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Development of an ethno-stem teaching modules based on project based learning to improve elementary school students' science literacy

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Abstract

Science literacy among elementary school students remains insufficient, partly because existing instructional materials lack contextual relevance and fail to connect scientific concepts with students' cultural experiences. This study developed an Ethno-STEM teaching module grounded in Project-Based Learning (PjBL) to enhance science literacy through meaningful and culturally responsive learning. Using the ADDIE development model, the research involved needs analysis, module design, prototype development, implementation, and evaluation. Data were obtained through teacher and student needs surveys, expert validation, classroom observations, response questionnaires, and science literacy tests analyzed using the Rasch Model. Findings show that the module achieved a feasibility level of 85% (very feasible) from material experts and 78.1% (feasible) from media experts. Implementation in three partner schools demonstrated improved student engagement and effective integration of cultural elements within STEM learning. Rasch analysis reported item reliability of 0.92 and person reliability of 0.85, indicating strong instrument consistency. Overall, the Ethno-STEM PjBL module shows high potential to strengthen science learning, support Merdeka Curriculum principles, and improve students' science literacy.

Keywords: *Ethno-STEM; Project-Based Learning; Science Literacy; Elementary School; Teaching Module.*

INTRODUCTION

Science literacy is a fundamental competence required by students to navigate the complexities of the twenty-first century. However, numerous studies indicate that elementary students in Indonesia continue to demonstrate low levels of science literacy, primarily due to teacher-centered instruction, limited contextual learning resources, and insufficient integration of real-world applications in science lessons. Instructional materials commonly used in schools often emphasize rote memorization rather than inquiry, problem-solving, or meaningful engagement with scientific processes.

Project-Based Learning (PjBL) has been widely recognized as an approach that promotes active learning, fosters inquiry, and develops students' critical thinking, collaboration, and creativity. Through authentic projects, students construct scientific understanding by engaging in real-world problem-solving activities. Empirical studies confirm that PjBL enhances motivation, conceptual mastery, and the development of essential 21st-century skills, including communication, collaboration, and critical thinking. Innovation in teaching methodologies is crucial in the digital era to meet these learning needs, with PjBL consistently shown to be effective in facilitating active and contextual learning, particularly in elementary-level science (Putri et al., 2025). This model enables students to apply theoretical knowledge to practical contexts, improving collaboration, critical thinking, and conceptual understanding (Putri et al., 2025; Rahayu & Ismawati, 2022).

To further strengthen PjBL outcomes, recent literature emphasizes the importance of

integrating Science, Technology, Engineering, and Mathematics (STEM) within instructional design. STEM-integrated PjBL allows students to apply scientific knowledge collaboratively and creatively to design solutions to everyday problems. This aligns with the growing demand for critical thinking skills and the ability to apply scientific knowledge in daily life (Rahmawati & Airlanda, 2023; Nafahah & Ratnasari, 2025). When culturally relevant knowledge is embedded within STEM-based projects, learning becomes more contextual and meaningful. This approach, known as Ethno-STEM, situates scientific concepts within local wisdom, cultural practices, and indigenous technologies, allowing students to connect modern scientific reasoning with traditional knowledge systems.

The alignment of PjBL and Ethno-STEM is consistent with Indonesia's Merdeka Curriculum, which encourages contextual, project-based learning that promotes creativity, cultural appreciation, and higher-order thinking (Devyanti & Andriani, 2025). By integrating local cultural practices into STEM-based projects, students develop not only conceptual understanding but also cultural identity, problem-solving abilities, and scientific reasoning. Existing studies demonstrate that the integration of ethnoscience, PjBL, and STEM improves scientific literacy and learning outcomes by strengthening critical thinking, collaboration, and problem-solving skills (Astuti et al., 2019; Sudarmin et al., 2023; Putri et al., 2025).

Despite the potential of Ethno-STEM PjBL, research on its systematic development in elementary school science modules remains limited. Existing modules frequently lack structured project activities, culturally grounded content, and explicit alignment with science literacy indicators. These gaps highlight the importance of developing teaching modules that integrate PjBL, Ethno-STEM, and scientific literacy to improve the quality of learning in elementary schools (Example Introduction.pdf, n.d.; Putri et al., 2025).

