysis of various needs and determining the right problems, solutions, and products including curriculum analysis, needs analysis, and analysis of student characteristics. The results of this analysis are taken to the next stage, namely the design of the product to be developed. At the design stage, the E-LKPD framework to be developed is designed along with the research instruments to be used. At the development stage, product development is carried out from the framework that has been made along with the research instruments. In addition, validation of the E-LKPD from media experts and material experts, validation of the practicality of biology teachers and students, revision I, limited trials, and revision II are also carried out. At the implementation stage, the implementation of the E-LKPD that has been developed in the field trial is carried out in phase E learning at SMA

N 1 Seyegan. At the evaluation stage, it is carried out throughout the research process.

Result and Discussion

Analysis Stage

This analysis stage aims to identify problems and needs in biology learning at SMA N 1 Seyegan to improve learning achievement. This stage is very important to understand the problems faced and determine what is needed by students so that they can achieve or even exceed the learning achievement targets that have been set. This analysis was carried out by involving biology teachers at SMA N 1 Seyegan, as well as students through a needs assessment sheet.

The results of the analysis showed several findings, including that SMA N 1 Seyegan has just started implementing the independent curriculum. The implementation of this curriculum is still in the transition phase, meaning that the school is in the process of adjusting from the old curriculum to the new curriculum. In this transition phase, there are shortcomings in the variety of media and teaching materials used. Teachers still rely on media and teaching materials provided by publishers, such as textbooks and printed Student Worksheets (LKPD), which are not in accordance with the characteristics of the independent curriculum. The LKPD currently used contains a summary of the material and practice questions. However, this LKPD has significant shortcomings in terms of visual appeal. The illustrations in the LKPD are limited and not colored, which reduces its effectiveness in attracting student interest and makes the learning process less enjoyable. Students expressed that they really need a more varied and interesting learning approach. The school allows students to bring cellphones and provides wifi facilities in each class. However, its use in the learning process is not optimal. The biology learning process at SMA N 1 Seyegan is still carried out using the lecture method in class, so it often does not utilize relevant environmental phenomena.

One of the materials that is closely related to the environment is ecosystem material. The results of the initial assessment showed that 60% of students had not achieved minimal completion in ecosystem material and 40% of students had low environmental literacy scores, indicating that environmental care practices were still rarely carried out. This was also confirmed by interviews with teachers, which revealed that assessments and practice questions had not yet accustomed students to questions that required critical thinking skills and environmental literacy skills. Based on the results of this analysis, there is an urgent need to develop teaching materials that can present environmental problems that are relevant to sustainable values, so that researchers

formulated an innovation in the form of developing E-LKPD based on Problem Based Learning (PBL) which is integrated with Education for Sustainable Development (ESD) on ecosystem material.

Design Stage

At the design stage, an E-LKPD framework was created using Canva software to facilitate the creation of attractive and interactive visual materials. This E-LKPD consists of three learning meetings, each of which contains ESD-integrated PBL syntax. At this stage, a teaching module was also designed to guide the implementation of learning using ESD-integrated PBL E-LKPD. This module includes detailed instructions on how E-LKPD is applied in learning and how each element of learning should be carried out. In addition, research instruments were also designed, including feasibility assessment instruments for material experts and media experts, practicality assessment instruments carried out by biology teachers and students, and environmental literacy and critical thinking skills question instruments.

Development Stage

At this stage, the development of the E-LKPD framework that has been made in the previous stage is carried out, in addition to expert validation, practicality assessment, and limited trials. Expert validation is carried out by lecturers from biology education, faculty of mathematics and natural sciences, Yogyakarta state university. E-LKPD is assessed by two experts based on material and media aspects.

Table 1. Results of the Feasibility Assessment on the Material Aspect

Aspects	Score	Category
Suitability and accuracy of materials	16	Good
Material presentation techniques	33	Very good
Relevance of facts and concepts of the material	4	Very good
Language	12	Very good
Average	65	Very good

Table 2. Results of the Feasibility Assessment on the Media Aspect

Aspects	Score	Category
Display quality	16	Very good
Language	12	Very good
Quality of illustrations (articles, images and videos)	12	Very good
Average	40	Very good

After validation, a limited trial was conducted on the research instrument to measure its validity and reliability. The environmental literacy and critical thinking skills instruments were tested on 36 phase E

students at SMA N 1 Seyegan using a paper-based test. Item analysis was conducted to determine valid and reliable items to be used in the pre-test and post-test instruments of the implementation stage.

