



Integrating Ekopira Media into Problem-Based Learning: Effects on Elementary Students' IPAS Learning Outcomes

Wachida Krisna Murti*, Iin Purnamasari, Achmad Buchori

Master of Elementary Education Study Program, Postgraduate Program,
Universitas PGRI Semarang, Indonesia.

*Corresponding Author. Email: wachidakrisnamurti280786@gmail.com

Abstract: This study aims to examine the effect of Problem-Based Learning (PBL) integrated with Ekopira media on elementary school students' learning outcomes in Integrated Science and Social Studies (IPAS). The study employed a quantitative approach with a quasi-experimental design using a nonequivalent control group design. The participants comprised 32 fifth-grade students, with 16 students in the experimental group and 16 students in the control group. The experimental group received instruction through PBL supported by Ekopira media, whereas the control group received conventional instruction. Data were collected through pretests and posttests and analyzed using descriptive statistics and simple linear regression with SPSS version 22. The findings showed that the mean score of the experimental group increased from 61.69 on the pretest to 89.06 on the posttest, whereas the control group's mean score increased from 59.44 to 77.00. The regression analysis indicated a statistically significant relationship between the instructional approach and students' learning outcomes ($p < .001$). The coefficient of determination ($R^2 = .714$) indicated that 71.4% of the variance in learning outcomes was explained by the predictor included in the regression model. These findings suggest that integrating Ekopira media into PBL provides a potentially effective, hands-on instructional strategy for supporting students' understanding of complex ecosystem concepts in elementary IPAS learning.

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Introduction

The rapid advancement of science and technology in the twenty-first century has transformed educational practices and increased the demand for students to develop critical thinking, creativity, communication, collaboration, and problem-solving skills. Accordingly, learning should provide meaningful and contextual experiences that enable students to actively construct knowledge and apply concepts to real-life situations (Nouri et al., 2020; Saleem et al., 2024). In Indonesia, the Merdeka Curriculum similarly emphasizes meaningful and contextual learning to develop students' competencies. Science and Social Studies (IPAS) is particularly relevant to these goals because it integrates scientific and social perspectives to help students understand natural phenomena, environmental interactions, and social issues while developing scientific literacy, environmental awareness, and problem-solving abilities (Suhelayanti et al., 2023). However, IPAS learning, particularly ecosystem topics, remains challenging for elementary students because concepts such as food chains, food webs, ecological relationships, and energy flow involve complex interactions that are difficult to visualize. Preliminary observations at SDN 2 Keser indicated that only six of sixteen fifth-grade students achieved the minimum mastery criterion, while classroom



activities were predominantly teacher-centered and relied on lectures and printed materials, with limited opportunities for discussion, investigation, and hands-on learning. These conditions may restrict students' engagement and conceptual understanding of ecosystem materials.

One pedagogical approach that can address these challenges is Problem-Based Learning (PBL), a student-centered model that engages learners in authentic and contextual problems through collaborative inquiry, investigation, and problem solving (Erviana et al., 2022). Grounded in constructivist learning theory, PBL enables students to connect prior knowledge with new information, actively construct meaning, and reconstruct their understanding through experience and social interaction (Hmelo-Silver, 2004; Savery, 2006; Loyens et al., 2015; Dolmans et al., 2016). Previous studies have reported that PBL can improve students' learning achievement, conceptual understanding, participation, and character development, including in elementary education (Nurma'ardi & Kuswaty, 2023; Komarudin, 2025; Yunitasari, 2025). Its effectiveness can be further supported by appropriate learning media. According to the Cognitive Theory of Multimedia Learning, the use of multiple representations can facilitate cognitive processing and conceptual understanding (Mayer, 2009), while interactive learning environments can increase students' engagement, motivation, and academic performance (Sung et al., 2015; Hwang & Wu, 2012). Thus, combining PBL with learning media that provide concrete representations may be particularly relevant for teaching abstract ecosystem concepts.

