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# Exploration of Sustainability Literacy Through Environmental Perspectives in the Context of Energy Conservation and Transformation

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**Abstract**

Sustainability is a major challenge in the 21st century that must be managed by physics learning. This study aims to explore students' sustainability literacy in the context of energy conservation and transformation through physics questions created with an environmental approach. This study uniquely integrates local pesantren contexts into physics education to address sustainability literacy, offering a novel contribution to science education by incorporating cultural and contextual relevance. With a descriptive exploration of 30 grade X students from SMA Nurul Jadid, the research was conducted using tests, questionnaires, and interviews. The results on the knowledge dimension showed that students performed very well at low cognitive levels, but higher-order thinking skills, especially evaluation and creation, were still low. In the skill dimension, students' ability to solve problems was moderate, with weaknesses in the aspects of evaluation and reflection. Although students responded well to the contextual problems, many had difficulty in drawing energy transformation schemes. These results indicate the need for more practical and contextualized learning to strengthen sustainability literacy in physics learning.

**Keywords:** Sustainability literacy, Energy conservation, Energy transformation, Environmental perspective

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## INTRODUCTION

Education holds a crucial role in developing individuals who not only master academic knowledge, but also have skills that are relevant to global needs. Today, the world is faced with major challenges, such as climate change, exploitation of natural resources, and increasingly complex social inequalities. Addressing these global challenges requires an educational approach that can instill awareness of the importance of sustainability, as well as develop critical thinking skills and problem-solving abilities. Education for Sustainable Development (ESD) serves as a cornerstone in the global education system, aiming to equip learners with the ability to think systematically, make data-based decisions, and the ability to innovate in dealing with sustainability issues (Jones et al, 2022).

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(ESD) serves as a cornerstone in the global education system, aiming to equip learners with the ability to think systematically, make data-based decisions, and the ability to innovate in dealing with sustainability issues (Jones et al., 2022). Sustainability literacy is an important aspect in forming the mindset of students to be more concerned about the environment and be able to contribute to solving global problems. It includes an understanding of ecological systems, awareness of the environmental impacts of human activities, and the ability to make responsible decisions (Wals et al., 2022). The development of sustainability literacy is one of the main focuses to equip students for the era of society 5.0.

Physics as a discipline holds unique relevance in this context, especially through material such as energy conservation and transformation, which are at the core of global sustainability efforts. Energy-related topics are not only fundamental in physics curricula but also serve as real-world anchors for understanding environmental issues such as fossil fuel depletion, renewable energy transitions, and climate mitigation (Permana et al., 2021). However, most previous research in this area remains limited to theoretical frameworks or decontextualized applications, often disconnected from learners' lived experiences or cultural environments. According to UNESCO (2020), the indicators used to measure sustainability literacy include three main dimensions: knowledge (cognitive), behavior (skills), and attitude (values). Yet, studies such as Kinasih et al. (2023) and Aldiono et al. (2023) have shown that current assessments often fall short in measuring higher-order thinking and action-oriented sustainability competences, particularly in the context of physics. This signals a gap in both instructional design and evaluation strategies.This study addresses that gap by integrating sustainability literacy into physics learning on energy conservation and transformation, using real-world, culturally grounded problems in a pesantren environment. This integration represents a methodological and contextual novelty, as no previous studies were found to systematically incorporate the pesantren’s local wisdom, values of resource efficiency, and daily practices into a physics learning model oriented toward ESD. Comparative studies such as those by Putri et al. (2021) and Sari et al. (2022) have highlighted the value of contextual and environment-based learning in science, but none have directly explored how localized religious and cultural practices, such as those in pesantren communities, can become pedagogical assets in building sustainability literacy through physics content. Additionally, studies by Husain (2022) and Yuniawan et al. (2023) focused more on environmental education broadly, without a direct link to disciplinary depth in physics or structured sustainability literacy dimensions as defined by UNESCO

Local contexts such as the pesantren environment have great potential to support sustainable-based physics learning. Energy-saving practices, wise use of resources, and the values of simplicity in the lives of santri are important entry points for internalizing sustainability values (Nurfadhilah et al., 2021). For example, issues such as the high consumption of electricity or the utilization of alternative energy based on local potential can be used as relevant project or problem-based learning topics. That way, students not only understand the law of conservation of energy theoretically, but also understand the relevance of the law in the practice of energy efficiency in their environment.

Several studies that capture students' sustainability literacy have been conducted with various innovative methods and approaches. Research by Husain (2022) explored the impact of project-based learning on students' sustainability literacy and collaboration in the context of environmental pollution. The research, conducted using a quasi-experimental method, showed results in the form of improvement although not statistically significant. Adam (2022) mapped the sustainability literacy profile of junior high school students with contextual learning method of science based on Education for Sustainable Development (ESD), using descriptive quantitative approach. The results showed that the economic dimension of students was in the low category, while the social and environmental dimensions were in the medium category. Yuniawan et al. (2023) raised the importance of conservation literacy through environmental news texts as a means of building students' awareness of sustainability issues. Research by Aldiono et al. (2023) assessing students' sustainability literacy through the topic of global warming showed that most students have not been able to demonstrate a thorough understanding of the environmental impact of energy consumption. Most students were only able to answer at the basic knowledge level (C1-C2), while the analysis and creation dimensions (C4-C6) that lead to alternative solutions were still weak. The same thing was also observed by Devanti et al. (2020) who measured sustainability literacy through the integration of questionnaires, interviews, and contextual questions; the results showed that the majority of students were still in the medium to low category.

