OPEN ACCESS

Journal of Excellence in Natural Science Education
Vol. 1 No. 1. December 2025, pp. 24-43

DOI. XX.XXXXX/jense.vxix.xxx

Research Article

THE EFFECT OF LKPD-EL ESD PROJECT ON USED COOKING OIL PROCESSING ON CREATIVE DISPOSITION AND SCIENCE LITERACY

Salma Aziza Yasmin[1], Ekosari Roektiningrum[2], and Asri Widowati[3]
[1] Yogyakarta State University, Indonesia
[2] Yogyakarta State University, Indonesia
[3] Yogyakarta State University, Indonesia

Corresponding Author:

Salma Aziza Yasmin,
Department of Science Education, Faculty of Mathematics and Natural Sciences, Yogyakarta State University.
Jl. Colombo No.1, Karangmalang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281
Email: salmaaziza.2021@student.uny.ac.id

Article Info

Received: 5-11-2025
Revised: 19-11-2025
Accepted: 10-12-2025
Online Version: 15-12-2025

Abstract

Low creative disposition and science literacy skills, as well the lack of relevance of teaching materials, remain obstacles in the learning process. Learning innovation in the form of applying ESD-based electronic worksheets focused on used cooking oil management is needed. The purpose of this study is to determine the effect of using ESD-based electronic worksheets on improving students' creative disposition and science literacy skills. This study used a quasi-experimental nonequivalent control group design. The research was conducted in a public junior high school in Yogyakarta with a population of 10 classes from grades VIII A to J. The sample used cluster random sampling, and grade VIII E was selected as the experimental class and grade VIII G as the control class. The research instruments included an observation sheet on learning implementation, a creative disposition questionnaire, and science literacy questions. The scoring techniques used were the N-Gain test, normality test, homogeneity test, independent sample T-test, and Cohen's effect size d test. The results showed that the use of ESD-based electronic worksheets for used cooking oil processing had a significant effect on: (1) creative disposition ability with a significance of 0.001, an effect size of 2.13966 in the very strong category; and (2) science literacy ability with a significance of 0.001, an effect size of 1.25231 in the very strong category.

Keywords: electronic LKPD, ESD PjBL, waste cooking oil processing, creative disposition skills, science literacy skills.

Journal Homepage	https://jurnal.educatech.id/index.php/jense
How to cite:	Yasmin, S. A., Roektiningrum, E., & Widowati, A. (2025). The Effect of LKPD-EL ESD Project on Used Cooking Oil Processing on Creative Disposition and Science Literacy. *Journal of Excellence in Natural Science Education 1*(1), 24–43
Published by:	Indonesia Cakap Digital

INTRODUCTION

Science education in Indonesia is currently focused on preparing students to succeed in the 21st century. The National Education Association identifies the skills that students must possess in the 21st century as “The 4Cs,” which include critical thinking, creativity, communication, and collaboration (Suparya et al., 2022: 161). However, the reality on the ground shows that the demands of 21st-century skills in Indonesia are still not fully adequate. Isma et al. (2023: 24) say that the main problems in developing 21st-century skills in students include obstacles in educational infrastructure, low quality and relevance of the curriculum, and issues related to teaching staff.

Education today prioritizes the development of skills that are relevant to the demands of the times, with 21st-century skills being a major focus. 21st-century skills in the form of creative disposition skills are a person's tendency to think and do things under conscious control and voluntarily with a deliberate orientation towards broader goals (Noyes, 2000: 2). Creative disposition can also be referred to as Habits of Mind (HOM). HOM is a term that refers to strong mental dispositions and intelligent behavior, introduced by Costa & Kallick (2008: 203) with the concept of thinking habits with a tendency to behave intellectually or intelligently when faced with problems, especially those whose solutions are not immediately apparent. Through a strong creative disposition and intelligent behavior, a person will have the ability to face various life problems and situations, ranging from simple to very complex, with high self-confidence and independence (Tran-Duong & Do-Hung, 2025: 5). However, the results of the 2015 Global Creativity Index survey show that Indonesia is one of the countries with a low level of creativity. Indonesia ranks 115th out of 139 countries in terms of creative thinking skills and abilities (Florida et al., 2015: 57). In addition, based on preliminary research, the creative disposition of eighth-grade students at a public junior high school in Yogyakarta is still relatively low, as seen from interviews with science teachers and direct observation. Most students tend to be passive, lack confidence, and show minimal initiative, both in expressing their opinions and completing tasks creatively, as seen from the observation results which show that they wait for the teacher's instructions rather than looking for solutions themselves.

Another 21st-century skill that deserves significant attention is scientific literacy. According to the Organization for Economic Co-operation and Development (OECD), scientific literacy is the ability to use knowledge to formulate questions, build new knowledge, explain scientifically, draw conclusions based on evidence, and think reflectively when facing scientific challenges (OECD, 2019: 78). The National Academy of Science (1996: 31) states that the importance of science literacy lies not only in understanding and knowledge of scientific concepts and processes, but also in the ability of individuals to make appropriate decisions and play an active role in various aspects of social, cultural, and economic life in society. The development of science literacy equips students with the knowledge and skills to understand natural phenomena and technology and to make wise decisions on global issues. This is an important investment in shaping a generation capable of supporting a sustainable future. However, the level of science literacy among students in Indonesia is still far below average, as evidenced by the results of the science literacy evaluation in the PISA (Programme for International Student Assessment) program, which announced that Indonesia ranked 67th out of 81 countries in 2022 with a score of 383 (OECD, 2023: 63). In addition, based on preliminary research, the science literacy skills of eighth-grade students at a public junior high school in Yogyakarta City are still relatively low, as seen from the results of the Minimum Competency Assessment (AKM) for science literacy, with an average score of 66.46.

The lack of 21st-century skills among students requires educators to develop teaching materials using learning methods that can improve students' 21st-century skills. Creative disposition and science literacy skills can be developed using teaching materials that are appropriate and in line with the times. One type of teaching material that is in line with the times is the electronic Student Worksheet (LKPD elektronik). The electronic LKPD is a form of teaching material that is systematically arranged into specific learning units and presented in electronic format (Lathifah et al., 2021: 28). Electronic LKPD is an attractive tool when students' interest in learning begins to decline, so it can help increase their interest in the material being taught (Syafitri & Tressyalina, 2020: 286). However, there are still many educators who have not optimally utilized electronic LKPD in the learning process. Research on electronic worksheets used by educators in schools is generally still in printed form and does not fully meet the needs of existing practical work (Suryaningsih & Nurlita, 2021: 1260). Therefore, to support a more effective and interactive learning process, electronic worksheets that are adapted to current learning conditions and needs are required.