To support this pedagogical integration, this study employs Ekopira (Ekosistem Piramida Interaktif Rantai Makanan), a concrete and interactive ecosystem-based learning medium designed to represent producers, consumers, decomposers, food chains, food webs, and energy flow. Unlike learning materials that rely primarily on verbal explanations or two-dimensional representations, Ekopira uses a physical three-dimensional ecosystem pyramid that allows students to observe, arrange, manipulate, and discuss ecological relationships directly. Such concrete representations are relevant to elementary students because ecosystem concepts require an understanding of interactions among biotic and abiotic components that may be difficult to visualize through conventional instruction alone. By providing tangible representations of ecological structures and relationships, Ekopira can complement the inquiry, collaboration, and problem-solving processes embedded in PBL and create more contextual and engaging learning experiences. Previous research has also shown that interactive learning media can enhance students' motivation, conceptual understanding, engagement, and learning achievement (Yonanda et al., 2024; Aryfien et al., 2026).

Despite the documented benefits of PBL and interactive learning media, an empirical gap remains concerning their integration with concrete ecosystem-oriented media in elementary IPAS learning. Previous studies have predominantly examined PBL in combination with digital, audiovisual, Canva-assisted, Quizizz-based, or Wordwall media, while limited attention has been given to physical three-dimensional manipulative media specifically designed to represent ecological relationships. Existing research has demonstrated the potential of PBL and interactive media separately or in combination, but evidence regarding the use of a tangible ecosystem representation to support students' problem-solving and conceptual understanding remains limited (Maulidasari, 2025; Mardati et al., 2026). The use of a physical 3D medium such as Ekopira therefore addresses a cognitive and pedagogical gap by enabling students to directly manipulate representations of food chains, food webs, and energy flow rather than relying solely on abstract verbal or visual explanations. Investigating this integration is important for determining whether a



concrete ecosystem medium can strengthen the learning processes and outcomes promoted by PBL.

Based on this gap, the present study investigates the effect of Problem-Based Learning assisted by Ekopira media on elementary students' IPAS learning outcomes. The study specifically positions Ekopira as a concrete and interactive medium integrated into PBL activities to support students in exploring and solving ecosystem-related problems. By examining this integration, the study seeks to provide empirical evidence on the use of physical ecosystem-based media in elementary IPAS learning and to contribute practical insights for teachers in designing contextual, interactive, and student-centered learning experiences.

Research Method

This study employed a quantitative approach using a quasi-experimental design. The research design applied was the Nonequivalent Control Group Design, which involved an experimental group and a control group (Creswell, 2018; Sugiyono, 2022). The experimental group received instruction through Problem-Based Learning assisted by Ekopira media, whereas the control group received conventional learning. The research design is presented in Table 1.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Treatment	Posttest
Experimental	O ₁	X	O ₂
Control	O ₃	–	O ₄

Description:

O₁ = Pretest of experimental group

O₂ = Posttest of experimental group

O₃ = Pretest of control group

O₄ = Posttest of control group

X = Problem-Based Learning assisted by Ekopira media

The study was conducted in two elementary schools located in Tunjungan District, Blora Regency, Central Java, Indonesia. The participants consisted of 32 fifth-grade students from two selected elementary schools. The schools were selected using a purposive sampling technique based on their suitability for the study, including the availability of fifth-grade students and comparable learning conditions. Sixteen students from SDN 2 Keser were assigned to the experimental group, while sixteen students from SDN 1 Keser served as the control group. The selection of the schools was intended to provide comparable groups for examining the effect of Problem-Based Learning assisted by Ekopira media on students' IPAS learning outcomes.

Data were collected using learning outcome tests administered before and after the intervention. The test instrument consisted of multiple-choice questions developed based on the learning objectives of ecosystem materials in IPAS. Prior to implementation, the instrument was reviewed and validated to ensure its suitability for measuring students' learning outcomes. The research procedure consisted of three stages. First, students in both groups completed a pretest to determine their initial knowledge of ecosystem concepts. Second, the experimental group participated in learning activities using Problem-Based Learning assisted by Ekopira media, while the control group received conventional instruction. The implementation of Problem-Based Learning followed five stages: (1) orienting students to problems, (2) organizing students for learning, (3) guiding individual



and group investigations, (4) developing and presenting solutions, and (5) analyzing and evaluating the problem-solving process. During these stages, Ekopira media was utilized to facilitate students' understanding of ecosystem concepts, food chains, food webs, and ecological interactions. Third, both groups completed a posttest to measure learning achievement after the intervention.