These studies show significant results in capturing students' sustainability literacy, but research that specifically captures sustainability literacy in the context of physics materials such as energy conservation and transformation is still very limited. In addition, there are still few that incorporate the local context or educational culture in the pesantren environment as a learning tool. This research endeavor presents the novelty of capturing students' sustainability literacy in the context of physics materials related to energy and environmental issues, as well as connecting it with the local context of the pesantren environment. This approach is expected to provide a more authentic picture of students' understanding and readiness to support sustainable development.

This study aims to explore students' sustainability literacy in energy conservation and transformation through an environment-based approach. The main focus is to identify the extent to which learners understand the concept of energy and are able to relate it to sustainability challenges in their surrounding environment. It is hoped that the results of this research can contribute to the development of physics learning tools that are contextual, problem-based, and in line with the principles of Education for Sustainable Development (ESD) proclaimed in the Merdeka Curriculum (Kemendikbudristek, 2022; Wahyuni et al, 2022).

## METHOD

This study employed an explorative descriptive approach aimed at identifying the profile of students’ problem-solving skills in the context of environmental issues. The research was conducted with 30 tenth-grade students from Nurul Jadid Islamic Senior High School (MA Nurul Jadid), who participated in face-to-face learning activities on March 6, 2025. The study was situated within a pesantren (Islamic boarding school) environment, which is deeply rooted in Islamic cultural values. The results of this research are expected to contribute to the practice of sustainability literacy through the application of the Problem-Based Learning (PBL) model, integrated with local wisdom to foster a learning experience that is contextual and relevant to students' daily lives and surroundings (Smith, 2023).

The research procedure consisted of several stages. First, the development of research instruments was carried out, including test questions, questionnaires, and interview protocols. The test questions were designed based on real problems within the pesantren environment, such as the efficient use of electricity in dormitories and energy management in daily student activities. The questionnaire was developed to explore students’ perceptions of environmentally-based physics learning, while semi-structured interviews were conducted to obtain deeper insights into students’ expectations and experiences regarding the learning model being implemented (Suárez et al., 2018). In the second stage, the test was administered, and students completed both the questionnaire and interview. The third stage involved the analysis of data using qualitative approaches and descriptive statistics. The sustainability literacy test was constructed to assess two dimensions: the knowledge dimension and the skills dimension. The knowledge dimension was based on Bloom’s taxonomy, covering six levels of cognitive processes—remembering, understanding, applying, analyzing, evaluating, and creating (Khairi et al., 2022). Each level was represented by specific indicators, such as identifying forms of energy transformation in everyday life (C1), describing energy changes in specific systems (C2), applying concepts to daily phenomena (C3), analyzing energy use efficiency (C4), evaluating sustainable practices (C5), and designing energy-saving solutions within the pesantren environment (C6).

To ensure the quality and credibility of the research instruments, a rigorous validation process was conducted. Content validation involved three experts—an academic in physics education, a specialist in educational assessment, and a physics teacher experienced in pesantren-based learning. These experts reviewed the alignment of the instrument items with the cognitive indicators, providing both structured feedback and quantitative ratings. Based on their recommendations, the test and questionnaire were revised for clarity, contextual relevance, and consistency with Bloom's taxonomy. Following this validation, a pilot study was conducted with a group of ten students from a different school with similar characteristics. The reliability of the knowledge dimension test was determined using Cronbach's Alpha, which resulted in a coefficient of 0.81, indicating high internal consistency. The questionnaire obtained a reliability score of 0.79, which also meets the threshold for reliable instruments (Nunnally, 1978). For the skills dimension, which relied on a performance-based rubric, inter-rater reliability was measured to ensure consistency between evaluators.. Instruments in the knowledge dimension are arranged based on indicators at each stage of thinking. Indicators of each stage are presented in Table 1.

**Table 1**. Sustainability literacy indicators of the knowledge dimension

| cognitive level | indicator |
|---|---|
| C1 (Remembering) | Identify forms of energy transformation in everyday life |
| C2 (Understanding) | Describe the process of energy change in a particular system or device |
| C3 (Applying) | Apply the concept of energy transformation to explain phenomena in daily life |
| C4 (Analyzing) | Analyze the efficient use of energy in systems in the surrounding environment. |
| C5 (Evaluating) | Evaluate the practice of using electrical energy in pesantren from the aspect of sustainability. |
| C6 (Creating) | Designing energy-saving solutions to be implemented in the pesantren environment. |

The selection of research participants was based on purposive sampling, considering several criteria. Nurul Jadid Islamic Senior High School was chosen due to its location within a pesantren environment, which supports the integration of sustainability literacy with religious and cultural values. Additionally, the physics teacher at the school had received prior training in the Problem-Based Learning model, ensuring its proper implementation. Tenth-grade students were selected because they are at a developmental stage suitable for engaging in abstract thinking and contextual learning, particularly related to energy transformation and environmental conservation. To maintain objectivity and consistency in scoring, an inter-rater reliability procedure was applied. Two independent raters assessed the students' responses to the test items in both the knowledge and skills dimensions using the established scoring rubrics. The agreement between raters was measured using Cohen's Kappa, which yielded a score of 0.87, indicating a high level of agreement (Landis & Koch, 1977). In cases where discrepancies occurred, both raters conducted joint reviews and discussions to reach consensus and further refine their interpretation of the rubrics.

