

Design of reflective - Sustainable development education oriented project-based learning platform for elementary school students in Indonesia



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Abstract: This study aims to develop a project-based learning platform oriented towards Education for Sustainable Development (ESD) and reflective thinking for elementary school students in Indonesia. The platform is designed to support the implementation of the *Merdeka Curriculum*, particularly in science learning (IPA and IPS), integrating reflective aspects and Sustainable Development Goals (SDGs). The study employs a Research and Development (R&D) method with a mixed-methods approach involving six elementary school teachers from five districts in East Java. The research stages include needs analysis, platform design, development, trials, and evaluation. The results show that the platform is effective in enhancing teachers' reflective thinking skills, with an average N-Gain score ranging from 91 to 95. Additionally, teachers provided positive perceptions of the platform's implementation within the curriculum, highlighting its potential to boost student engagement and motivation. The study also identifies several challenges in implementing project-based learning in elementary schools, such as integrating the platform with existing Learning Management Systems (LMS), managing time effectively, and adapting to varying technological proficiencies among teachers. Feedback from the participants highlights the importance of user-friendly interfaces and continuous professional development to maximize the platform's effectiveness. Overall, this platform offers an innovative solution for fostering project-based learning in elementary education, aligning with reflective thinking and SDGs. Furthermore, the findings contribute to improving educational practices by offering practical strategies for integrating technology and sustainability-oriented education, thus addressing global and local educational needs. Future research is suggested to explore scalability and long-term impacts of the platform on student learning outcomes and teacher professional growth. However, this study also identified several challenges, including limited technological infrastructure in schools, lack of technical training for teachers, and integration of the platform with existing Learning Management Systems (LMS). To overcome these challenges, continuous efforts are needed to improve teacher capacity and support school infrastructure. Overall, the development of this platform provides an innovative solution and contributes to strengthening the quality of basic education oriented towards Reflective-SDGs, supporting the achievement of sustainable development goals in the education sector.

Keywords: learning platform, project-based learning, reflective-SDG, elementary school students

1. Introduction

Sustainable development has become a global goal adopted by United Nations member states (Fuentes-Camacho et al., 2021; Lee & Williams, 2020). This goal addresses major world problems today: poverty eradication, environmental sustainability, gender equality, and access to decent education and health services. The implementation of sustainable development goals (SDGs) in various sectors is hoped to achieve a more prosperous and sustainable world (Seid & Andualem, 2021) (Vilmala et al., 2022). In education, incorporating the SDGs into the curriculum has excellent potential for developing students' knowledge and skills to actively contribute to achieving these goals. Education not only acts as a means of conveying information but also as a tool to form values and a deep understanding of the importance of sustainable development (Rahayu et al., 2021) (Mylvaganam et al., 2021) (Hernita, 2023). SDG-based education should be integral to the formal education curriculum, especially at the early childhood and primary education levels. This approach allows the instilling of sustainable development values from an early age, forming a more concerned and committed generation to achieve these global goals. Education for sustainable development (ESD) is a form of education that can significantly impact sustainable development. ESD focuses on developing the skills, knowledge, and attitudes needed to create a sustainable society (Zulkarnaini et al., 2020) (Novidsa et al., 2021) (Penebbangan & Nasional, 2010). Thus, ESD provides theoretical insights and encourages real action in



the field to realize more equitable and inclusive development. Integrating the SDGs in education is expected to produce a young generation that can effectively become agents of change in facing global and local challenges. They will be equipped to think reflectively, innovate, and work together to create sustainable solutions for society and the environment in the future (Obada et al., 2021) (Rahayu et al., 2021) (Fibonacci et al., 2020).