Table 3. Results of Practicality Assessment by Biology Teachers

Aspects	Score	Category
Material	13	Very good
Language	9	Good
Media	21	Very good
Learning	20	Very good
Average	63	Very good

Table 4. Results of Practicality Assessment by Students

Aspects	Score	Category
Language	17.31	Very good
Learning	17.53	Very good
Display quality	7.14	Very good
Operational convenience	13.69	Very good
Presentation	13.44	Very good
Average	69.11	Very good

At this stage, a practicality assessment was also carried out by two practitioners, namely biology teachers at SMA N 1 Seyegan and 36 students. Input and suggestions provided by experts and practitioners will then be used as a basis for further improvements.

Implementation Stage

In the implementation stage, a trial of the product along with all research instruments was conducted on a larger group after revision. This large group trial was conducted at SMA N 1 Seyegan, Sleman Regency, for three meetings starting on February 20, 2024. The method used was a quasi experiment with a non-randomized control group pretest-posttest design. This trial involved two classes: X-G (36 students) as the control class and X-H (36 students) as the experimental class. The experimental class used E-LKPD PBL integrated with ESD, while the control class used LKPD Discovery Learning prepared by the researcher.

Table 5. Results of the N-Gain analysis of Environmental Literacy

Domain	Class	N-gain	Criteria
Knowledge	Experiment	0.61	Quite Effective
	Control	0.42	Less Effective
Competencies	Experiment	0.60	Quite Effective
	Control	0.55	Less Effective
Dispositions	Experiment	0.64	Quite Effective
	Control	0.56	Quite Effective

The results of the study showed differences in increasing environmental literacy in three domains (knowledge, competencies, and dispositions) between

the experimental class and the control class. In the knowledge domain, the experimental class scored 61% (quite effective), while the control class scored 42% (less effective), meaning that students in the experimental class understood aspects of environmental knowledge well. In the competencies domain, the experimental class scored 60% (quite effective), while the control class scored 55% (less effective), meaning that students in the experimental class had developed skills and abilities related to environmental literacy. In the dispositions domain, the experimental class scored 64% (quite effective), while the control class scored 56% (quite effective), meaning that students in the experimental class showed a positive attitude towards the environment.

Table 6. Results of N-Gain Analysis of Critical Thinking Skills

	Experimental Class	Control Class
Percentage (%)	72.18	48.88
N-Gain	0.72	0.49
Criteria	Quite Effective	Less Effective

In the experimental class, the average pre-test score of critical thinking skills was 56 and the post-test was 86, while in the control class the average pre-test score was 57 and the post-test was 78. This shows a higher increase in critical thinking skills in the experimental class compared to the control class. The N-gain value analysis supports this result, with the experimental class obtaining an average percentage increase in N-Gain of 72.18% (quite effective), while the control class obtained 48.88% (less effective). This study is in line with previous studies showing that PBL is more effective than other learning models in improving students' critical thinking skills. PBL emphasizes solving real problems, encourages deep and creative thinking, and engages students in a learning process that is centered on them. ESD-integrated PBL E-LKPD has proven to be quite effective in improving critical thinking skills of phase E students on ecosystem material, combining ecological, economic, and social concepts for sustainable learning. This helps students develop higher-order thinking skills and prepares them to face complex challenges in the future.

Evaluation Stage

At this stage, various improvements are made in the product development process. In the first evaluation stage, an evaluation is carried out by material experts, media experts, biology teacher practitioners, and student practitioners. The evaluation results are used as a reference for improvements in each development process, so that the products developed are in accordance with learning needs. In the second

evaluation, an evaluation is carried out related to the implementation of the E-LKPD product along with the instruments developed.

Conclusion

Based on the results of research and development, it is concluded that E-LKPD PBL integrated with ESD is suitable for use in biology learning because it meets various assessment aspects such as material accuracy, presentation, and display quality; practical for use in ecosystem learning in SMA phase E according to the assessment of biology teachers and students; and effective for use in improving environmental literacy and critical thinking skills of students in ecosystem material.

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Conflicts of Interest

This research did not experience any conflict during the completion of the writing. All parties can work together very well.

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