The Merdeka Curriculum not only advocates the use of PjBL but also emphasizes the development of 4C competencies—critical, creative, collaborative, and communicative thinking (Devyanti & Andriani, 2025). Prior research shows that PjBL significantly improves students' cognitive abilities, critical thinking skills, and learning outcomes (Andriyani et al., 2025), and these benefits can be further amplified through cross-disciplinary approaches such as STEM or STEAM (Afifah et al., 2025). Studies also show that combining PjBL with Ethno-STEM effectively enhances scientific literacy and supports 21st-century skill development (Sudarmin et al., 2023).

The integration of digital media within PjBL environments has become increasingly important, as digital tools offer diverse resources that facilitate deeper engagement and interactive learning. Digital-supported PjBL strengthens students' analytical and creative thinking, preparing them to face increasingly complex global challenges (Putri et al., 2025). Additional research highlights that PjBL enhances students' higher-order thinking skills, cognitive achievement, and motivation in science learning (Muchsinan et al., 2024; Atana & Ansori, 2025).

Given these considerations, integrating PjBL, STEM, and ethnoscience into a coherent learning module holds significant potential to improve elementary students' science literacy. However, systematic research on the development and validation of Ethno-STEM-based PjBL modules remains scarce. Therefore, this study aims to develop

an Ethno-STEM teaching module based on Project-Based Learning and evaluate its feasibility, practicality, and effectiveness in improving elementary school students' science literacy**.**

RESEARCH METHODS

This study employed the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) as a systematic and iterative framework for producing an Ethno-STEM teaching module based on Project-Based Learning (PjBL). The ADDIE model was selected because it provides a structured process for instructional product development, enabling continuous refinement based on empirical findings and expert feedback. The ultimate aim of this research was to produce a feasible, practical, and effective Ethno-STEM–based PjBL module capable of improving elementary students' scientific literacy.

Research Setting and Participants

The research was conducted from March to October 2025 across three elementary schools SDN 1 Nagarawangi, SDN 2 Nagarawangi, and SDN 3 Nagarawangi. These schools were deliberately selected based on preliminary observations showing considerable variation in students' scientific literacy and suboptimal science teaching methods, particularly in promoting active engagement (Rahmad & Budiyanti, 2022; Wirda et al., 2022). Additional preliminary studies revealed persistent gaps in basic science concept mastery at these schools, which correlate with broader trends of low scientific literacy among Indonesian elementary students (Suparya et al., 2022; Yohamintin & Huliatunisa, 2023).

These variations provided an ideal context for evaluating the effectiveness of Ethno-STEM PjBL modules in diverse learning environments and identifying factors that influence science literacy improvement (Khauzanah & Wardani, 2023). Supporting evidence from literacy and numeracy assessments such as those documented at SDN 1 Tawang further indicated that well-designed educational interventions can significantly enhance student motivation and understanding (Dianasti et al., 2024). Similar findings from prior research on guided inquiry using multimedia (Suprianti et al., 2021) reinforced the need for innovative science modules grounded in scientific literacy (Prayoga et al., 2023; Dianasti et al., 2024).

Research Subjects

The research involved 120 fourth-grade students across the three schools, selected due to their cognitive readiness for science inquiry and their representativeness for assessing the module's instructional impact;
44 teachers (classroom and subject teachers), whose involvement provided insights into instructional practice, content understanding, and implementation challenges. Students served as the primary participants in module testing, while teachers acted as facilitators and sources of pedagogical data.

ADDIE Model Stages

1. Analysis Stage

   The analysis phase included a comprehensive review of literature on ethnoscience, STEM integration, PjBL, and the Sustainable Development Goals (SDGs). This review established the theoretical foundation for the module and identified key components relevant to scientific literacy development.

   Following the literature review, the research team conducted internal discussions to formulate a detailed implementation plan. This included designing needs-assessment instruments,

drafting teaching module specifications, constructing validation tools, identifying trial procedures, and determining data processing and analysis techniques.

The needs analysis focused on three aspects, Current state of science learning**,** assessing whether existing approaches effectively cultivate scientific literacy or require innovation; Student needs**,** particularly for contextual, culturally grounded modules integrating ethnographic elements relevant to their environment; Teacher readiness**,** including their ability to implement PjBL and integrate STEM concepts into science lessons.

The analysis confirmed that contextualized science learning incorporating cultural elements and project-based activities is essential for improving students' scientific literacy.