In addition to the use of electronic LKPD, learning can be developed using the Project Based Learning (PjBL) model. PjBL is a learning model that emphasizes projects as its focus by involving students in the process of solving problems with the end result being a valuable product that is relevant to real-life situations (Mayuni et al., 2019: 185). According to Kamaruddin's research (2023: 2745), the successful implementation of the PjBL model in the context of education can provide benefits for students in understanding concepts, developing skills, and preparing themselves to face challenges in the real world. However, implementing the PjBL model is not a simple matter. Educators need to have a deep understanding of how to effectively apply this model in various educational contexts (Kamaruddin, 2023: 2743). In addition to PjBL, learning models have been developed using a sustainable development approach. Education for Sustainable Development (ESD) is learning to help shape students to participate in sustainable development (Hoffmann & Siege, 2018: 5). Amran et al. (2019: 372) state that learning based on ESD by integrating various models, tools, and learning media has the potential to improve cognitive abilities and develop relevant 21st-century skills. However, in practice, the learning process is often still focused on the dominant aspect of imparting knowledge, resulting in the implementation of ESD not yet reaching an optimal level. According to Amran's research (2019: 368), the lack of ESD achievement is due to the fact that some educators still do not fully understand the concept of ESD in the context of its application in science learning.

The application of ESD-based electronic worksheets in this study focused on an environmental issue that is often overlooked but has a significant impact, namely the management of used cooking oil waste. The role of education, particularly through learning using ESD-based electronic worksheets, is very important. Through waste cooking oil management activities in the learning process, students not only gain knowledge about the negative impacts of improper waste disposal but also learn about creative and innovative environmentally friendly solutions. Thus, this study provides practical recommendations for educators in implementing the use of ESD-based electronic worksheets in mixed sub-chapter materials that integrate sustainability issues into the science education curriculum. This study also aims to determine the effect of implementing ESD-based electronic worksheets on waste cooking oil management on students' creative disposition and literacy skills.

RESEARCH METHOD

Research Design

This research is a quantitative study employing the Quasi-Experimental method with a Nonequivalent Control Group Design. In this design, two groups were selected using random procedures, consisting of an experimental group and a control group. The experimental group received treatment using electronic LKPD based on ESD projects for waste cooking oil processing, while the control group was given treatment using printed LKPD based on Discovery Learning. Before the treatment was administered, an initial measurement was conducted through a pretest, and after the treatments were completed in both groups, a final measurement was conducted through a posttest to determine whether there was an effect resulting from the different learning approaches.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X_1	O_2
Control	O_3	X_2	O_4

This study was conducted at a public junior high school in Yogyakarta during the even semester of the 2024/2025 academic year, from February to March 2025. All research activities, including the implementation of treatments, pretests, posttests, and observations, were carried out in the natural school environment during regular classroom learning sessions.

Research Target/Subject

The population in this study consisted of all 316 eighth-grade students divided into 10 classes ranging from Class VIII A to VIII J. The research sample was determined using cluster random sampling, conducted by generating random numbers through Excel. The selected samples consisted of Class VIII E as the experimental class and Class VIII G as the control class, each comprising 32 students. These samples were chosen to represent the population and to allow comparison of learning outcomes between students receiving electronic ESD-based LKPD and those receiving printed LKPD based on Discovery Learning.

Research Procedure

The research procedure began with a pretest administered to both the experimental and control groups to measure their prior knowledge and initial abilities. Following this, the experimental group received treatment using electronic LKPD developed based on ESD PjBL projects for waste cooking oil processing, while the control group received treatment using printed LKPD designed based on Discovery Learning syntax. Throughout the learning process, observers monitored the implementation of learning activities in both classes. After completing the treatment sessions, a posttest was administered to both groups to determine changes in student learning outcomes and to evaluate the effectiveness of the treatments. The procedure ensured consistency across both groups to maintain the validity of the experimental comparison.

Instruments, and Data Collection Techniques

Several instruments were used to collect data in this study, including teaching modules for both experimental and control classes, observation sheets on learning implementation following the ESD PjBL syntax, and electronic student worksheets. Additional instruments included a creative disposition questionnaire comprising 20 statements—15 positive and 5 negative—covering five indicators: curiosity, collaboration, perseverance, imagination, and discipline. Science literacy test items were also administered, consisting of 25 questions based on three indicators: explaining scientific phenomena, evaluating and designing investigations, and interpreting data and evidence scientifically. Data collection techniques involved classroom observations using scoring sheets, administration of questionnaires, and the use of written tests. Questionnaire and test data were also analyzed using N-Gain to measure improvement before and after treatment.

Data Analysis Technique

The data analysis techniques used in this study included several stages. First, descriptive statistics were employed to calculate the mean, standard deviation, variance, maximum value, and minimum value for each measured variable. Next, prerequisite tests were conducted, including the Shapiro–Wilk normality test and Levene's homogeneity test, with data considered normal when the significance value (Sig.) was greater than 0.05. Inferential statistical analysis was then performed using the Independent Sample T-Test to determine whether there were significant differences between the experimental and control groups; results were considered significantly different if the significance value (Sig.) was less than 0.05. Additionally, an effectiveness test using Cohen's effect size (d) was conducted to evaluate the magnitude of the treatment's impact. These techniques ensured that the interpretation of data aligned with the research objectives and provided a comprehensive evaluation of the implemented learning interventions.

RESULTS AND DISCUSSION

This study involved 316 eighth-grade students divided into 10 classes. The sample consisted of class VIII E as the experimental class (using PjBL ESD-based electronic worksheets) and class VIII G as the control class (using DL-based printed worksheets), each with 32 students. The material used was a mixed subchapter, with three meetings over two weeks. Creative disposition data were obtained through a questionnaire containing 20 statements, while science literacy data were obtained from 25 questions, both of which were compiled based on related indicators. The initial questionnaire and pretest were conducted before learning, while the final questionnaire and posttest were conducted after learning. Learning implementation data were measured through observation, and all data were analyzed using descriptive statistics, normality and homogeneity tests, independent sample T-tests, and effect size tests.

Observation of Learning Implementation

Learning implementation observation was conducted to assess the effectiveness of the learning model used in each class. The experimental class was conducted using electronic LKPD based on PjBL ESD for used cooking oil processing, while the control class used printed LKPD based on DL. The results of the descriptive analysis of the percentage of learning implementation in the experimental and control classes are presented in Table 2.