The students' responses on the knowledge dimension were scored on a scale of 1 to 4. A score of 4 was given for answers that were highly accurate, complete, and demonstrated deep understanding and creativity. Scores of 3 indicated fairly accurate and contextually relevant answers with a good level of comprehension. A score of 2 reflected partial understanding and the presence of misconceptions, while a score of 1 indicated a lack of understanding or incorrect answers. Meanwhile, the skill dimension was evaluated using Polya's problem-solving indicators, which include understanding the problem, devising a plan, carrying out the plan, and evaluating the results (Pratiwi et al., 2021; Jones & Thompson, 2022). Each of these indicators was scored from 1 to 3 based on students' clarity, depth, and contextual relevance in applying energy concepts to real-life pesantren issues. Assessment rubric used in collecting data on students' sustainability literacy in the skills dimension is presented in Table 2.

**Table 2.** Rubric for scoring the skills dimension of the sustainability literacy test

| Indicator | Score 3 (high) | Score 2 (medium) | Score 1 (low) |
|---|---|---|---|
| Understand the problem | Identify the problem clearly and relate it to the concept of conservation and transformation of energy accurately. | Identified the problem quite clearly, but there were still limitations in connecting it to the concept of energy. | Unable to identify the problem or irrelevant to the concept of energy. |
| Devise a plan | Devise solutions that are innovative, realistic, and in accordance with the environmental conditions of the pesantren and explain energy transformation well. | Devise an appropriate solution, but the explanation of the energy transformation was incomplete. | Solution is not relevant or does not explain the energy transformation. |
| Carry out the plan | Create a clear scheme or diagram that shows the energy transformation process in detail. | Create schemes or diagrams that are quite clear, but lack detail in showing the process of energy transformation. | no relevant schemes or diagrams. |
| Look back | Evaluate the advantages and disadvantages of the solution in depth and consider its impact on the environment and life in the pesantren. | Evaluate the strengths and weaknesses of the solution fairly well, but not in depth. | No evaluation or not relevant. |

The questionnaire on students' perceptions of environment-based physics learning consisted of 12 items measured on a four-point Likert scale, with responses ranging from strongly disagree to strongly agree. Items were constructed to assess four aspects: material relevance, conceptual understanding, learning motivation, and expectations of the learning process. The average scores were calculated to categorize student responses, with ranges indicating low, medium, or high sustainability literacy (Azizah et al., 2021). Finally, interviews were conducted to provide qualitative insights into students' views on physics learning, including perceived challenges and suggestions for improvement, with a range of values in Table 3.

**Table 3.** Likert scale of students' response

| Direction of questioning | Strongly Agree | Agree | Disagree | Strongly disagree |
|---|---|---|---|---|
| Positive | 4 | 3 | 2 | 1 |
| Negative | 1 | 2 | 3 | 4 |

(Rohendi, 2018)

The results from the questionnaire were analyzed by calculating the average score of the four indicators. Based on these average scores, students' sustainability literacy in the skills dimension was classified into three categories, as shown in Table 4.

**Table 4.** Sustainability literacy of Skill dimension categorization

| Category | Value |
| --- | --- |
| Low | $1.00 \leq x < 1.50$ |
| Medium | $1.50 \leq x < 2.50$ |
| High | $2.50 \leq x \leq 3.00$ |

(Azizah et al, 2021)

Interview was designed to find out more about students' perceptions and expectations about physics learning. Contains simple questions about how perceptions, constraints and expectations in learning physics.

## RESULTS AND DISCUSSION

In the knowledge dimension, the questions are arranged based on Bloom's taxonomy from level C1 to C6 to measure the understanding of the concept of energy transformation while encouraging santri's awareness of energy efficiency and sustainability. At the C1 level, students are asked to mention examples of energy transformation that are commonly found in everyday life, such as electrical energy into light when turning on the lights, electrical energy into sound and light when turning on the television, or electrical energy into motion in a fan. A study by Kurniawan (2020) showed that learning based on household contexts can improve students' understanding of energy transformation because it is closer to their experience. At the C2 level, students explain the process of energy change when using an electric iron, namely from electrical energy to heat. This is in accordance with the findings of Putri et al. (2021), which states that visualization of household appliances in physics learning helps students understand energy conversion. Problem C3 leads students to observe the heating of water by an electric dispenser, where electrical energy is converted into heat energy by the heating element. Prasetyo et al's study (2019) showed that the household experiment approach can improve students' analytical thinking skills in explaining the energy conversion process.

In question C4, students compared the efficiency between fans and air conditioners. Fans are considered more efficient due to lower power consumption compared to air conditioners, and are more sustainable in the long run. Research by Susanti et al (2022) confirmed that the use of fans in schools can save up to 60% of energy compared to the use of air conditioners. In question C5, students evaluate the habit of leaving the dorm room lights on constantly. This is an inefficient habit and is not in line with the principle of sustainability. A study by Maulana (2020) found that energy-saving habits need to be instilled early on through habituation and institutional policies in schools or pesantren. Finally, in question C6, students are asked to design energy-saving solutions that maintain comfort. One solution that can be applied is the use of automatic motion sensors for room or toilet lights. Research from Ramadhan et al (2021) shows that the application of sensor technology in lighting can save electricity consumption by up to 40%, while educating users to be more aware of energy use.