Sustainable (development goal SDG-based learning emphasizes the importance of integrating these global goals into the educational process to create a generation that is aware of and contributes to sustainable development. However, for SDG-based learning to have a significant impact, reflection on the learning process is very important. Reflective thinking is the activity of contemplating or rethinking the learning process that has taken place. Teachers and students can carry out this activity to evaluate the learning process, confirm student achievement, and improve inappropriate learning processes (Rosmiati et al., 2020; Rosmiati et al., 2024). Reflection in the context of SDG-based learning plays a vital role in ensuring that the education provided is informative and transformative. The reflective process allows teachers to evaluate the effectiveness of the methods and materials used in teaching the SDG-based. Through reflection, teachers can identify aspects that need to be improved and adjust teaching strategies to suit students' needs better. In addition, reflection helps teachers understand the extent to which students have internalized the values of sustainable development. For students, reflective thinking provides an opportunity to develop self-awareness and a deeper understanding of the learning they receive. Students are invited to reflect on how the knowledge and skills they have acquired can be applied in everyday life to support the SDG-based (Bernsteiner et al., 2023) (Zguir et al., 2021). Reflection also encourages students to become more independent and critical learners who can continuously evaluate and improve their understanding. The implementation of SDG-based learning with a reflective approach has several main benefits. First, reflection allows for continuous adjustment and improvement in the learning process so that the education provided is relevant and practical. Second, through reflection, students and teachers can work together to create a learning environment that is more inclusive and responsive to existing changes and challenges. Third, reflection supports the development of critical and creative thinking skills essential to addressing the complexity of sustainable development issues.

Project-based learning (PBL) is an instructional approach designed to enable learners to develop knowledge and skills through projects involving real-world challenges and problems (Satriawan et al., 2022) (Satriawan et al., 2024). PBL goes beyond simple projects by investigating and addressing authentic, engaging, and complex problems in depth and with continuity. While the definition and parameters of a project may vary from school to school and PBL is sometimes confused with experiential learning or discovery learning, the critical characteristics of PBL are clear. Most modern workers' careers are projects rather than years at a single organization. Therefore, it is critical to prepare learners for a project-based world. In short, to prepare learners for success in life, we must prepare them for a project-based world. PBL connects learners to the real world, preparing them to confront and solve existing challenges, similar to what professionals do daily. Rather than relying on short-term memorization strategies, PBL provides learners with opportunities to engage deeply with content, focusing on long-term retention. PjBL also improves students' attitudes toward education because it keeps them engaged. The structure is suitable for building intrinsic motivation because it centers students' learning around a crucial central question or problem and produces meaningful outcomes (Satriawan et al., 2022) (Rahayu et al., 2021).

Elementary schools in Indonesia have begun implementing the independent curriculum, which includes project-based learning. One of the new policies introduced by the Ministry of Education, Culture, Research, and Technology (Kemendikbud Ristek) is the integration of Natural Sciences (IPA) and Social Sciences (IPS) subjects into project-based Natural and Social Sciences (IPAS) (Anjarini & Suyoto, 2022) (Safitri et al., 2023). The independent curriculum is designed to provide greater flexibility for teachers and students in learning. One of the approaches used is project-based learning (PBL). PBL is a learning model that allows students to learn through direct experience by working on projects that are relevant to real life. This model improves students' conceptual understanding and develops 21st-century skills such as critical, creative, collaborative, and reflective thinking. Integrating the IPA and IPS into project-based IPAS is an innovative step to provide more holistic and contextual learning. Students can understand the relationship between natural science and social science in everyday life through this approach. The projects performed by students cover various disciplines, allowing them to see the connection between the concepts they learn and how they are applied in solving real problems. The implementation of this new curriculum is also expected to increase student motivation and engagement in learning. By working on exciting and meaningful projects, students can be more enthusiastic about learning and see the direct relevance of what they learn. In addition, PBL encourages students to become independent and responsible learners because they need to plan, manage, and evaluate their projects. The policy of integrating project-based science also provides opportunities for teachers to develop more creative and innovative teaching methods. Teachers can design projects appropriate to students' local context and needs and combine various learning resources that can enrich students' learning experiences. This also encourages collaboration between teachers in designing and implementing cross-disciplinary projects.

Although the independent curriculum in elementary schools has adopted project-based learning (PBL) and integrated natural sciences (IPAs) and social sciences (IPSS) into natural and social sciences (IPASs), several problems hinder the optimal implementation of this approach.