Table 2. Descriptive Analysis Results of Learning Implementation Observation

Class	Meeting Number			Criteria
	1	2	3	
Experiment	100	100	100	Very Good
Control	100	100	100	Very Good

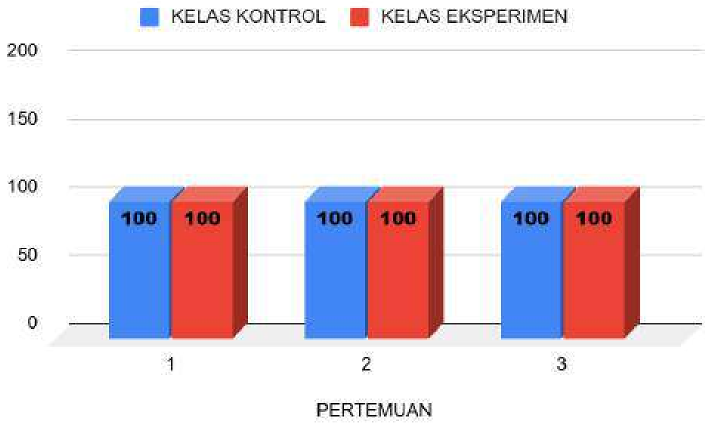

Figure 1. Learning Implementation Diagram

Based on the data in Table 1 and Figure 1, it can be seen that the learning process in both classes was implemented well. The experimental and control classes obtained an average learning implementation score of 100%, which is categorized as very good.

Creative Disposition Questionnaire

Creative disposition ability was measured using a questionnaire compiled based on creative disposition indicators. The descriptive analysis data of the creative disposition questionnaire for the experimental and control classes is presented in Table 3.

Table 3. Results of Descriptive Analysis of the Creative Disposition Questionnaire

Class	Initial Questionnaire			Final Questionnaire			N-Gain	Criteria
	Average	Max	Min	Average	Max	Min		
Experiment	64.41	83.75	46.25	88.32	93.75	82.50	0.6	Moderate
Control	65.27	83.75	43.75	80.20	86.25	73.75	0.4	Moderate

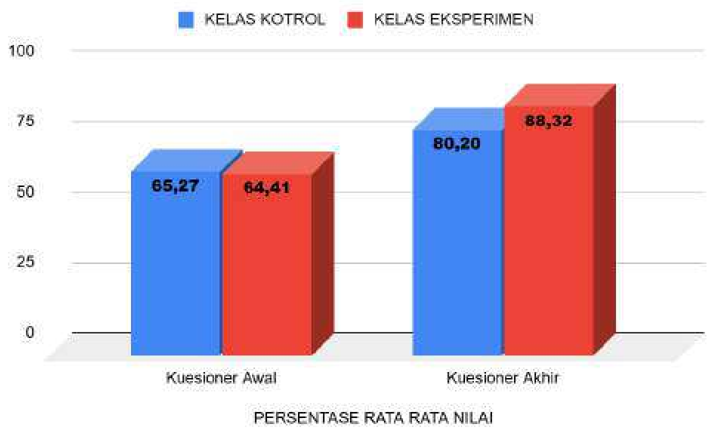

Figure 2. Diagram of Average Questionnaire Scores

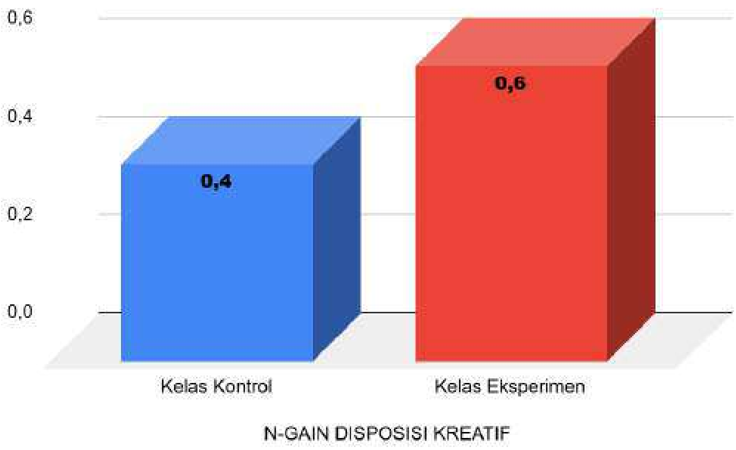

Figure 3. N-Gain Questionnaire Score Diagram

Based on Table 2 and Figures 2 and 3, it can be seen that the results of the descriptive analysis of the initial creative disposition questionnaire show that the average percentage of the experimental class is 64.41%, the control class is 65.27%, with a difference of 0.86%. The highest score for the experimental class and control class was 83.75. The lowest score for the experimental class was 46.25, while for the control class it was 43.75. Meanwhile, analysis of the final creative disposition questionnaire shows that the average percentage score for the experimental class was 88.32%, while for the control class it was 80.20%, with a difference of 8.12%. The highest score in the experimental class was 93.75, while in the control class it was 86.25. The lowest score in the experimental class was 82.50, while in the control class it was 73.75. On the other hand, the *N-Gain* score in the experimental class was 0.6, while in the control class it was 0.4. Both scores are in the moderate category.

The creative disposition indicators in this study included curiosity, collaboration, perseverance, imagination, and discipline. The data from the descriptive analysis of the average questionnaire scores for each creative disposition indicator in the experimental and control classes are presented in Tables 4 and 5.

Table 4. Results of Descriptive Analysis of the Average Questionnaire Scores for Each Creative Disposition Indicator

Indicator	**Experimental Class**		**Control Class**	
	Initial	**Final**	**Initial**	**Final**
Curiosity	60.16	90.82	59.18	71.41
Collaborative	71.09	88.48	74.02	82.81
Never Give Up	62.89	88.28	64.84	83.20
Imaginative	62.30	88.67	61.33	79.10
Discipline	65.63	85.35	66.99	81.45

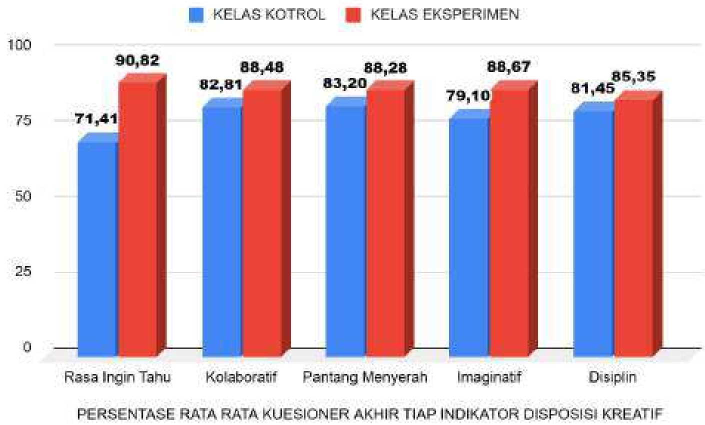

Figure 4. Percentage Diagram of Average Final Questionnaire Scores for Each Creative Disposition Indicator