2. Design Stage

Based on the needs analysis, the design phase involved planning key elements of the teaching module.

a. Learning Objectives

The module was designed to enhance scientific literacy through activities integrating science, technology, engineering, mathematics, and local cultural wisdom (ethnoscience). Objectives emphasized inquiry, creativity, and contextual learning.

b. Module Structure

The module adopted a PjBL structure**,** comprising real-world problems requiring scientific and technological solutions; integration of local wisdom into project tasks; hands-on activities aligned with students' daily experiences.

c. Research Instruments

Several instruments were designed, including Teacher and Student Response Questionnaires; Science Literacy Tests; Student Engagement Observation Sheets. These instruments informed subsequent development and evaluation processes.

3. Development Stage

During the development stage, the teaching module was constructed and refined based on empirical data and expert validation.

a. Module Creation

Learning materials were developed to integrate local cultural practices with STEM concepts. Content was structured to allow students to engage in meaningful investigations, experiments, and culturally contextualized projects.

b. Project Plan Development

Projects were designed around science themes that could be learned through Ethno-STEM approaches, emphasizing engineering design, problem-solving, and cultural relevance.

c. Validation and Revision

A validation instrument was developed and used during Focus Group Discussions (FGDs) with experts. Feedback obtained was used to revise the module to improve feasibility, clarity, and scientific accuracy.

d. Limited Trial

The draft module underwent a small-scale trial with a student group to assess clarity, engagement, and initial impact on scientific literacy. Data were collected through observations, interviews, and student questionnaires.

4. Implementation Stage

The revised module was implemented in the three partner schools, including SDN Komplek Nagarawangi.

a. Classroom Implementation

Teachers conducted science lessons using the Ethno-STEM PjBL module. Lessons emphasized inquiry, group collaboration, and contextual problem-solving.

b. Teacher Training

Teachers received training to ensure they could effectively facilitate PjBL, manage

group work, integrate cultural elements, and guide scientific inquiry.

c. Student Project Execution

Students worked collaboratively on projects embedded in the module. Project tasks enabled the application of scientific knowledge within cultural, environmental, and social contexts.

5. Evaluation Stage

The evaluation stage assessed the module's feasibility, practicality, and effectiveness.

a. Learning Outcome Assessment

Science literacy improvement was measured using tests, classroom observations, and evaluations of student project products.

b. Process Evaluation

The quality of learning implementation was evaluated to determine whether the Ethno-STEM PjBL approach effectively enhanced engagement, inquiry, and understanding of scientific concepts.

c. Teacher and Student Feedback

Feedback from students and teachers was collected regarding the module's clarity, relevance, and usability. This feedback informed final revisions and served as input for future development cycles.

RESULTS AND DISCUSSION

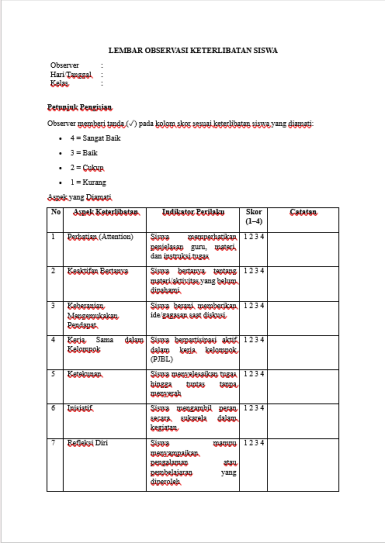
Result

1. Results of the Analysis and Design Stages

The research process began with an extensive literature review on ethnoscience, STEM integration, and the Sustainable Development Goals (SDGs). This review established a robust theoretical foundation and mapped relevant empirical findings that informed the development of the Ethno-STEM PjBL teaching module. Following the literature review, the research team conducted structured discussions to formulate the implementation plan. This included the construction of needs-analysis instruments, development of the preliminary teaching module, drafting of validation tools, procedures for module trials, data processing techniques, and preparation of expected research outputs and final reporting.

Based on the needs analysis conducted in the field, the design phase focused on preparing instruments to explore teachers' needs regarding the integration of ethnoscience and STEM in elementary science learning. These instruments consisted of Teacher and Student Response Questionnaires, a Science Literacy Test, and a Student Engagement Observation Sheet. The observation sheet prepared for the field survey is presented in Figure 1**.**

Figure 1
Observation Sheet



LEMBAR OBSERVASI KETERLIBATAN SISWA

Observer :
Hari/Tanggal :
Kelas :

Petunjuk Pengisian

Observer memberi tanda (✓) pada kolom skor sesuai keterlibatan siswa yang diamati.