1. Lack of an Integrated Support System Platform. Currently, there is no support system platform specifically designed to support project-based learning in science in elementary schools. An effective support system platform is needed to provide the tools, resources, and support needed by teachers and students in implementing learning projects. Teachers need help managing projects, monitoring student progress, and providing constructive feedback with an adequate platform.

2. Unintegrated Learning Management System (LMS). The current learning management system (LMS) still needs to be able to integrate various disciplines, especially science and social studies, in the context of learning in elementary schools. Unintegrated LMSs hinder the collaboration and interdisciplinary processes essential in project-based learning. Students do not have a holistic learning experience because of their limited access to and ability to connect materials from various disciplines.

3. Learning Still Limited to Nonprojects. Although the concept of project-based learning has been introduced, its implementation in many elementary schools still needs improvement. Learning often focuses on traditional nonproject methods, such as direct teaching and memorization. This reduces the opportunity for students to engage in deeper and more meaningful learning experiences, which should be the primary goal of implementing PBL. These problems show that although the independent curriculum with project-based learning has great potential for improving the quality of education, its implementation still needs to be improved. Further efforts are needed to develop and provide an integrated support system platform, optimize the use of LMSs that support interdisciplinary learning, and encourage the widespread implementation of project-based learning in elementary schools. By overcoming these problems, project-based learning in the independent curriculum can run more effectively and significantly impact student development.

The integrated project-based learning system platform has been widely researched previously via the STEM approach for the implementation of education 4.0 (Muntamah et al., 2024) (Latip et al., 2022) (Satriawan et al., 2022) (Bakhri et al., 2023) (Reflianto & Syamsuar, 2018). The STEM-integrated project-based learning model with aquaponic media can be used as an alternative learning model to improve students' scientific skills in science and social studies materials (Hendri et al., 2021) (Nugroho et al., 2021) (Wiratman et al., 2023) (Satriawan et al., 2021). *Project-based learning* is used in the independent curriculum because it is the policy of the Minister of Education and Culture to encourage students in elementary school education units to master knowledge that is useful for becoming active learners; learning becomes more interactive, provides students with the opportunity to manage their own activities or task completion activities so that they train students to be independent, can provide a deeper understanding of concepts or knowledge to students, and can provide opportunities for students to be able to master the subjects they will receive (Anjarini & Suyoto, 2022) (Dewi et al., 2023) (Yamin et al., 2020) (Satriawan & Rosmiati, 2022). In addition, reflective-based learning implemented in PJBL KUMER can help improve students' abilities in learning activities (Juniati, 2020) (Arochman et al., 2024) (Rizkianida et al., 2023). Students must reflect on the relationship between learning and previous insights regarding material and the learning process. Reflective thinking skills can be the basis for solving various problems. They can reflect on their experiences to think far ahead according to the SDGs to produce scientific findings (Fuentes-Camacho et al., 2021) (Bernsteiner et al., 2023) (Mylvaganam et al., 2021). The Merdeka curriculum can be implemented to address the challenges of technological developments with OBE (*outcome education*) learning system education so that graduates focus on learning outcomes that align with scientific disciplines (Nissa, 2022) (Atikah et al., 2023). Research has shown that *the Integrated Project learning system platform* significantly influences student learning outcomes. However, research conducted by (Chikurteva & Chikurtev, 2020) (Isrokaton et al., 2023) explains the increasing trend of *implementing integrated project learning system platforms* in education. However, they have yet to be implemented in elementary school students on the basis of reflective learning and SDG learning. Integration development must be performed to connect the learning system, teachers, and students. On the basis of several previous studies that have been explained, although they have the same theme regarding *the integrated project learning system platform*, the results of different studies lie in *the prototype of the integrated project learning system platform* for elementary school students on the basis of reflective SDGs in this case, and the development shows a *research gap*. This study aims to develop a project-based learning platform oriented towards Education for Sustainable Development (ESD) and reflective thinking for elementary school students in Indonesia. The novelty of this study is the production of *a prototype of the Integrated Project learning system platform* into the education system, especially elementary education, which is based on reflection SDGs, because, generally, most elementary school students and teachers still face resource and technology barriers to implementing the independent curriculum, especially in science and science learning.