Table 5. Average N-Gain Scores for Each Creative Disposition Indicator in the Experimental and Control Classes

Indicator	Experimental Class		Control Class	
	N-gain	Criteria	N-Gain	Kriteria
Curiosity	0.7	Height	0.2	Low
Collaborative	0.6	Moderate	0.3	Moderate
Never Give Up	0.6	Moderate	0.5	Moderate
Imaginative	0.6	Moderate	0.4	Moderate
Discipline	0.5	Moderate	0.4	Moderate

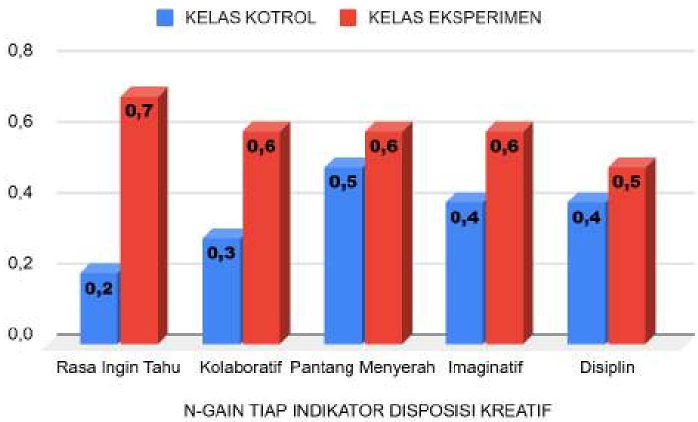

Figure 5. Diagram of Average N-Gain Values for Each Creative Disposition Indicator

Based on Tables 4 and 5 and Figures 4 and 5, it can be seen that the results of the descriptive analysis of the average percentage of the initial questionnaire scores for the curiosity indicator in the experimental class was 60.16%, while in the control class it was 59.18%, with a difference of 0.98%. Meanwhile, the final questionnaire for the experimental class was 90.82%, while for the control class it was 71.41%, with a difference of 19.41%. The N-Gain value for the experimental class was 0.7, which is in the high category, while for the control class it was 0.2, which is in the low category. The initial questionnaire for the collaborative indicator in the experimental class was 71.09%, while in the control class it was 74.02%, with a difference of 2.93%. Meanwhile, the final questionnaire in the experimental class was 88.48%, while in the control class it was 82.81%, with a difference of 5.67%. The N-Gain value in the experimental class was 0.6, while in the control class it was 0.3, both of which were in the moderate category. The initial questionnaire for the never-give-up indicator in the experimental class was 62.89%, while in the control class it was 64.84%, with a difference of 1.95%. Meanwhile, the final questionnaire score for the experimental class was 88.28%, while that for the control class was 83.20%, with a difference of 5.08%. The N-Gain score for the experimental class was 0.6, while that for the control class was 0.5, both of which were in the moderate category. The initial questionnaire for the imaginative indicator in the experimental class was 62.30%, while in the control class it was 61.33%, with a difference of 0.97%. Meanwhile, the final questionnaire for the experimental class was 88.67%, while in the control class it was 79.10%, with a difference of 9.57%. The N-Gain value in the experimental class was 0.6, while that in the control class was 0.4, both of which were in the moderate category. The initial questionnaire for the discipline indicator in the experimental class was 65.63%, while that in the control class was 66.99%, with a difference of 1.36%. Meanwhile, the final questionnaire for the experimental class was 85.35%, while the control class was 81.45%, with a difference of 3.9%. The N-Gain value in the experimental class was 0.5, while the control class was 0.4, both of which were in the moderate category.

Science Literacy Questions

Science literacy skills were measured using questions compiled based on science literacy indicators. The descriptive analysis data for science literacy questions in the experimental and control classes are presented in Table 6.

Table 6. Descriptive Analysis Results of Science Literacy Questions

Class	Initial Questionnaire			Final Questionnaire			N-Gain	Criteria
	Average	Max	Min	Average	Max	Min		
Experiment	73.50	88.00	56.00	90.63	100.00	76.00	0.6	Moderate
Control	73.25	88.00	56.00	81.88	92.00	72.00	0.3	Moderate

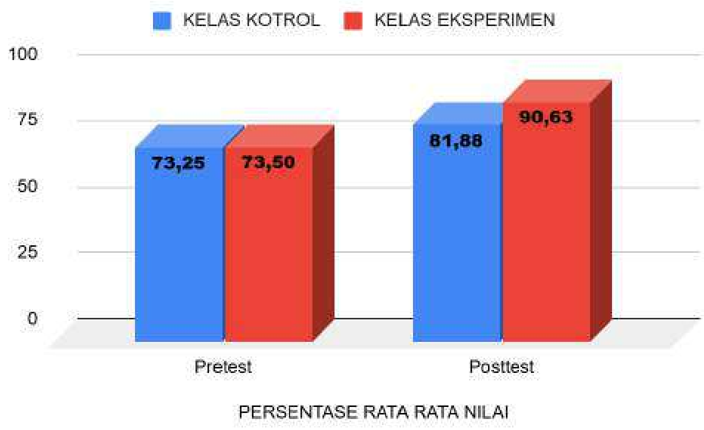

Figure 6. Average Question Value Diagram

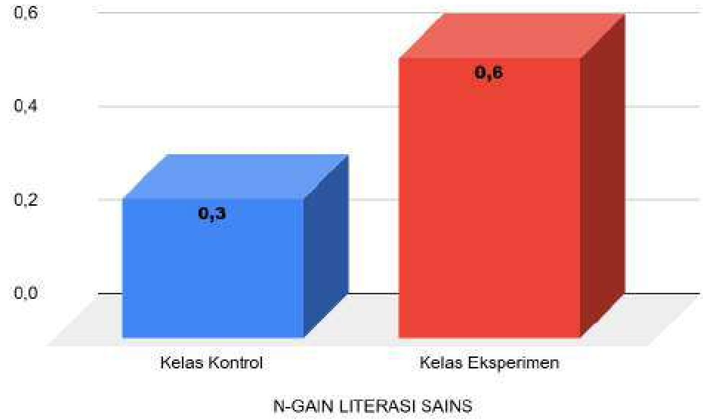

Figure 7. Diagram of N-Gain Scores

Based on Table 6 and Figures 6 and 7, it can be seen that the results of the descriptive analysis of the science literacy pretest show that the average percentage of the experimental class is 73.50%, the control class is 73.25% with a difference of 0.25%. The highest score for the experimental and control classes is 88.00. The lowest score for the experimental and control classes was 56.00. Meanwhile, analysis of the posttest for science literacy shows that the average score for the experimental class was 90.63%, while the control class scored 81.88%, with a difference of 8.75%. The highest score for the experimental class was 100.00, while the control class scored 92.00. The lowest score in the experimental class was 76.00, while in the control class it was 72.00. On the other hand, the N-Gain score in the experimental class was 0.6, while in the control class it was 0.3. Both scores are in the moderate category.