The results of the sustainability literacy exploration in the knowledge dimension show that students' mastery of the C1 (remembering) and C2 (understanding) thinking levels is very good with an average score close to 4, indicating that most students have a very good understanding of the basic concepts in energy conservation and transformation material, especially when related to the environmental context. This suggests that when questions are presented in a way that is relevant to real situations in the environment, such as the use of renewable energy or energy efficiency in everyday life, students more easily understand and relate it to their existing knowledge.

The average score at C3 (applying) is also still quite good even though the value is not close to 4, but the average score still shows more than 3, which means that the ability of students to apply understanding in a real context is quite good. The average score began to decrease at C4 (analyzing), which indicates that although students are still able to understand and apply understanding, the level of depth of knowledge begins to decrease when the question demands a more complex understanding of the concept or when it is associated with a more abstract energy transformation process. The most striking decrease occurred in C5 (evaluating) and C6 (creating) abilities, which were in the range of scores 2 and 1, respectively. These low scores indicate that students have difficulty in solving problems that require higher-level thinking, such as evaluating the practice of using electrical energy in pesantren from the aspect of sustainability and designing energy-saving solutions to be implemented in the pesantren environment, as shown in Figure 1.

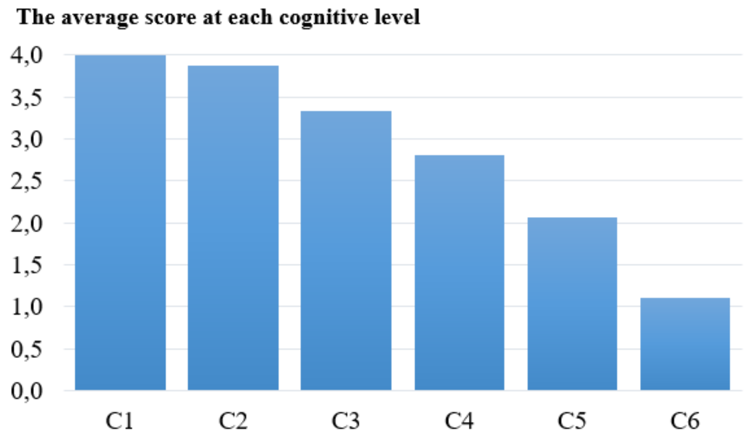


**Figure 1.** Score distribution in knowledge dimension

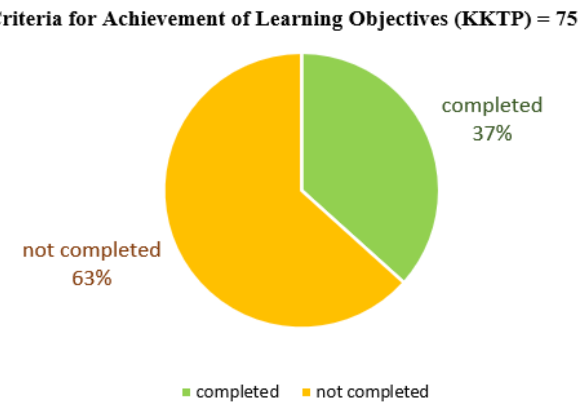


**Figure 2.** Student completeness based on Criteria for Achievement of Learning Objectives (KKTP)

The diagram in Figure 2 shows that only 37% of students successfully completed the task, while the other 63% were still unsuccessful. This indicates that most students still face challenges in understanding the material or completing the tasks given. This finding emphasizes the need to evaluate the learning strategies applied as well as the importance of strengthening the environmentally-based contextual approach to help students improve sustainability literacy and get better learning outcomes.

The graph of students' final sustainability literacy scores in the knowledge dimension in Figure 3 shows the distribution of scores of the 30 students who participated in the learning. The majority of students scored between 70 to 80, which shows a fairly good achievement and although most still could not reach the criteria for achieving learning objectives (KKTP) of 75. Some students, such as Student 10 and Student 27, even achieved scores close to 95, showing a very good understanding of the material of conservation and transformation of energy based on the environment. Some students who obtained scores below the KKTP, such as Student 15 and Student 18, were in the range of 60. This shows that although in general the learning outcomes are good, there are still students who have difficulty in understanding the material or solving problems, especially in the context of environmental-based energy conservation and transformation.