Data analysis was conducted using SPSS version 22. Descriptive statistics were employed to determine the mean, maximum score, minimum score, and standard deviation of students' learning outcomes. Prior to hypothesis testing, prerequisite analyses were conducted, including normality testing using the Shapiro–Wilk test and linearity testing. After the data met the required assumptions, simple regression analysis was performed to determine the effect of Problem-Based Learning assisted by Ekopira media on students' learning outcomes. The coefficient of determination (R^2) was also calculated to determine the contribution of the independent variable to the dependent variable. All statistical analyses were conducted at a significance level of 0.05. The research was conducted following ethical principles. Permission was obtained from the participating schools prior to data collection. All participants were informed about the purpose of the study, and all collected data were used solely for research purposes while maintaining the confidentiality and anonymity of participants' identities.

Results and Discussion

The effectiveness of Problem-Based Learning assisted by Ekopira media was evaluated through students' learning outcomes in ecosystem materials. Learning outcome data were obtained from pretest and posttest scores administered to both the experimental and control groups. Descriptive statistical analysis was conducted to determine the differences in students' learning outcomes before and after the implementation of the learning intervention.

Table 2 presents the comparison of pretest and posttest scores between the experimental and control groups.

Table 2. Comparison of Pretest and Posttest Scores

Group	Pretest Mean	Posttest Mean
Experimental	61.69	89.06
Control	59.44	77.00

Table 2 shows that both groups experienced improvements in learning outcomes after the learning process. However, the experimental group demonstrated a substantially greater increase than the control group. The average pretest score of the experimental group was 61.69, which increased to 89.06 in the posttest. Meanwhile, the control group improved from 59.44 in the pretest to 77.00 in the posttest.

These findings indicate that students who participated in Problem-Based Learning assisted by Ekopira media achieved better learning outcomes than those who received conventional instruction. The higher increase observed in the experimental group suggests that the integration of Problem-Based Learning and Ekopira media contributed positively to students' understanding of ecosystem concepts. Prior to hypothesis testing, prerequisite analyses were conducted to determine whether the data met the assumptions required for inferential statistical analysis. The prerequisite analyses included normality testing and linearity testing. The results of the normality test are presented in Table 3.



Table 3. Normality Test Results

Group	Statistic	Significance Value	Conclusion
Experimental	0.961	0.624	Normal
Control	0.947	0.472	Normal

The normality test was conducted using the Shapiro–Wilk test to determine whether the learning outcome data were normally distributed. Table 3 shows that the significance value of the experimental group was 0.624, while the significance value of the control group was 0.472. Both significance values were greater than 0.05. Therefore, it can be concluded that the learning outcome data in both groups were normally distributed. Since the normality assumption was satisfied, the data were considered appropriate for further parametric statistical analysis. Based on Table 3, the normality test results indicate that the distribution of students' learning outcome scores in both the experimental and control groups met the normality criteria. This finding suggests that the data accurately represent the population and can be used for subsequent hypothesis testing procedures.

After the normality assumption was satisfied, a linearity test was conducted to determine whether there was a linear relationship between Problem-Based Learning assisted by Ekopira media and students' learning outcomes. The linearity test was performed using the Deviation from Linearity analysis in SPSS. The results of the linearity test are presented in Table 4.

Table 4. Linearity Test Results

Variable	Sig. Deviation from Linearity	Conclusion
Problem-Based Learning Assisted by Ekopira Media and Learning Outcomes	0.287	Linear

Table 4 shows that the significance value of Deviation from Linearity was 0.287. Since the significance value was greater than 0.05, the relationship between Problem-Based Learning assisted by Ekopira media and students' learning outcomes was considered linear. The findings indicate that changes in the implementation of Problem-Based Learning assisted by Ekopira media were followed by proportional changes in students' learning outcomes. Therefore, the linearity assumption required for regression analysis was fulfilled. Because both the normality and linearity assumptions were satisfied, the data were considered appropriate for further hypothesis testing using simple regression analysis. The hypothesis testing was subsequently conducted to determine whether Problem-Based Learning assisted by Ekopira media had a significant effect on students' IPAS learning outcomes. The results of the regression analysis are presented in Table 5.