The science literacy indicators covered in this study include explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The data from the descriptive analysis of the average scores for each science literacy indicator in the experimental and control classes are presented in Tables 7 and 8.

Table 7. Descriptive Analysis Results of the Average Scores for Each Science Literacy Indicator

Indicator	**Experimental Class**		**Control Class**	
	Pre-test	Posttest	Pre-test	Posttest

Explaining Phenomena Scientifically	77.23	69.64	93.30	80.36
Evaluating and Designing Scientific Investigations	73.13	75.00	90.31	82.19
Interpreting Data and Evidence Scientifically	70.70	74.22	88.67	82.81

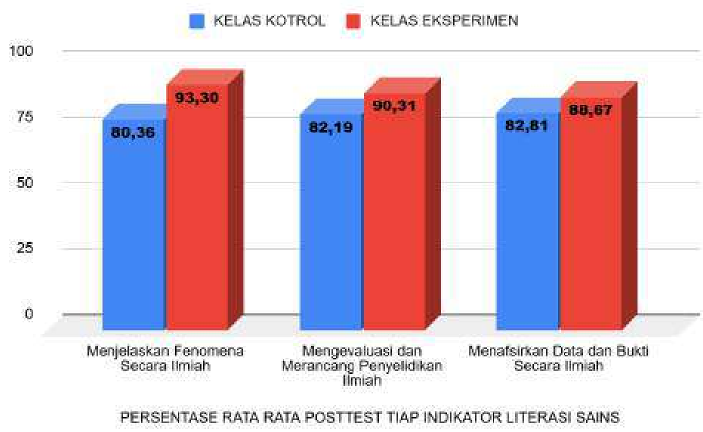

Figure 8. Percentage Diagram of Posttest Average Scores for Each Science Literacy Indicator

Table 8. Average N-Gain Scores for Each Science Literacy Indicator in the Experimental and Control Classes

Indicator	Experimental Class		Control Class	
	N-gain	**Criteria**	**N-Gain**	**Kriteria**
Explaining Phenomena Scientifically	0.7	High	0.3	Moderate
Evaluating and Designing Scientific Investigations	0.6	Moderate	0.2	Low
Interpreting Data and Evidence Scientifically	0.6	Moderate	0.3	Moderat

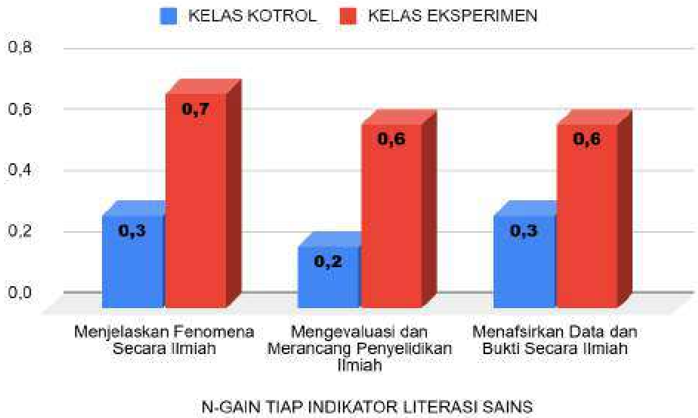

Figure 9. Diagram of Average *N-Gain* Values for Each Science Literacy Indicator

Based on Tables 7 and 8 and Figures 8 and 9, it can be seen that the results of the descriptive analysis of the average percentage of pretest scores for the indicators explain the scientific phenomenon that the experimental class scored 77.23%, the control class scored 69.64%, with a difference of 7.59%. Meanwhile, the posttest for the experimental class was 93.30%, while for the control class it was 80.36%, with a difference of 12.94%. The N-Gain value for the experimental class was 0.7, which is in the high category, while for the control class it was 0.3, which is in the moderate category. The pretest indicator evaluates and designs scientific investigations in the experimental class at 73.13%, the control class at 75.00% with a difference of 1.87%. Meanwhile, the posttest in the experimental class is 90.31%, the control class is 82.19% with a difference of 8.12%. The N-Gain value in the experimental class was 0.6, categorized as moderate, while the control class was 0.2, categorized as low. The pretest indicator for interpreting data and evidence scientifically in the experimental class was 70.70%, while the control class was 74.22%, with a difference of 3.52%. Meanwhile, the posttest score for the experimental class was 88.67%, while that for the control class was 82.81%, with a difference of 5.86%. The N-Gain value for the experimental class was 0.6, while that for the control class was 0.3, both of which were in the moderate category.

Independent Sample T-test

The independent sample T-test is a test used to determine the difference in the average scores of the experimental and control classes in terms of improvements in creative disposition and science literacy separately. The test results are considered significant at a significance level of 0.05 if the probability value (Sig.) is < 0.05, and is performed if the data is normally distributed and homogeneous. The results of the independent sample T-test of the final questionnaire data on creative disposition and posttest science literacy of the experimental and control classes are presented in Table 9.

Table 9. Results of the Independent Sample T-Test for Creative Disposition and Science Literacy in the Experimental and Control Classes

Ability	Sig. (2-tailed)	Criteria	Description
Creative Disposition (Final Questionnaire)	0.001	Sig. (2-tailed) < 0.05	H_1 Accepted and H_0 Rejected
Science Literacy (Posttest)	0.001	Sig. (2-tailed) < 0.05	H_1 Accepted and

	H_0 Rejected

Based on Table 8, it can be seen that the results of the independent sample T-test analysis of creative disposition and science literacy obtained a sig. (2-tailed) value of 0.001, so sig. (2-tailed) < 0.05, indicating a significant difference between the average creative disposition of the experimental class and the control class.

Effect Size Test

The effect size test was used to measure the size of the difference in learning from PjBL ESD-based electronic LKPD on creative disposition and science literacy in the experimental and control classes. The results of the effect size test of the final questionnaire data on creative disposition and posttest science literacy in the experimental and control classes are presented in Table 10.

Table 10. Effect Size Test Results for the Experimental and Control Classes

Dependent Variable	Effect Size	Criteria
Creative disposition	2.1396	Strong Effect
Science literacy	1.25231	Strong Effect

Based on Table 8, it can be seen that the results of the effect size test analysis on creative disposition obtained a value of 2.13966, while science literacy obtained a value of 1.25231, both of which are classified as strong effects.