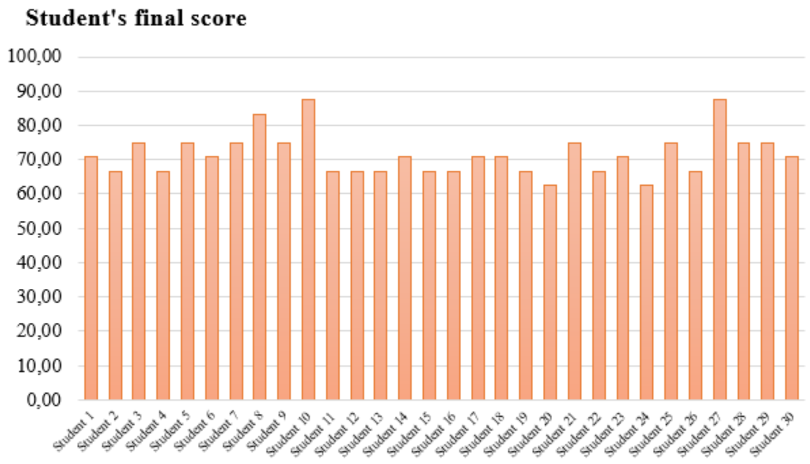


**Figure 3.** Students' final score of sustainability literacy in the knowledge dimension

In skill dimension, based on the graph in Figure 4 which displays four aspects of the problem-solving thinking process (understand the problem, devise a plan, carry out the plan, look back) and the category distribution diagram in Figure 5, several important things can be concluded about students' abilities. In the problem understanding, most students obtained a score of 2, indicating that they were in the moderate category in understanding the problem. Only a few achieved Score 3 (high), and none were at Score 1 (low), indicating that students' initial understanding of the problem was generally quite good. In the devising a plan, the majority of students also obtained a score of 2, but there were still students with a score of 1, and no one got a score of 3. This shows that students' ability to devise problem-solving strategies is still at the developing stage and not yet optimal. In the carrying out the plan, the distribution of scores showed a similar condition, with the majority of students at score 2 and some at score 1, but none reached score 3, which indicated that student's carrying out the solution ability was not fully effective or consistent.

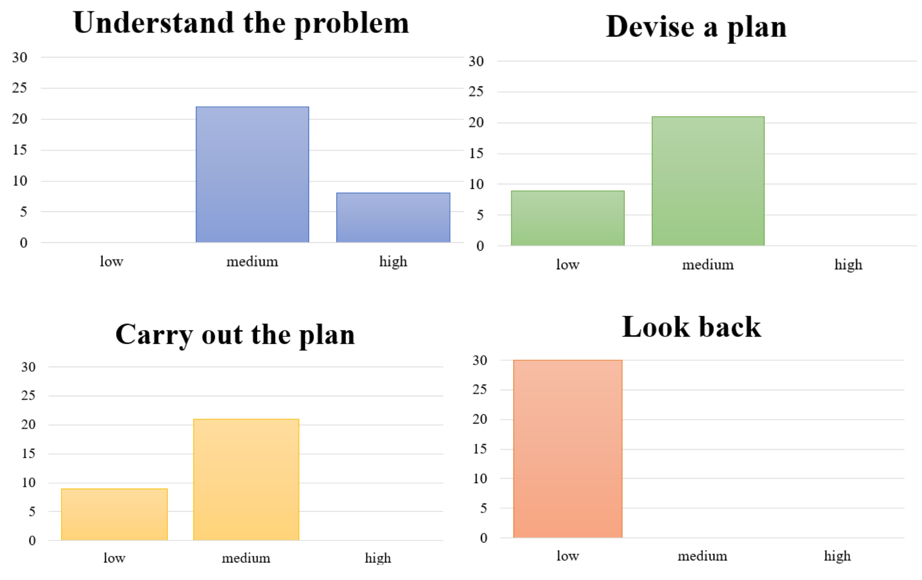


**Figure 4.** Student's sustainability literacy in skill dimension

In look back, all students scored 1, which shows the most significant weakness in evaluating the process and results of problem solving. This indicates that reflection or review of their solutions is still very low or unformed. Based on category distribution diagram in figure 5, the overall category distribution shows that 69% of students fall into the medium category, while 31% are in the low category, and no students fall into the high category. This confirms that students' problem solving skills in general are still not optimal, with the majority of students only at the medium level and none of them showing high abilities.

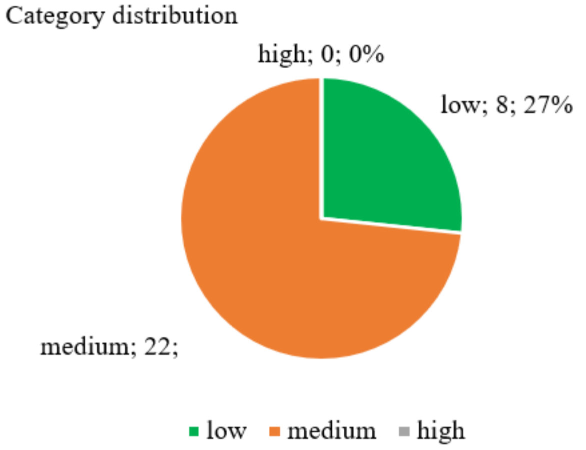


**Figure 5.** Category distribution of sustainability literacy in skill dimension

The results show that although most students have sufficient initial ability in understanding the problem, they still have difficulty in developing and implementing plans effectively, and are very weak in evaluating. The absence of students in the high category indicates the need for learning interventions that emphasize the development of reflective thinking, strategic planning, and evaluation of results. The application of a more active and contextual environment-based approach in learning is expected to improve students' sustainability literacy in skill dimension.

Figure 6, shows the distribution of student's responses to several statements (S1 to S12) based on four categories: strongly agree (green), agree (blue), disagree (yellow), and strongly disagree (red).

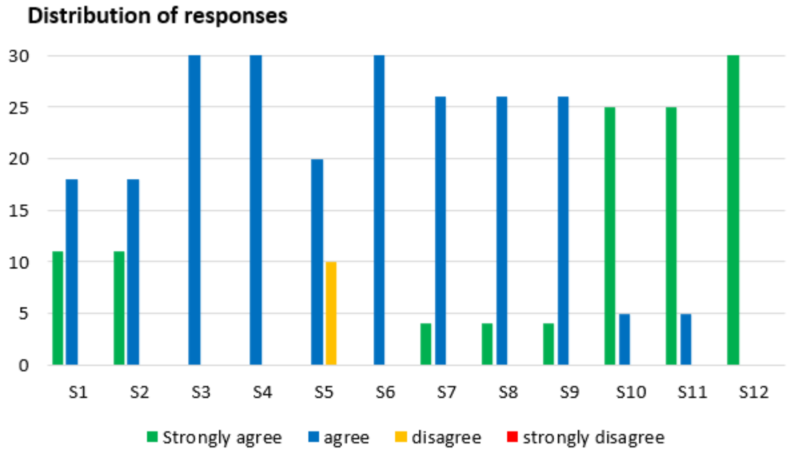


**Figure 6.** Distribution of student's responses in skill dimension

Statement:

- S1 – Understand the problem given in the problem.
- S2 – This question helps me understand the concept of conservation of energy and energy transformation.
- S3 – I can develop a good solution plan after reading the problem.