Table 5. Regression Analysis Results

Variable	R	R-square	Sig.
Problem-Based Learning Assisted by Ekopira Media and Learning Outcomes	0.845	0.714	0.000

Table 5 presents the results of the simple regression analysis examining the effect of Problem-Based Learning assisted by Ekopira media on students' IPAS learning outcomes. The analysis revealed a significance value of 0.000, which was lower than the significance level of 0.05. Therefore, the null hypothesis was rejected, indicating that Problem-Based Learning assisted by Ekopira media had a significant effect on students' learning outcomes. Furthermore, the correlation coefficient (R) was 0.845, indicating a strong positive relationship between the implementation of Problem-Based Learning assisted by Ekopira media and students' learning outcomes. This finding suggests that the increased



implementation of Problem-Based Learning assisted by Ekopira media was associated with higher student achievement in IPAS learning.

The regression results demonstrate that students who participated in Problem-Based Learning assisted by Ekopira media achieved better learning outcomes than those who received conventional instruction. The learning model encouraged students to engage actively in problem-solving activities, collaborative discussions, and knowledge construction processes. In addition, the use of Ekopira media helped students visualize ecosystem concepts more concretely, enabling them to understand ecological relationships more effectively.

These findings provide empirical evidence that the integration of Problem-Based Learning and Ekopira media contributes positively to students' understanding of ecosystem materials. Consequently, Problem-Based Learning assisted by Ekopira media can be considered an effective instructional approach for improving elementary students' IPAS learning outcomes. To determine the magnitude of the contribution of Problem-Based Learning assisted by Ekopira media to students' learning outcomes, a coefficient of determination analysis was conducted. The results are presented in Table 6.

Table 6. Coefficient of Determination

R	R-square
0.845	0.714

Table 6 presents the coefficient of determination analysis of Problem-Based Learning assisted by Ekopira media on students' IPAS learning outcomes. The analysis revealed an R-square value of 0.714, indicating that 71.4% of the variation in students' learning outcomes could be explained by the implementation of Problem-Based Learning assisted by Ekopira media.

The results of this study indicate that the integration of Problem-Based Learning and Ekopira media contributed positively to students' IPAS learning outcomes. Students in the experimental group achieved higher posttest scores than those in the control group, suggesting that the learning intervention provided more effective learning experiences for understanding ecosystem concepts. The statistical analysis further confirmed that the intervention had a significant positive effect on students' achievement in IPAS learning. This finding is consistent with previous meta-analyses showing that Problem-Based Learning has a positive effect on students' academic achievement, including in science education (Dağyar & Demirel, 2015; Uluçmar, 2023).

From a constructivist perspective, meaningful learning occurs when students actively participate in exploring problems, exchanging ideas, and connecting new information with their prior knowledge. During the learning process, students were involved in identifying ecosystem-related issues, discussing possible explanations, collecting relevant information, and presenting solutions collaboratively. Such activities encouraged students to construct their own understanding rather than depend solely on information provided by the teacher (Hmelo-Silver, 2004; Savery, 2006). This interpretation is further supported by Erdem (2024), whose meta-analysis of K–12 studies found that PBL had substantial effects on students' thinking skills, problem-solving skills, and academic achievement.

The positive outcomes observed in this study were also influenced by the characteristics of Ekopira media. Ecosystem concepts involve interconnected relationships that are often difficult for elementary school students to visualize. By providing a concrete representation of food chains, food webs, producers, consumers, and decomposers, Ekopira helped students observe ecological interactions directly. This hands-on experience enabled learners to understand abstract concepts more easily and strengthened their conceptual



comprehension. The role of interactive media in supporting science learning is consistent with Sahronih et al. (2019), who reported a positive overall effect of interactive learning media on students' science learning outcomes, with particularly notable effects in elementary education and biology-related learning.