Implementation of Learning

The implementation of learning in the experimental class used electronic worksheets based on PjBL ESD for used cooking oil waste management, while the control class used printed worksheets based on DL. The implementation of learning in both classes obtained an average percentage score of 100% in all meetings with a very good criterion. This shows that the implementation of learning in both classes went very well, as expected. In accordance with Widoyoko's (2009: 242) statement that the criteria for learning implementation refer to assessment provisions, where a percentage of $80 < X \leq 100$ indicates excellent results. The optimal implementation of learning indicates that both learning models can be implemented effectively and efficiently in the teaching and learning process. This is in accordance with the opinion of Firman et al. (2022: 163) that excellent criteria can create optimal learning conditions, a pleasant learning atmosphere, and the achievement of learning objectives.

The Effect of PjBL ESD-Based Electronic Worksheets on Creative Disposition

This study analyzes the effect of using PjBL ESD-based electronic worksheets on creative disposition abilities. Creative disposition abilities are an individual's conscious tendency toward positively using creative thinking patterns related to various categories of interests, talents, and attitudes. Maulana & Djuanda (2017: 262) explain that creative disposition is an individual's tendency to use creative thinking and attitudes. By having good creative disposition, students will be better able to face challenges, adapt to changes, and produce original and effective solutions in various situations. Based on the results of the increase in creative disposition abilities in the experimental and control classes, it can be seen that there was an increase in both classes. The analysis results show that the increase was higher in the experimental class than in the control class. The use of PjBL ESD-based electronic LKPD enriches the process by providing various resources that can be accessed interactively, allowing students to compile, design, and develop their projects more flexibly, easily, and creatively. This is in line with the statement by Khainingsih et al. (2022: 77) that electronic worksheets completed by students are designed to facilitate understanding of the material in electronic form. This is reinforced by Markula & Aksela (2022: 3) that the main characteristic of PjBL is the use of technological equipment, which shows the importance of computer technology in modern scientific research. In addition, research by Rohmawati et al. (2023: 199) states that learning tools that focus on ESD have been proven to be effective in developing students' creative thinking skills. This is reinforced by research by Ningsih et al. (2021: 50) that PjBL learning has a positive impact on improving students' creative thinking skills.

Based on the results of the improvement in each indicator of creative disposition in the experimental and control classes, a significant improvement occurred in the first indicator of curiosity. The curiosity indicator had the highest difference in the final questionnaire average score compared to the other indicators, because the curiosity indicator was facilitated by the six stages of ESD PjBL. In the initial stage of learning, students were invited to examine illustrations and narratives about the impact of used cooking oil waste. This activity encouraged them to identify relevant issues, formulate problems, and conduct direct observations, which effectively aroused their curiosity and motivation to find solutions. In accordance with the implementation of the 2013 curriculum, the characteristic of PjBL is that students are responsible as a group for accessing and managing information in order to solve problems (Kemendikbud, 2014: 35). Westwood (2008: 33) explains that PjBL has a relevant orientation and encourages meaningful learning by connecting new information. In addition, ESD learning has the characteristics of training to overcome the dilemmas and challenges of sustainable development with critical thinking and problem-solving skills (Watanabe, 2015: 5). Students are then asked to formulate project titles that are in line with the principles of sustainable learning, which not only focus on short-term results but also consider the positive and sustainable impact on the environment and society. This is in line with UNESCO (2014: 11) which states that ESD emphasizes a systemic thinking approach to help individuals understand complexity, find connections, and create solutions to problems that threaten the sustainability of life on earth. At the presentation stage, students presented their project results in the form of infographics and engaged in intergroup discussions. This process encouraged active interaction that stimulated curiosity, as students were encouraged to explore ideas, question findings, and dig deeper for information related to the issues at hand. This is in line with what Lucas et al. (2013: 16) said, that indicators of curiosity include actively exploring and investigating questions by seeking deeper information and not accepting everything at face value without critical examination or ensuring that their assumptions are correct.

There was no significant increase in the fifth indicator of discipline. This indicator had the lowest difference in the final questionnaire average score compared to the other indicators, because the discipline indicator was only facilitated by three stages of ESD PjBL. At this stage, students discussed relevant questions and planned steps in analyzing the projects in the electronic worksheets so that the projects could be completed on time. Each step had to be carried out with discipline. The discipline referred to includes good time management and an understanding of the responsibilities of each group member. This is in line with Westwood's (2008: 33) statement that PjBL makes students responsible for the project, thereby increasing self-direction and motivation. ESD is an educational vision that empowers and involves individuals to take responsibility for creating, making decisions, and taking action for a sustainable future (Listiawati, 2011: 139). In addition, students are asked to make a schedule that has been agreed upon by the group, which must be strictly followed so that the results obtained are in accordance with the plan. This process requires students to maintain consistency in carrying out tasks and adhere to deadlines, which directly contributes to improving their discipline. This is in line with the statement by Lucas et al. (2013: 16) that indicators of discipline include designing and refining with attention to detail, correcting mistakes, and ensuring that everything functions perfectly as expected. Punctuality in completing each stage of the project is very important. If students cannot manage their time well, the project process will be hampered, which in turn can have a negative impact on their learning outcomes. This is in line with Grant's (2002: 11) opinion that one of the weaknesses of learning using the PjBL model is the need for more time to complete the learning.

The Effect of PjBL ESD-Based Electronic Worksheets on Waste Cooking Oil Processing on Science Literacy

This study analyzes the influence of the independent variable, namely PjBL ESD-based electronic worksheets, on the dependent variable, namely science literacy skills. Science literacy ability is a person's ability to use scientific concepts by identifying, solving, applying, describing, and concluding phenomena and problems in everyday life based on scientific evidence in order to understand and make decisions related to nature. This is in line with the OECD (2018: 75) statement that science literacy is the ability to participate in science issues and understand science ideas as critically thinking citizens. Science literacy is also an important foundation for community development, equipping individuals with the skills necessary to innovate and adapt to ever-changing scientific advances. Based on the results of the improvement in science literacy in the experimental and control classes, it can be seen that there was an improvement in both classes. The analysis results show that the improvement was higher in the experimental class than in the control class. The use of PjBL ESD-based electronic LKPD emphasizes a learning approach based on real projects that actively involve students in identifying, investigating, and solving problems relevant to sustainability issues. This process provides opportunities for students to develop their science literacy skills in a more applicable and contextual manner. This is in line with research by Cholifah & Novita (2022: 31) that understanding the material studied through e-LKPD can contribute to improving learning outcomes, both in the cognitive domain and in students' science literacy. This is reinforced by research by Ramdani et al. (2023: 213) that PjBL has an influence on students' science literacy because in the learning process, students are expected to be more active, which can lead to scientific questions. Ultimately, this enables them to answer these questions using scientific evidence. This is further reinforced by research by Tahmid et al. (2024: 241) that ESD-based science learning has a significant effect on improving science literacy.