- S4 – This question encourages me to think creatively and find innovative solutions.
- S5 – I can visualize the energy transformation scheme or diagram.
- S6 – This question is relevant to daily life at pesantren.
- S7 – After doing this question, I recognize energy transformation.
- S8 – The question's reflection helped me reflect on my solution.
- S9 – I want to do this kind of question more often in physics learning.
- S10 – Environment-based learning helps me understand physics concepts better.
- S11 – I feel more motivated to learn physics when it is related to environmental problems.
- S12 – I hope physics learning is more related to the environmental problem solution.

Most of the students responded well to the questions presented. This can be seen from the dominance of the "Agree" (blue) category in the majority of statements, especially in S1 to S4, and S6 to S9. These statements relate to the understanding of the issue, the concept of energy conservation and change, the skills to formulate solutions, innovative thinking, and reflection and motivation after solving the problem.

In statements S1 and S2, the majority of students answered "Agree" and "Strongly Agree", indicating that they understood the problem presented and found it helpful in understanding the concept of energy. Statements S3 and S4 also showed the same response, indicating that students could formulate solutions and were encouraged to think creatively through the questions.

Statement S5 shows different variations in the distribution of responses. The number of respondents who chose "Agree" was less than the other statements, and there were quite a few who chose "Disagree" (yellow). This indicates that some students still face challenges in describing the energy transformation process in the form of schematics or diagrams.

In statement S6, most students chose "Agree". This indicates that students accepted the local approach of the pesantren environment in the problem well. This is supported by statements S7, S8, and S9, where students felt that the problem helped them understand energy transformation, reflect on the solutions they have made, and show interest in getting similar problems in physics lessons in the future.

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Statements S10, S11 and S12 reflect a great appreciation for environmentally oriented education. In statement S12, almost all students answered “Strongly Agree” (green), indicating a strong expectation that physics learning is more often linked to environmental issues and solutions. Statements S10 and S11 also show a predominance of “Agree” and “Strongly Agree” responses, indicating that students feel more motivated to learn physics when the material is related to environmental issues around them.

In general, the results of student responses show that the problems given are effective in strengthening concept understanding, sharpening thinking skills, and increasing the relevance of learning to real situations. However, the visualization element as seen in S5 still needs more attention in the development of further questions.

The results of interviews with 30 students of class X SMA Nurul Jadid showed that 25 students considered physics as a difficult subject, while only 5 students felt physics could be understood. Some of the reasons that cause physics to be considered difficult include: The number of confusing concepts in the application of the problem, understanding the concept when explained, but having difficulty when working on problems, difficult to understand physics as a whole, lack of understanding of the benefits of learning physics, too many formulas that must be memorized, learning atmosphere that is considered stressful.

However, all students who find physics difficult still have the desire to be able to understand it. They consider that physics looks interesting, but difficult to understand. Therefore, one solution that can be done is to practice sustainability literacy that links physics understanding with the context of everyday life, especially in environmental, social and economic aspects so that learning will be more meaningful to students and students will be more motivated in learning. Before implementing this learning strategy, it is necessary to conduct research on students' sustainability literacy profile by adjusting the difficulty level of the questions based on their surrounding environment (Putri et al., 2021; Redish, 2003).

Some students also stated that they lacked confidence in learning physics because they did not have an effective way to link problems with their prior knowledge. With an environmental perspective, it is expected that students can be more confident in solving problems that are in accordance with the real conditions around them (Sari et al, 2022). In addition, the integration of environmental perspective is also expected to bridge students' awareness of the benefits of learning physics. Some students question the relevance of physics in their lives, so this approach can help students see how physics concepts play a role in instilling students' sustainability literacy. Thus, students can be more motivated in understanding physics and see its usefulness in their own lives (Fadhilah et al, 2024).

The results of the analysis reflect a clear alignment with key educational theories such as constructivism, situated learning, and cognitive development. From a constructivist viewpoint, the emphasis on student-centered inquiry and experiential learning indicates a shift toward active knowledge construction where learners build understanding through meaningful engagement. Situated learning theory is also evident in the focus on context-based education, suggesting that many interventions situate learning within real-world environmental and scientific issues to enhance relevance and retention. Furthermore, cognitive development theories, particularly those of Piaget and Vygotsky, are reflected in the progression from lower-order to higher-order thinking skills (C4–C6), highlighting an increasing emphasis on analysis, evaluation, and creation in science education. However, these trends cannot be fully understood without acknowledging external factors such as teacher quality, curriculum flexibility, and resource availability, all of which significantly influence how these pedagogical strategies are implemented and received. In comparison with similar interventions in the literature—especially those in environmental and physics education that apply project-based or problem-based learning—there is strong evidence that such approaches enhance student engagement, critical thinking, and conceptual understanding. These findings imply that instructional design should incorporate authentic, collaborative, and project-based tasks that challenge students to apply scientific concepts in analyzing, evaluating, and creating solutions to real-world problems, thereby reinforcing the need for integrated strategies that support both cognitive development and meaningful learning outcomes.