- 4 = Sangat Baik
- 3 = Baik
- 2 = Cukup
- 1 = Kurang

Aspek yang Diamati

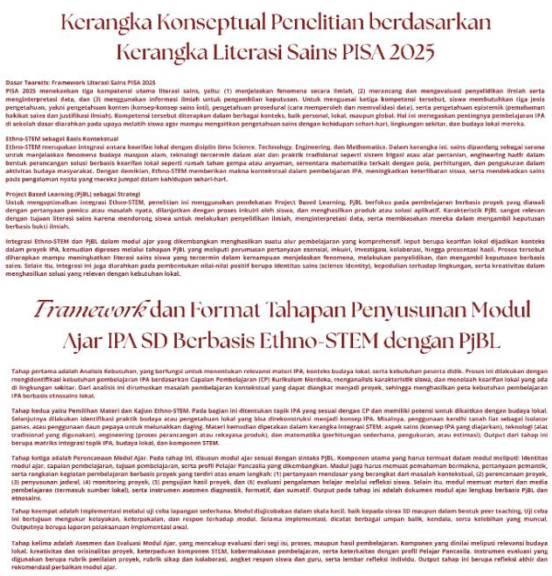
No	Aspek Keterlibatan	Indikator Perilaku	Skor (1–4)	Catatan
1	Perhatian (Attention)	Siswa memperhatikan penjelasan guru, materi, dan instruksi tugas	1 2 3 4	
2	Kesiapan Belajar	Siswa bersiap tentang materi pelajaran yang akan dipelajari.	1 2 3 4	
3	Keberanian Mengemukakan Pendapat	Siswa berani memberikan ide jawaban dan diskusi.	1 2 3 4	
4	Kerja Sama dalam Kelompok	Siswa berpartisipasi aktif dalam kerja kelompok. (PJBL)	1 2 3 4	
5	Ketekunan	Siswa menyelesaikan tugas hingga tuntas tepat waktu.	1 2 3 4	
6	Inisiatif	Siswa mengambil peran secara sukarela dalam kegiatan.	1 2 3 4	
7	Refleksi Diri	Siswa mampu menyampaikan pengalaman atau pembelajaran yang diperoleh.	1 2 3 4	

2. Development of the Ethno-STEM Framework and Module Prototype

The survey findings served as the empirical basis for drafting the initial Ethno-STEM teaching module framework. This framework was designed by considering student

characteristics, learning media availability, content feasibility, and suitable instructional models. The initial conceptual structure of the module is shown in Figure 2**.**

Figure 2
Framework



Subsequently, the research team developed a module validation instrument and conducted expert validation through Focus Group Discussions (FGDs). The validation process focused on three domains: content appropriateness, media quality, and methodological rigor.

a. Material Expert Validation

The material expert rated the module as *very feasible*, with a feasibility score of 85%**.** However, several important notes for improvement were provided: Scientific and STEM concepts should be simplified through concrete examples grounded in students' daily experiences. Assessment rubrics for STEM components and 8 *Dimensi Profil Lulusan* indicators need clearer descriptions. Cultural elements must be strengthened; for example, expanding the explanation of Garut dodol philosophy and integrating socio-cultural values such as *gotong royong* in local food production. More engaging visualizations infographics, authentic photographs, or illustrations of traditional tools should be included.

Learning time allocation must be more flexible, offering both a full project (making *dodol*) and a simplified experimental mini-project.

Alternative materials should be provided for schools with limited resources. A concise teacher guide should be included for practical implementation.

b. Media and Model Expert Validation

The media and model expert awarded the module a feasibility rating of **78.1%**, categorized as *Feasible* with strong potential to improve to *Very Feasible* after revision. Recommendations included Strengthening visual and media components by integrating authentic Sundanese cultural images, clear process-flow infographics, icons, and child-friendly color schemes.

Incorporating QR codes linked to cultural videos, short animations, or digital simulations to support flexible learning. Clarifying teacher instructions and student reflection prompts, including sample reflection sheets and exemplars of PjBL workflows.

Refining the project assessment rubric to include explicit indicators for STEM integration and cultural appreciation. Strengthening engineering components through simple design activities such as creating basic mixers or traditional measurement tools. Providing flexible alternatives for schools with limited facilities (e.g., low-cost materials or simulation-based activities). Ensuring language simplicity appropriate for elementary learners. Including a short teacher manual to enhance module usability.