2. Method

The selection of the R&D research design is based on the advantages and suitability of this design for the research problem. The research data were analyzed via *a mixed-method* descriptive quantitative and qualitative method, with science teachers from elementary schools from 5 districts/cities in East Java (Gresik, Surabaya City, Mojokerto, Sidoarjo, and Pasuruan). This *project learning system platform innovation* will expand features such as a project collaboration platform, a virtual lab for science experiments, a learning resource portal, and project-based learning applications. By implementing these features, the innovative platform can create a learning environment that supports the "freedom to learn" principle, allowing students to

learn more independently, creatively, and meaningfully. Science learning becomes more exciting and interactive, helping students develop knowledge and skills relevant to the future.

The mixed method applied in this study is the embedded experimental type (Creswell & Plano Clark, 2007). It was chosen for several reasons in the research study. This method allows researchers to integrate quantitative and qualitative data in one study. This is especially useful in answering complex research questions that benefit from multiple perspectives. Quantitative data can provide a broad understanding through numerical analysis, whereas qualitative data can offer deeper insights and explanations. The priority of this study is the quantitative experimental method and supporting qualitative data. The purpose of choosing this method is to collect qualitative and quantitative data while designing a project-based learning platform oriented toward sustainable development education and reflection for elementary school students. This study was conducted in four stages, namely, before the intervention, during the intervention, after the intervention, and interpretation. This is done because qualitative research is needed before the intervention, so the resulting intervention can be considered appropriate.

2.1. Participants and Locations

This research was conducted in elementary schools in Surabaya and Sidoarjo, East Java Province, Indonesia, in grades 4, 5, and 6. The participants in this study were all elementary school teachers in Surabaya city, East Java Province, Indonesia. The sample used in this study consisted of elementary school teachers in grades 4, 5, and 6 and 3 classes consisting of 6 teachers.

2.2. Data collection

Data collection was carried out via observation techniques, tests, and reflective thinking questionnaires. Observations were carried out to collect initial research data. The test technique was used to collect data on platform usage skills, and the questionnaire was a reflective thinking questionnaire.

2.3. Data analysis

Reflective thinking improvement analysis was conducted to assess the score results via five reflective thinking questions to measure whether there was a significant increase in the initial, pretest, and posttest scores. This increase was obtained via the normalized gain score formula (N-gain score). The N-gain value obtained was used to determine the increase in the reflective thinking ability of elementary school teachers. Furthermore, an effectiveness test was carried out to determine the effectiveness of the implementation of the Integrated Project-Based Learning System Platform in the independent curriculum in Science Learning Reflective SDGs oriented toward elementary schools. The effectiveness value is obtained from the percentage of elementary school teachers who obtain N gains with high criteria. The effectiveness criteria for using the model are explained via the criteria shown in Table 1.

Table 1 Interpretation Categories of Implementation Effectiveness.

Percentage (%)	Interpretation
< 40	Ineffective
41 – 55	Less Effective
56 – 75	Quite Effective
>75	Effective

The results of the questionnaire data analysis were used to assess the reflective thinking skills attitudes of the elementary school teachers. The indicators of reflective thinking attitudes refer to the framework of (Bell ate al., 2011) (Buzdar & Ali, 2013) (Kember et al., 2010), which includes habitual action, which is an activity that is carried out automatically because it has been studied before and is often used; understanding, which existing knowledge without relating it to other situations; reflection, which is constant and actively considered, by paying attention to everything that is believed to be accurate; and critical reflection, which is the highest level of reflective thinking ability where someone can change the framework of thinking and know the reasons for something happening. Each of the four statements represents an indicator, and the attitude scale used is a 4-point scale, including 1: Strongly Disagree (SD), 2: Disagree (D), 3: Agree (A), and 4: Strongly Agree (SA).

3. Results and Discussion

The following results were obtained from observations conducted with elementary school teachers in Surabaya city, Indonesia, via Google Forms with the link <https://forms.gle/9T4CpTHrL5K89gw8A>. Elementary school teachers' perceptions of the importance of project-based learning system platforms in the independent curriculum shown in figure 1.