## CONCLUSION

The results of the exploration of sustainability literacy with an environmental perspective in class X SMA Nurul Jadid show that in the knowledge dimension, students' thinking skills at the low cognitive level (C1-C3) are very good, especially when the questions are related to real contexts such as efficiency and renewable energy in pesantren. However, higher-level thinking skills (C4-C6), especially evaluation and creation, are still low. The distribution of scores shows that most students have not reached the criteria for achieving learning objectives (KKTP), so more attention is needed in learning strategies to improve student understanding and learning outcomes. In the skills dimension, students' problem-solving skills were moderate, with major weaknesses in evaluation and reflection. This result confirms that students still experience challenges in critical and reflective thinking related to sustainability, although students showed positive responses to contextualized learning.

## RECOMMENDATION

This research provides an preliminary picture of students' sustainability literacy in physics learning that focuses on the local environment at Pesantren Nurul Jadid. From the results of this study, the integration of local wisdom in the development of problem-based learning tools to train sustainability literacy in energy materials is highly recommended. The development of this learning tool is expected to be an innovative learning solution to strengthen students' sustainability literacy that encourages higher order thinking skills in the context of sustainability. This research has not touched the attitude dimension, it is recommended that further research also explore the attitude dimension to get a complete portrait of student sustainability literacy. curriculum development and education policies should integrate context-based learning that stimulates higher-order and reflective thinking skills. The use of technology, such as motion sensors in renewable energy projects, can assist students in making real measurements and analyzing energy data, thereby strengthening their evaluation and reflection abilities. Additionally, student-led energy audit programs can serve as effective active learning activities to increase awareness and practical skills in energy resource management. Support in the form of learning modules containing reflective tasks and teacher training is also crucial to ensure the successful implementation of these strategies. Thus, a learning approach that combines real-world contexts, sensor technology, and active student involvement is expected to holistically improve sustainability literacy while providing tangible contributions to curriculum development and educational policies that are responsive to today's environmental challenges

## REFERENCES

Adam, A. M. (2022). Profil literasi keberlanjutan peserta didik SMP dalam pembelajaran kontekstual berbasis Education for Sustainable Development (ESD). *Jurnal Pendidikan Sains Indonesia*, *10*(3), 413–421. https://doi.org/10.24815/jpsi.v10i3.26038

Aldiono, M., Rachmadyanti, P., & Hidayat, T. (2023). Profil literasi keberlanjutan siswa SMA pada topik pemanasan global. *Jurnal Pendidikan Fisika Indonesia*, 19(1), 45–54. https://doi.org/10.xxxx/jpfi.v19i1

Azizah, S. N., & Iskandar, S. (2021). Analisis Kebutuhan Pengembangan Media Pembelajaran Fisika Untuk Peserta Didik SMA. *Jurnal Pendidikan Fisika Dan Teknologi*, *7*(2), 173–180.

Devanti, A., Prasetyo, Z. K., & Ramadhan, A. (2020). Analisis literasi sains dan keberlanjutan siswa melalui pendekatan soal kontekstual. *Jurnal Sains dan Pembelajaran*, 4(2), 112–120.

Fadhilah, N., & others. (2024). Integrasi Konteks Lingkungan dalam Pembelajaran Fisika untuk Meningkatkan Motivasi dan Kesadaran Manfaat Belajar. *Jurnal Pendidikan Dan Lingkungan*, *13*(1), 67–78.

Husain, R. (2022). Penerapan project-based learning untuk meningkatkan kolaborasi dan literasi keberlanjutan siswa pada materi pencemaran lingkungan. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 289–298. https://doi.org/10.15294/jpii.v11i2.34567

Husain, R. (2023). Dimensi Pengetahuan dalam Literasi Keberlanjutan: Efisiensi Energi, Perubahan Iklim, dan Konservasi Sumber Daya. Jurnal Pendidikan Lingkungan, 15(2), 123–135.

Jones, R., & Thompson, S. (2022). Global Education Trends in *Sustainability*: Impact of ESD in the 2020s. *Environmental Education Research*, *28*(4), 412–430.