3. Implementation of the Teaching Module

After revision, the module was piloted in three elementary schools one of which was SDN Komplek Nagarawangi. Teachers implemented the Ethno-STEM PjBL lessons using the revised module, supported by prior training and mentoring. The implementation process is depicted in Figure 3**.**

Figure 3
Implementation

The pilot implementation provided insights into classroom practicality, student engagement levels, and the clarity of project-based instructions. Observations and teacher reflections indicated that students were actively involved in hands-on cultural-science projects.

4. Final Evaluation Results

Data from the module trial were processed using the Rasch Model to evaluate the effectiveness, reliability, and validity of the scientific literacy assessment instrument. Rasch analysis showed that the instrument met model fit criteria, indicating strong internal consistency and reliable measurement.

Overall, empirical results demonstrated increased student engagement during cultural-science projects. Improved clarity and usability of the module after expert-recommended revisions. Positive teacher and student responses indicating high perceived relevance and practicality. Enhanced scientific literacy performance, with variability across items suggesting the activation of higher-order thinking skills.

Discussion

The findings indicate that the Ethno-STEM PjBL teaching module has strong potential to improve the quality of science learning in elementary schools. High validation scores confirm that integrating local cultural elements with STEM principles is both relevant and pedagogically innovative. This supports previous studies demonstrating the effectiveness of contextualized science learning grounded in cultural practices for enhancing conceptual understanding and scientific literacy (Suparianti et al., 2021; Suparya et al., 2022; Yohamintin & Huliatunisa, 2023).

The expert recommendations such as clarifying rubrics, enriching cultural visualizations, and simplifying scientific terminology underscore the importance of designing learning materials that are accessible for students and practical for teachers. This aligns with literature emphasizing the necessity of clear scaffolding and culturally responsive pedagogy in elementary science instruction.

Field implementation results showed significant increases in student motivation and engagement. Culturally situated projects, such as designing tools or participating in local food-making processes, helped students relate scientific concepts to their everyday lives, consistent with constructivist learning principles and previous Ethno-STEM research.

The Rasch analysis confirmed that the module not only increased observable learning activity but also strengthened conceptual understanding. Item distribution suggested that the module supported higher-order thinking skills through problem-solving tasks embedded within cultural contexts,

resonating with STEM-PjBL frameworks that emphasize inquiry, creativity, and engineering design.

Taken together, the findings demonstrate that this module aligns well with the goals of the Merdeka Curriculum, which prioritizes contextual learning, project-based inquiry, differentiation, and the development of 21st-century competencies. The module not only contributes to improved scientific literacy but also enhances students' appreciation of local wisdom and fosters key competencies such as creativity, collaboration, communication, and problem-solving.

CONCLUSION

The results of this study demonstrate that the development of an Ethno-STEM teaching module based on Project-Based Learning (PjBL) provides a substantial contribution to enhancing the quality of science instruction and the scientific literacy of elementary school students. Utilizing the ADDIE development model enabled the creation of a structured, contextual, and pedagogically relevant module that aligns with both teacher needs and student characteristics.

Expert validation findings confirmed the module's quality, with material experts rating it at 85% (very feasible) and media experts assigning 78.1% (feasible) following revisions. These evaluations indicate that the module meets the required standards for use as an alternative instructional resource in elementary schools, particularly for science learning integrated with local cultural contexts.

Pilot trials conducted in three partner schools further revealed that the module effectively increased student engagement, including heightened attention, active questioning, collaborative participation, and initiative during project completion. These findings affirm the capacity of Ethno-STEM PjBL to foster active learning behaviors consistent with constructivist educational principles.

The analysis of scientific literacy outcomes using the Rasch Model produced strong psychometric evidence, with an item reliability of 0.92 and a person reliability of 0.85. These results confirm the consistency and validity of the measurement instrument while also indicating that the module successfully supports gains in students' conceptual understanding of science.

Positive feedback from both teachers and students reinforces the conclusion that the integration of Ethno-STEM and PjBL offers a more meaningful, engaging, and culturally grounded learning experience. This aligns with broader educational goals emphasizing contextual, student-centered learning as mandated in the Merdeka Curriculum

Overall, the Ethno-STEM PjBL teaching module represents an innovative instructional solution for strengthening scientific literacy in elementary schools. Future research should consider expanding the scale of implementation and conducting broader evaluations to further validate the module's effectiveness across diverse educational contexts.