This figure provides information that most elementary school teachers strongly agree with the importance of using digital platforms in various aspects of the independent curriculum. This graph presents teachers' views on the importance of using digital platforms. The Y-axis shows the percentage (%), ranging from 0 to 100%. Moreover, the X-axis lists four categories of perceptions related to digital platforms: understanding the importance of digital platforms, ease of implementation, access

to devices and the internet, and the importance of digital platforms. Each bar shows a very high level of teacher agreement regarding each category. All bars range from 70% to almost 100%, with "Ease of Implementation" reaching the highest percentage. Some factors influencing teacher perceptions are that digital platforms are essential for increasing student engagement and allowing for more flexible and direct access to learning at the source. According to research by (Fan et al., 2021) (Schmid et al., 2021), the use of digital technology can make students more engaged and learn more independently and adaptively according to their needs. Research by (Anghelo Josué et al., 2023) revealed that digital platforms provide access to broader educational resources, accelerate the teaching and learning process, and provide opportunities for teachers to create more diverse teaching methods. In the digital era, students need to develop digital literacy from an early age. According to research by (Sunday et al., 2021) (Galang, 2020), digital platforms enrich students' learning experiences and prepare them to face future challenges that are increasingly dominated by technology. (Rahayu et al., 2022) reported that digital platforms can help students develop 21st-century skills, such as reflective thinking, which are very much needed in the modern workplace.

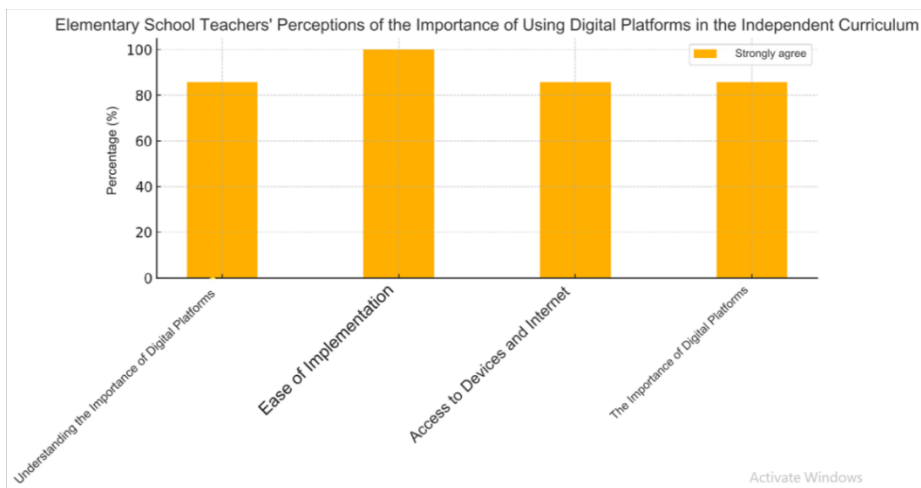


Figure 1 Elementary School Teachers' Perceptions of the Importance of Project-Based Learning System Platforms in the Independent Curriculum.

The development results show that the platform we developed can be seen on page <https://pmbd.id/>. The text displayed is in Indonesian and has the title "Breaking Boundaries." The sentence below the title reads, "Teaching anywhere for an extraordinary generation of the nation," emphasizing the mission of teaching anywhere for an extraordinary generation. Transformation - "Digital innovation for basic education." Vision - "Create the future of children's learning." Unggul - "Smart investment, brilliant education." And Synergy - "Collaboration for the future generation." This display is likely the platform's main page, which focuses on digital innovation and education for the younger generation. The overall design emphasizes the vision of a transformational future of education. Elementary school teachers input teaching modules according to the syntax of project-based learning on the website N -Gain value of elementary school teachers' reflective thinking shown in figure 2.