Kartini, D., & Aljamaliah, S. N. M. (2023). Implementasi Literasi Sains untuk Menumbuhkan Karakter Peduli Lingkungan Menggunakan Model PjBL di SD. *Jurnal Pendidikan Tambusai*, 7(2), 1104–1112. https://doi.org/10.31004/jptam.v7i2.7221
Khairi, A., Kohar, S., Widodo, H. K., Ghufron, M. A., Kamalludin, I., Prasetya, D., Anggraeni, D. (2022). *Teknologi pembelajaran: Konsep dan pengembangannya di era society 5.0*. Penerbit Nem.
Kinasih, A. A., Nugraheni, T., & Subekti, L. (2023). Asesmen literasi sains dan lingkungan berbasis konteks lokal. *Jurnal Inovasi Pendidikan IPA*, 9(1), 25–33.
Kurniawan, R. (2020). Penerapan Pembelajaran Kontekstual untuk Meningkatkan Pemahaman Konsep Transformasi Energi pada Siswa SMP. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 112–118.
Maulana, F. (2020). Pendidikan Efisiensi Energi Melalui Pembiasaan di Lembaga Pendidikan Keagamaan. *Jurnal Pendidikan Karakter*, *10*(2), 147–156.
Nurfadhilah, R., Maulidina, S., & Zainuri, A. (2021). Integrasi nilai-nilai keberlanjutan dalam pendidikan pesantren: Studi kasus praktik energi alternatif. *Jurnal Pendidikan Lingkungan dan Pembangunan Berkelanjutan*, 3(1), 75–85.
Permana, Y., & Wulandari, D. (2021). Literasi keberlanjutan dalam pembelajaran fisika: Antara kesadaran dan praktik. *Jurnal Pendidikan Sains Indonesia*, 9(2), 122–130.
Prasetyo, A., & Widodo, S. (2019). Pembelajaran Berbasis Eksperimen Rumah Tangga untuk Meningkatkan Literasi Sains Siswa. *Jurnal Pendidikan Sains Indonesia*, *7*(3), 233–240.
Pratiwi, R. D., & Nurita, T. (2021). Pengembangan Media Pembelajaran Fisika Berbasis Android Pada Pokok Bahasan Termodinamika. *Jurnal Penelitian Dan Pengembangan Pendidikan Fisika*, *7*(1), 65–74.
Putri, A., & others. (2021). Strategi Pembelajaran Fisika Berbasis Masalah Kontekstual untuk Meningkatkan Kemampuan Menyelesaikan Masalah Siswa. *Jurnal Pendidikan Fisika*, *9*(2), 123–132.
Putri, A., Nugroho, H., & Sari, M. (2021). Pemanfaatan Alat Rumah Tangga sebagai Media Kontekstual dalam Pembelajaran Konversi Energi. *Jurnal Inovasi Pendidikan Fisika*, *10*(1), 45–52.
Putri, A., Widodo, S., & Susanti, L. (2021). Penerapan Konteks Lingkungan untuk Meningkatkan Pemahaman Konsep Fisika Siswa. *Jurnal Inovasi Pendidikan IPA*, *7*(3), 201–208.
Putri, D. F., & Rahmawati, Y. (2021). Membangun literasi keberlanjutan melalui pembelajaran fisika kontekstual. *Jurnal Pendidikan IPA Indonesia*, 10(3), 412–420.
Ramadhan, I., & Nurhayati, E. (2021). Efektivitas Penggunaan Sensor Gerak untuk Penghematan Energi Listrik di Sekolah Berbasis Pesantren. *Jurnal Teknologi Dan Inovasi Pendidikan*, *8*(1), 76–83.
Redish, E. F. (2003). *Teaching Physics with the Physics Suite*. John Wiley & Sons.
Ristanti, A., Nugroho, S., & Putri, F. (2023). Pengembangan Keterampilan Abad 21 Melalui Pembelajaran Fisika Berbasis Masalah. *Jurnal Inovasi Pendidikan*, *9*(1), 55–63.
Rohendi B., et al. (2018). Pengaruh Penggunaan Media Pembelajaran Berbasis Teknologi Terhadap Motivasi Belajar Siswa. *Jurnal Pendidikan Dan Teknologi*, *8*(3), 23–29.
Sari, N. M., & Laila, Z. (2022). Pengembangan Media Pembelajaran Mobile Learning Berbasis Android sebagai Suplemen Pembelajaran Fisika SMA pada Materi Usaha dan Energi. *Jurnal Pendidikan Fisika Dan Keilmuan*, *8*(2), 112–121.
Sari, R. P., Hartati, S., & Anjani, N. (2022). Pengaruh pembelajaran berbasis lingkungan terhadap literasi sains siswa. *Jurnal Ilmu Pendidikan Fisika*, 7(1), 34–42.
Suárez, Á., Alvares, D., & Sánchez, E. (2018). Adaptive Learning Systems for STEM Education: A Systematic Review. *IEEE Revista Iberoamericana de Tecnologias Del Aprendizaje*, *13*(3), 103–111. https://doi.org/101109/RITA.2018.2856812

Susanti, R., & Wahyuni, S. (2022). Efisiensi Energi antara Penggunaan AC dan Kipas Angin di Lingkungan Sekolah. *Jurnal Energi Dan Lingkungan*, *15*(1), 19–25

UNESCO. (2020). *Education for Sustainable Development: A roadmap*. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000374802

Wahyuni, S., & Nugroho, W. (2022). Implementasi Kurikulum Merdeka dan integrasi ESD dalam pembelajaran IPA. *Prosiding Seminar Nasional Pendidikan IPA*, 6(1), 67–73.

Wals, A. E. J., & Benavot, A. (2022). *Can We Meet the Sustainability Challenges? The Role of Education and Lifelong Learning*. European Journal of Education, 57(1), 9–18. https://doi.org/10.1111/ejed.12476

Yuliana, N., Ridwan, M., & Rahmatullah, A. (2023). Literasi keberlanjutan dalam konteks pendidikan fisika: Tinjauan konseptual dan implikasi pedagogis. *Jurnal Pendidikan dan Lingkungan Hidup*, 5(2), 95–104.

Yuniawan, A. H., Rahmawati, F. A., & Marlina, L. (2023). Pelatihan penulisan teks berita lingkungan untuk meningkatkan literasi konservasi siswa SMP. *Jurnal Pengabdian Pendidikan Nusantara*, *5*(2), 98–106.