The findings are also consistent with the Cognitive Theory of Multimedia Learning, which states that students learn more effectively when information is presented through multiple representations (Mayer, 2009). In this study, the visual and interactive features of Ekopira assisted students in organizing information, connecting concepts, and interpreting ecosystem relationships. Consequently, students were able to process learning materials more effectively and achieve better learning outcomes. Recent evidence also indicates that interactive learning media can enhance learning outcomes in elementary education by providing engaging learning experiences and supporting students' motivation and participation (Aryfien et al., 2025).

Another important aspect was the collaborative nature of the learning activities. Through group discussions and problem-solving tasks, students actively communicated ideas, evaluated alternative solutions, and shared responsibilities in completing learning tasks. Such experiences not only supported conceptual understanding but also fostered critical thinking, communication, and collaboration skills that are essential for twenty-first-century learning. This interpretation is consistent with Erdem (2024), who reported strong effects of PBL on thinking and problem-solving skills across K–12 contexts.

The present findings are consistent with previous studies reporting positive effects of Problem-Based Learning on students' academic achievement. Earlier research has shown that problem-oriented instructional approaches encourage active participation, increase learning engagement, and promote deeper understanding of subject matter (Dağyar & Demirel, 2015; Uluçınar, 2023). Similarly, studies on interactive learning media have demonstrated positive effects on science learning outcomes. For example, Rukoyah and Bektiningsih (2024) reported that interactive learning media developed for elementary science and IPAS learning could support improved learning outcomes. The findings of the present study therefore strengthen existing evidence regarding the contribution of interactive media to elementary science learning.

A distinctive contribution of this study is the integration of Problem-Based Learning with Ekopira, a tangible ecosystem-learning medium designed to represent ecological relationships through direct manipulation and observation. This approach differs from many previous studies that primarily relied on digital applications, audiovisual resources, or web-based learning platforms. Through direct interaction with the ecosystem pyramid, students were able to explore food chains, food webs, and ecological relationships more actively. Consequently, the integration of Problem-Based Learning and Ekopira provided meaningful learning experiences that supported conceptual understanding and improved students' learning outcomes.

Overall, the findings indicate that Problem-Based Learning assisted by Ekopira media is an effective instructional approach for improving elementary students' IPAS learning outcomes. The combination of student-centered learning activities and ecosystem-based interactive media provides meaningful learning experiences that facilitate conceptual understanding, active participation, and academic achievement. However, the findings should be interpreted within the context of the study sample and implementation period, and further research with larger samples and varied educational contexts is needed to examine the consistency and broader applicability of the approach.



Conclusion

The findings of this study demonstrate that the integration of Problem-Based Learning and Ekopira media positively contributed to students' achievement in IPAS learning. Students who participated in learning activities supported by Ekopira showed better understanding of ecosystem concepts compared to those who experienced conventional instruction. The learning approach encouraged active participation, collaborative investigation, and direct interaction with ecosystem representations, enabling students to construct knowledge more effectively.

The statistical results confirmed that the learning intervention provided a meaningful contribution to students' learning outcomes. The combination of problem-oriented learning activities and ecosystem-based interactive media created learning experiences that supported conceptual understanding and increased student engagement during the learning process. Therefore, the integration of Problem-Based Learning and Ekopira media can be considered a promising instructional approach for ecosystem learning in elementary schools. The findings contribute to the growing body of knowledge regarding innovative instructional practices in elementary education and highlight the importance of integrating active learning strategies with concrete learning media to support meaningful learning experiences.

Recommendation

Based on the findings, teachers are encouraged to integrate Ekopira into the PBL stages. Ekopira can be used to present ecosystem-related problems during the problem orientation stage, support group investigation and manipulation of ecosystem components during the investigation stage, and facilitate students' presentation and evaluation of solutions in the final stages. Schools are encouraged to allocate resources through Teacher Working Groups (KKG) to develop affordable low-cost tactile manipulative tools using locally available materials and aligned with the Merdeka Curriculum. Future studies should involve larger samples, different grade levels, and longer implementation periods, as well as examine other outcomes such as critical thinking, scientific literacy, environmental awareness, motivation, and problem-solving abilities.

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