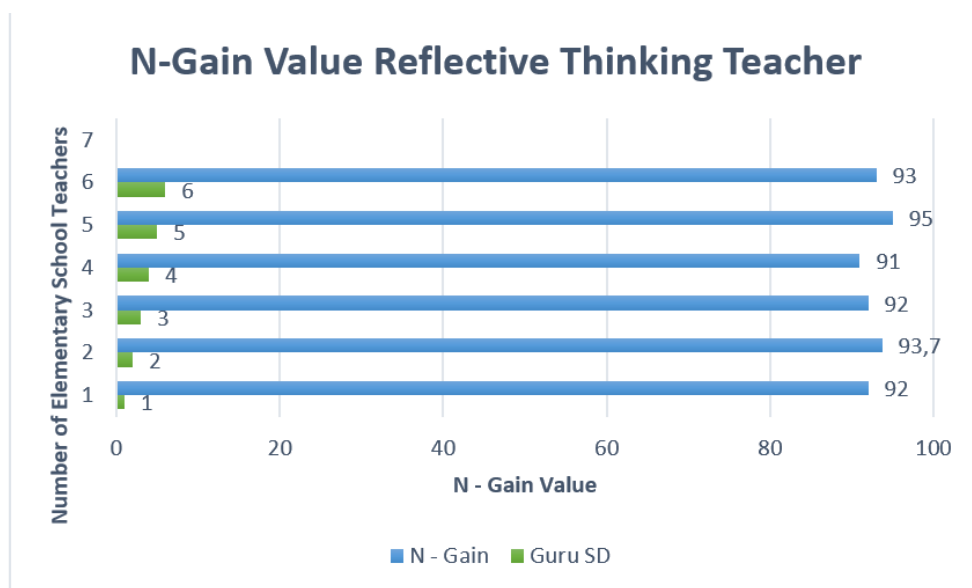


Figure 2 N-Gain Value of Elementary School Teachers' Reflective Thinking.



The image above focuses on measuring the reflective thinking scores of elementary school teachers after the implementation of the Integrated Project-Based Learning System Platform in the Independent Curriculum in Science Learning. Reflective SDGs Oriented in Elementary Schools. The Y-axis displays the categories of the number of elementary school teachers, where numbers from 1 to 6 represent groups of teachers. The X-axis displays the N-Gain value ranging from 0-100. N-Gain is a measure used to see improvements or changes in learning. The blue bar (N-Gain) shows the N-Gain value for each teacher. Each teacher has an N-gain between 91 and 95, with the highest value being 95 (teacher 6) and the lowest value being 91 (teacher 4).

The high N-Gain value across various teacher groups (with an average of approximately 91-95) shows that the implementation of the Integrated Project-Based Learning System Platform in the Independent Curriculum in Science Learning Reflective SDG-oriented learning in elementary schools has succeeded in improving teachers' understanding and effectiveness in learning via an integrated platform of Reflective SDG-based project learning. Recent research has revealed that reflective thinking is vital in sustainable education. A study by (Fuertes-Camacho et al., 2021) (Bernsteiner et al., 2023) (Mylvaganam et al., 2021) showed that interactions between teachers and students, feedback from colleagues, and pedagogical support play significant roles in developing teachers' reflective thinking skills. This improvement helps teachers become more adaptive to change and better prepared to adjust their teaching methods to the changing needs of their students. In addition, reflective thinking not only improves teaching skills but also contributes to the development of personal and professional competencies. Teachers who actively engage in reflective thinking can face new challenges and innovate their teaching. This is in accordance with the high values seen in the graph, which indicates that most teachers have internalized and practiced the reflective approach well. Continuing from the previous discussion, effective reflection is closely related to improving teacher professionalism. According to research by (Rosmiati et al., 2020), reflection depends not only on individual abilities. However, it is also driven by external factors such as institutional support and opportunities to work collaboratively with fellow teachers. In this context, consistent N-Gain values across teacher groups indicate that they have received a supportive learning environment for reflection. This could be due to access to relevant pedagogical tools and constructive feedback from their colleagues.