Based on the results of the improvement in each science literacy indicator in the experimental and control classes, a significant improvement occurred in the first indicator, explaining scientific phenomena. The indicator of explaining scientific phenomena had the highest difference in posttest average scores compared to the other indicators, because the indicator of explaining scientific phenomena was facilitated by the six stages of ESD PjBL. In the basic question stage, students were invited to identify and discuss the impact of used cooking oil waste on the environment and health. This activity trained them to analyze the causes and effects of these phenomena and develop the ability to construct scientific explanations based on facts and data. This is in line with Westwood's (2008: 33) statement that in PjBL learning, students learn valuable processes and skills for collecting and analyzing data. After understanding the impact of waste cooking oil, students are directed to find solutions such as recycling or creating alternative products. This problem-solving process encourages them not only to master scientific knowledge but also to be able to explain scientific phenomena in their surroundings. This is in line with Anggreni's (2020: 49) research that the application of the PjBL model is able to involve students to actively participate in project activities, which in turn improves students' ability to identify scientific issues and explain scientific phenomena using scientific evidence.

There was no significant improvement in the third indicator, interpreting data and evidence scientifically. This indicator had the lowest difference in posttest average scores compared to the other indicators, because this discipline indicator was only facilitated by four stages of ESD PjBL. The project planning stage encourages students to understand the design, tools, materials, and work steps in depth. This process strengthens the ability to interpret data scientifically because students must understand how to collect data and the variables involved, as well as organize data systematically and logically. This is in line with the statement by Nuraini & Waluyo (2021: 108) that through direct experience, students can collect evidence and formulate hypotheses from the ideas obtained, thereby contributing significantly to improving their science literacy skills. Next, in the data communication stage, students record their observations in tables to organize information in a structured manner. They then discuss questions that lead to the application of project products in the context of sustainable development. This discussion encourages students to analyze and interpret data and relate it to sustainability concepts and global scientific issues. This is in line with Markula & Aksela (2022: 3) who state that through PjBL learning, students can improve their communication skills by discussing and conducting collaborative research. In the conclusion stage, students formulated answers to the problem based on data analysis, interpreting the evidence scientifically and compiling it in a clear and accountable manner. This is in line with the statement by Komalasari et al. (2024: 1240) that the application of the PjBL model has a significant effect on students' science literacy because, during the project completion process, students can answer various questions by presenting evidence based on a scientific approach.

The difference in the increase in creative disposition and science literacy scores between the experimental and control classes was reinforced by testing the hypothesis using an independent sample T-test. After testing for normality and homogeneity, an independent sample T-test was conducted. The results of both tests showed a Sig. (2-tailed) value of $0.001 < 0.05$ with the hypothesis that there was a significant difference between the application of PjBL ESD-based electronic LKPD for waste cooking oil processing and the application of DL-based printed LKPD on creative disposition and science literacy abilities. After that, an effect size test was conducted to measure the magnitude of the difference in the use of PjBL ESD-based electronic LKPD on creative disposition and science literacy. The test results showed a creative disposition value of 2.13966 and science literacy of 1.25231, with both having strong effect criteria.

CONCLUSION

Based on the results of the study, it can be concluded that learning using electronic worksheets based on ESD projects for waste cooking oil processing has a significant effect on students' creative disposition abilities, as evidenced by the results of the independent sample T-test with a significance value of 0.001. This effect was assessed using an effect size of 2.13966, which is classified as very strong. In addition, it has a significant effect on students' science literacy abilities, as evidenced by the results of an independent sample T-test with a significance value of 0.001. This effect was assessed using an effect size test of 1.25231, which is classified as very strong.

ACKNOWLEDGMENTS

The author would like to thank the teachers and students at a public junior high school in Yogyakarta who were willing to participate in this study and contributed significantly to the data collection. The author would also like to express his appreciation to his supervisor and research group for their guidance, input, and constructive corrections throughout the research process. Thanks are also extended to fellow students and all parties who have helped directly or indirectly in the implementation and completion of this research.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Investigation; Project administration; Validation; Writing – review and editing; Data curation; Formal analysis; Methodology; Writing – original draft; Resources; Visualization.

Author 2: Validation; Formal analysis; Other contributions; Resources; Supervision.

Author 3: Validation; Formal analysis; Other contributions; Resources; Supervision.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

Amran, I. J., Perkasa, M., Satriawan, M., & Irwansyah, M. (2019). *Development of an ESD Character Learning Model to Improve the 21st Century Attitudes of High School Students*. In Taman Siswa Bima National Seminar 1(1), 366-373. https://www.academia.edu/download/68232291/42765.pdf

Anggreni, L. D., Jampel, I. N., & Diputra, K. S. (2020). The effect of the project-based learning model assisted by portfolio assessment on science literacy. *Mimbar Ilmu,* 25(1), 41-52. https://doi.org/10.23887/mi.v25i1.24475

Azzahra, U., Arsih, F., & Alberida, H. (2023). The Effect of the Project-Based Learning (PjBL) Model on Students' Creative Thinking Skills in Biology Learning: Literature Review. *BIOCHEPHY: Journal of Science Education,* 3(1), 49-60. https://doi.org/10.52562/biochephy.v3i1.550

Cholifah, S. N., & Novita, D. (2022). Development of guided inquiry-live worksheet e-LKPD to improve science literacy in the sub-material of reaction rate factors. *Chemistry Education Practice*, 5(1), 23-34. https://doi.org/10.29303/cep.v5i1.3280

Costa, A. L., & Kallick, B. (2000). Describing 16 habits of mind. Alexandria, VA.

Firman, F., Nurqalbi, N., & Hisbullah, H. (2022). The Implementation of the Talking Stick Cooperative Learning Model Based on Scouting Training in Elementary Schools. *Jurnal Sinestesia*, 12(1), 152–164. https://www.sinestesia.pustaka.my.id/journal/article/view/165

Florida, R., Mellander, C., & King, K. (2015). *The global creativity index 2015*. Martin Prosperity Institute.

Grant, M. M. (2002). Getting a grip on project-based learning: Theory, cases and recommendations. *Meridian: A middle school computer technologies journal*, 5(1), 83. https://www.academia.edu/download/109882155/project-based.pdf

Hoffmann, T., & Siege, H. (2018). What is education for sustainable development (ESD). *Human Development*, 1(8), 1-6. https://test.esd-expert.net/files/ESD-Expert/pdf/Was_wir_tun/Lehr-%20und%20Lernmaterialien/What_is_Education_for_Sustainable_Development.pdf

Isma, A., Isma, A., Isma, A., & Isma, A. (2023). Map of 21st Century Education Issues in Indonesia. *Journal of Applied Education*, 11–28. https://doi.org/10.61255/jupiter.v1i3.153

Kamaruddin, I., Suarni, E., Rambe, S., Sakti, B. P. S., Rachman, R. S., & Kurniadi, P. (2023). Application of project-based learning models in education: A literature review. *Journal of Education and Teaching Review* (JRPP), 6(4), 2742-2747.