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BIBLIOGRAPHY

Afifah, A. D. N., Indiati, I., & Rahmawati, N. D. (2025). the effectiveness of the steam-integrated project-based learning model based on ethnomathematics-based steam on students' creative mathematical thinking abilities. *Science Journal Of Mathematics And Science Education Innovation*, 5(3), 1437.

Afifah, A. N., Ilmiyati, N., & Toto, T. (2020). the effect of the project-based learning (pjbl) model with the stem approach on students' mastery of concepts and critical thinking skills. *J-Kip (Journal Of Teacher Training And Education)*, 1(2).

Ahmad, W., Abdullah, G., & Kudus, K. (2025). the effect of the project-based learning (pjbl) model using canva media on student learning outcomes on the water cycle in grade v of elementary school. *Science Journal Of Innovation In Mathematics And Science Education*, 5(2), 536.

Aini, M., Ridianingsih, D. S., & Yunitasari, I. (2022). the effectiveness of the stem-based project-based learning (pjbl) model on students' critical thinking skills. *Jurnal Kiprah Pendidikan*, 1(4), 247.

Andriyani, M., Kriswantoro, K., Asrial, A., & Muhammad, D. (2025). needs analysis for developing interactive multimedia based on stem-pjbl on chemical bonding. *Jurnal Pendidikan Matematika Dan Sains*, 13, 338.

Ariyatun, A. (2021). analysis of ethno-stem integrated project-based learning on students' critical and creative thinking skills. *Journal Of Educational Chemistry* (Jec), 3(1).

Asnita, B. W., Hakim, A. R., Mukti, H., & Triyanto, M. (2025). the effect of differentiated learning based on pjbl on students' creative thinking skills in civics in elementary schools. *Cokroaminoto Journal Of Primary Education*, 8(3), 1359.

Astuti, I. D., Toto, T., & Yulisma, L. (2019). a project-based learning (pjbl) model integrated with stem to improve students' mastery of concepts and learning activities. *Quagga Journal Of Education And Biology*, 11(2), 93.

Atana, Y., & Ansori, I. (2025). analysis of the implementation of the merdeka curriculum through the project-based learning (pjbl) model in science learning in grade v of state elementary school 4 gumiwang. *Science Journal Of Mathematics And Science Education Innovation*, 5(3), 1487.

Devyanti, M., & Andriani, A. E. (2025). the effect of problem-based learning and project-based learning designs on science learning outcomes. *Science Journal Of Mathematics And Science Education Innovation*, 5(3), 1276.

Dianastiti, Y., Putra, R. A., & Gumelar, W. T. G. (2024). education: the importance of literacy and numeracy for elementary school students. *Madiun Spoor Journal Of Community Service*, 4(1), 70. Https://Doi.Org/10.37367/Jpm.V4i1.354

Dina, A. S. (2025). systematic literature review: integrated learning strategies with steam (science, technology, engineering, art, mathematics) and their challenges. *Science Journal Of Innovation In Mathematics And Science Education*, 5(2), 658.

Effendi, M. I., & Yoto, Y. (2024). 21st-century learning through the stem-integrated project-based learning model (pjbl-stem) in improving higher-order thinking skills. *Briliant Journal Of Research And Conceptual Studies*, 9(1), 67.

Jannah, R., Festiyed, F., Yerimadesi, Y., Lufri, L., & Putra, S. (2022). ethnoscience in learning science: a systematic literature review. *Scientiae Educatia*, 11(2).

Khauzanah, A. N., & Wardani, K. W. (2023). improving creative thinking skills based on digital literacy using the project-based learning model in fifth grade Students Of secang 1 elementary school. *Kalam*

Cendekia Scientific Journal Of Education, 11(3).

Muchsinan, K., Prastiti, T. D., & Wahyuningrum, E. (2024). the effect of project-based learning and learning styles on critical thinking abilities and mathematics learning outcomes. *Learning Journal Of Innovation In Educational Research And Learning*, 4(1), 9.

Nafahah, Z., & Ratnasari, F. D. (2025). development of digital teaching materials based on project-based learning (pjbl) to improve science literacy of grade 10 high school students on renewable energy. *Upej (Unnes Physics Education Journal)*, 14(2), 223.

Nurhasnah, Festiyed, F., & Yerimadesi. (2023). A review analysis: implementation of steam project-based learning in science learning. *Sej (Science Education Journal)*, 7(1), 1. Muhammadiyah University Of Sidoarjo.