In addition, (Shavit & Moshe, 2019) (Rosmiati et al., 2024) emphasize the importance of technology integration in helping teachers practice reflective thinking. Technology allows teachers to access data on student progress in real time, which can then be used as reflection material to assess the effectiveness of their teaching methods. This is in line with the increase seen in the graph above, where reflection allows teachers to evaluate and adapt their approaches on the basis of direct evidence of student outcomes. At the global level, this trend is increasingly recognized by many education systems as a crucial component of continuous learning. For example, the United Nations Educational, Scientific and Cultural Organization (UNESCO) states that the development of reflective thinking is an integral part of the Sustainable Development Goals (SDGs), which focus on providing inclusive and high-quality education. This means that improving teachers' reflective abilities will directly impact the achievement of sustainable education goals by ensuring that continuous learning can occur, not only for students but also for teachers (Rosmiati et al., 2020) (Rosmiati et al., 2020). Reflective thinking attitude scale shown in figure 3.

Figure 3, shows that the scores in this category are 4, 4, 4, 3, 4, and 3. Habitual actions tend to reflect automatic behavior without deep reflective thought. A dominance score of 4 indicates that most individuals in this sample may have a strong tendency to act automatically in familiar or routine situations. However, scores of 3 for some items indicate that in certain situations, some individuals may begin to show more awareness of their actions, so there is a slight decrease in full automation. Scores of 4, 4, 4, 3, 4, and 4 indicate a relatively strong understanding of the individual regarding the context or information being faced. Most individuals indicate that they understand the situation or material they are studying well. However, a score of 3 indicates that some people may have difficulty understanding it in depth. The scores for reflection were 3, 4, 3, 3, 3, and 4. This suggests that individuals vary in their ability to reflect on their experiences. The more frequent score of 3 suggests that most individuals may reflect moderately but not consistently deeply. Their reflection may occur in specific situations or at a lower intensity. The scores here are 4, 4, 4, 3, 4, and 4. Critical reflection involves deeper thinking and a more thorough evaluation of actions, beliefs, and assumptions. score of 4 indicates that individuals in the sample tend to have good critical reflection skills, with the ability to evaluate their actions and assumptions in detail. However, a score of 3 for one item indicates that critical reflection is lacking in some situations.

The majority of scores indicate good individual tendencies in critical understanding and reflection, indicating that individuals are capable of deep thinking when necessary. However, there was variability in general reflection and habitual actions, suggesting that individuals may be more likely to act automatically without deep reflection in more routine situations. The lower scores in some categories (score 3) may be due to a lack of experience in reflection or specific contexts that do not require in-depth reflection. A score of 4 in most categories indicates the individual's great potential in developing reflective thinking, especially in more challenging contexts. High scores on habitual actions (mostly 4) indicate that individuals tend to act automatically without much deep reflection, especially in routine situations. Research suggests that these habits may occur because individuals become more comfortable with actions that have become routine. These automatic habits may reduce the level of reflection. However, in some situations, a decrease in scores to 3 may indicate that some individuals are becoming

more aware of their actions, especially in unfamiliar contexts. In this dimension, consistently high scores (4) indicate that individuals strongly understand the material being studied. Research suggests that reflectivity is closely related to one's epistemological beliefs; the more complex the epistemological beliefs are, the more likely the individual is to engage in deeper reflective thinking processes. This vital understanding may also be driven by an individual's ability to relate new knowledge to information they already have, allowing for more critical reflection when facing new situations. The varying scores on the reflection dimension (scores 3 and 4) indicate that not all individuals consistently engage in deep reflection. Research by (McKnight et al., 2020) (Barteit et al., 2021) (Elmqaddem, 2019) revealed that specific learning methods, such as augmented reality (AR), can enhance reflection, but these results are not uniform across all dimensions. This reflects that while specific methods can trigger reflection, the results depend on the context and how the technology or approach is applied. High scores on this dimension indicate that individuals are capable of critical reflection, which is a deep evaluation of their assumptions and actions. Research by (Beavers et al., 2017) (Salido & Dasari, 2019) emphasizes the importance of forming reflective habits in various professions to enhance critical reflection skills. Critical reflection allows individuals to understand their actions and question their basis.