Kebudayaan, R. I. (2014). *Implementation of the 2013 curriculum*. Ministry of Education and Culture. https://www.academia.edu/download/53852651/Paparan_Mendikbud_pada_Workshop_Pers_2.pdf

Khainingsih, F. G., Suanto, E., & Hutapea, N. M. (2022, February). *Design of Electronic LKPD Based on the PBL Model in the Context of Malay Culture Comparison Material to Facilitate Mathematical Critical Thinking Skills*. In PRISMA, Proceedings of the 5th National Mathematics Seminar, 76-86

Komalasari, B. R., Setiadi, D., Kusuma, A. S. H. M., & Jufri, A. W. (2024). The effect of the project-based learning model on biology science literacy in grade X at SMAN 7 Mataram in the 2023/2024 academic year. *Journal of Professional Education,* 9(2), 1237–1242. https://doi.org/10.29303/jipp.v9i2.2232

Lathifah, M. F., Hidayati, B. N., & Zulandri. (2021). The Effectiveness of Electronic Worksheets as a Learning Medium during the Covid-19 Pandemic for Teachers at YPI Bidayatul Hidayah Ampenan. *Journal of Master's Education in Science,* 4(1). https://doi.org/10.29303/jpmpi.v4i2.668

Listiawati, N. (2011). The relevance of ESD values and teachers' readiness to implement them in schools. *Journal of Education and Culture*, 17(2), 135-152. https://doi.org/10.24832/jpnk.v17i2.13

Lucas, B., Claxton, G., & Spencer, E. (2013). *Progression in student creativity in school: First steps towards new forms of formative assessments*. OECD Publishing

Markula, A., & Aksela, M. (2022). The key characteristics of project-based learning: how teachers implement projects in K-12 science education. *Disciplinary and Interdisciplinary Science Education Research,* 4(1), 2. https://link.springer.com/article/10.1186/s43031-021-00042-x

Maulana, D. D., & Djuanda, D. (2017). *The Influence of Murrderr Strategy, Interest in Specialization, and Basic Mathematical Ability on the Achievement of Mathematical Thinking Skills and Creative Disposition of PGSD Students*. In National Seminar on PGSD Education UMS & HDPGSDI Java Region, 263-281.

Mayuni, K. R., Rati, N. W., & Mahadewi, L. P. P. (2019). The effect of the project-based learning (PjBL) model on science learning outcomes. *Scientific Journal of Teacher Professional Education*, 2(2), 183-193. https://doi.org/10.23887/jippg.v2i2.19186

National Research Council, Division of Behavioral, Board on Science Education, & National Committee on Science Education Standards. (1996). *National science education standards*. National Academies Press.

Ningsih, M. Y., Efendi, N., & Sartika, S. B. (2021). The effect of the project-based learning model on students' creative thinking in science learning. *Journal of Science Education Innovation (JIPS),* 2(2), 42-51. https://doi.org/10.37729/jips.v2i2.1403

Noyes, D. (2000). *Developing the Disposition To Be a Reader: The Educator's Role*. https://eric.ed.gov/?id=ED470902

Nuraini, N., & Waluyo, E. (2021). Development of instructional design for project-based learning integrated with science process skills to improve science literacy. *Journal of Science & Science Learning*, 5(1), 101-111. https://jurnal.usk.ac.id/JIPI/article/view/2014

OECD. (2018). *PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science*. PISA OECD Publishing. http://dx.doi.org/10.1787/9789264305274-en

OECD. (2019). *PISA 2018 Assessment and Analytical Framework*. PISA OECD Publishing. https://doi.org/10.1787/b25efab8-en

OECD. (2023). *PISA 2022 Assessment and Analytical Framework*. PISA OECD Publishing. https://doi.org/10.1787/dfe0bf9c-en

Ramdani, A. (2023). The Effect of Using the Project-Based Learning (PBL) Model on Students' Science Literacy. *Journal of Classroom Action Research*, 5(1), 210-215. https://doi.org/10.29303/jcar.v5i1.2925

Rohmawati, Q. I., Siswanto, J., & Roshayanti, F. (2023). The Practicality and Effectiveness of Teaching Rotational Dynamics Concepts Oriented Towards Education for Sustainable Development (ESD) to Improve Creative Thinking Skills. *Journal of Learning Innovation in Schools,* 4(1), 193-200. https://doi.org/10.51874/jips.v4i1.75

Suparya, I. K., Suastra, I. W., & Arnyana, I. B. P. (2022). Low Science Literacy: Causes and Alternative Solutions. *Citra Bakti Scientific Journal of Education*, (1), 153-166. https://doi.org/10.38048/jipcb.v9i1.580

Suryaningsih, S., & Nurlita, R. (2021). The importance of innovative electronic student worksheets (E-LKPD) in the 21st century learning process. *Indonesian Education Journal*, 2(07), 1256-1268. https://doi.org/10.36418/japendi.v2i7.233

Syafitri, R. A., & Tressyalina. (2020). *The Importance of the Student Worksheets of Electronic (E-LKPD) Contextual Teaching and Learning (CTL) in Learning to Write Description Text during Pandemic COVID-19*. 485(Iclle), 284–287. https://doi.org/10.2991/assehr.k.201109.048.

Tahmid, T., Nurkhoiri, N., & Syaiful, M. (2024). Implementation of ESD-Based Science Learning Tools on Environmental Pollution Material to Improve Students' Literacy and Critical Thinking Skills. *Diklabio: Journal of Biology Education and Learning*, 8(2), 235–245. https://doi.org/10.33369/diklabio.8.2.235-245

Tran-Duong, Q. H., & Do-Hung, D. (2025). The mediating role of student growth mindset between teacher feedback, peer collaboration, and creative thinking dispositions. *Studies in Educational Evaluation*, 87. https://doi.org/10.1016/j.stueduc.2025.101526

UNESCO, U. (2014). *Roadmap for implementing the global action programme on education for sustainable development*. http://Unesdoc.unesco.org

Watanabe, R. (2015). Implementation of education for sustainable development (ESD) in Japan. [*Doctoral dissertation*, University of Stockholm].

Westwood, P. (2008). *What teachers need to know about teaching methods*. ACER Press.

Widoyoko, S. E. P. (2009). *Evaluation of practical guidance learning programs for educators and prospective educators*. Pustaka Pelajar.