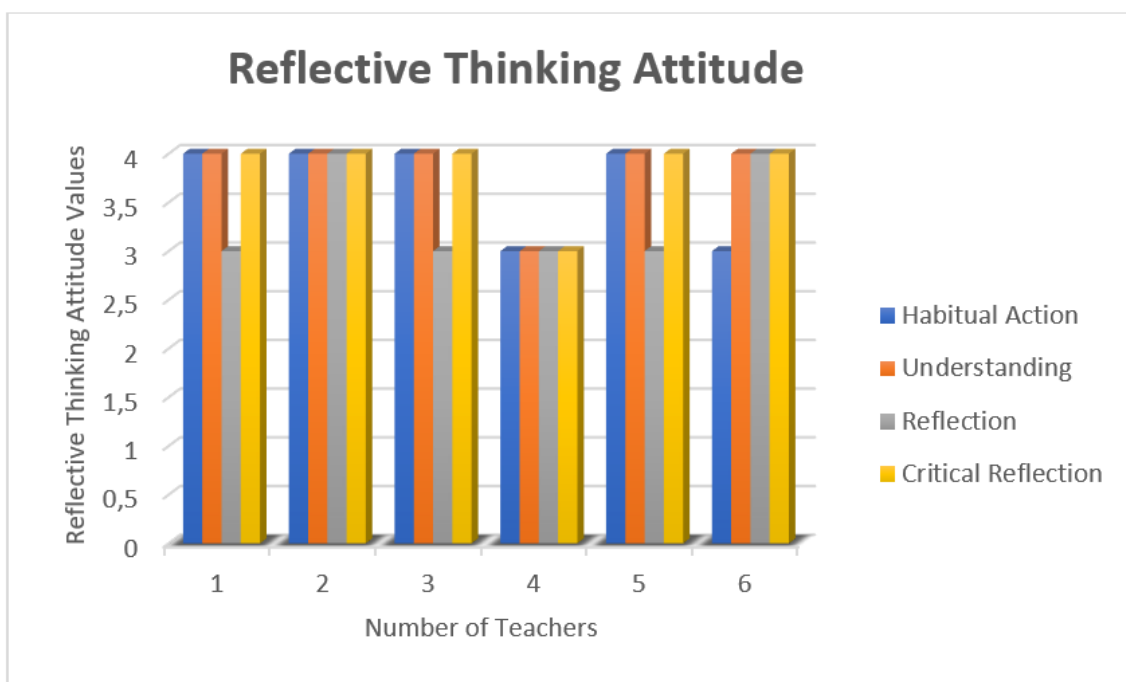


Figure 3 Reflective Thinking Attitude Scale.

4. Conclusion

Integrated Project-Based Learning Platform for Sustainable Development Education in Indonesia's elementary schools (SD). The main objective of this platform is to support the implementation of the independent curriculum, especially in learning IPASs (natural and social sciences), with a reflective approach based on sustainable development goals (SDGs). This platform is designed to improve the reflective skills of students and teachers and integrate natural and social sciences into one learning system. This approach aims to create learning that is more in depth, meaningful, and relevant to everyday life. One important element is the use of technology to provide virtual laboratories, resource portals, and collaborative tools for projects that focus on real-world challenges. The study results showed that this platform effectively improved the reflective thinking skills of elementary school teachers, as measured by high N-Gain scores. In addition, teachers also showed a positive attitude toward using this platform, which is necessary for increasing student engagement and motivation. However, this study also revealed that implementing project-based learning in many elementary schools still needs improvement, such as the lack of supporting platforms and the integration of the Learning Management System (LMS). Overall, the development of this platform provides an innovative solution to overcome barriers to project-based learning in elementary schools while supporting sustainable development goals in the education sector.

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Ethical considerations

This study was conducted in compliance with ethical research principles, including providing participants with complete information regarding the study's objectives, procedures, benefits, and potential risks, accompanied by the provision of informed consent as a form of voluntary agreement. Participant data confidentiality is guaranteed, and this research has been approved by the Ethics Committee of Universitas PGRI Adi Buana Surabaya. The researcher declares no conflicts of interest that could affect the objectivity of the research, whether personal, professional, or financial. This study was funded by Kemristek Dikti, with transparent use of funds for the procurement of research instruments, data analysis, and other technical needs, without any personal incentives that could influence the research results.

Conflict of interest

The authors declare that they have no conflicts of interest.

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