International Journal of Advance Social Sciences and Education (IJASSE)
Vol. 4, No. 5, 2026: 611-620

The Influence of Project-Based Learning and Creativity on Elementary Students' Critical Thinking in Science Learning: A Library Research

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A R T I C L E I N F O

Keywords: Project-Based Learning, Critical Thinking, Creativity, Elementary Science, Library Research

Received: 19, August
Revised: 20, September
Accepted: 30, October

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A B S T R A C T

This study aims to synthesize the literature on the influence of the project-based learning (PjBL) model and student creativity on critical thinking in elementary school science (IPA) learning. A library research method was used. Journal articles, meta-analyses, and reviews, mostly published in 2018–2024, were selected by inclusion criteria and analyzed through thematic content analysis. The synthesis shows that PjBL consistently supports science achievement, creativity, and critical thinking by engaging students in contextual and collaborative problem solving; that creativity is positively related to critical thinking; and that PjBL and creativity interact in shaping critical thinking, as shown by a Grade V quasi-experiment ($F = 8.807$; $p = .014$). Teachers are advised to combine PjBL with activities that nurture creativity.

DOI: https://doi.org/10.59890/ijasse.v4i5.29
ISSN-E: 2988-2133
https://journalijasse.my.id/index.php/ijasse

INTRODUCTION

Globalization requires education to adapt to twenty-first-century skills so that graduates are able to think critically, communicate, collaborate, and be creative (the 4Cs). One way to achieve this is to apply learning models that encourage students to collaborate, think critically, and create. Project-based learning (PjBL) is considered one such model: it focuses on solving real problems through projects and thereby helps students develop critical and creative thinking (Riskayanti, 2021). It also invites students to work with classmates to solve problems (Mora et al., 2020) and has been applied in various learning contexts (Barkah, 2024; Syawalia et al., 2024).

In elementary schools, science (IPA) learning lays the foundation for students to keep pace with later developments in science and technology. Science demands thinking and problem-solving skills rather than mere mastery of facts about living things, yet some of its content is hard to grasp because it is abstract and full of unfamiliar terms (Astuti et al., 2024). The choice of learning model therefore strongly affects students' understanding. Meta-analyses indicate that PjBL has a significant effect on science achievement (Balemen & Keskin, 2018) and on elementary science learning outcomes (Fahrezi & Taufiq, 2020).

Beyond achievement, several studies report benefits of PjBL for creativity and higher-order thinking. PjBL has been reported to improve students' creativity (Mustika & Ain, 2020; Chen et al., 2022) and higher-order thinking skills (Eliyasni et al., 2019). However, this evidence is scattered across studies that usually examine a single relationship, for example, PjBL and learning outcomes, or PjBL and creativity. Studies that place PjBL, creativity, and critical thinking in one framework, including their possible interactions, are relatively rare. A quasi-experiment with Grade V elementary students (Khairunnisa et al., 2024) found such an interaction, but a single study with a limited sample needs to be situated within a broader evidence map.

Accordingly, this article aims to synthesize relevant studies through a library research approach to explain (a) the influence of the PjBL model on students' critical thinking in elementary science learning, (b) the relationship between creativity and critical thinking, and (c) the interaction between PjBL and creativity in shaping critical thinking. The article contributes by bringing together evidence that has so far been separate into one conceptual framework that teachers can use to design science lessons, and researchers can use to formulate further studies.

LITERATURE REVIEW

The Nature of Science in Elementary School

Science (IPA) is the study of events that occur in nature. It has three interrelated dimensions, namely process, product, and scientific attitude, and generally covers biology, physics, and chemistry. The process dimension consists of skills for investigating natural phenomena in particular ways in order to acquire and develop knowledge (Aris & Afina, 2022). Science is also a way of solving problems, or the scientific method, which in elementary school is developed gradually and continuously (Somayana, 2020).

To carry out scientific processes, students need skills in observing, classifying, interpreting, predicting, hypothesizing, controlling variables, planning and conducting investigations, inferring, applying, and communicating (Inayah et al., 2020; Rusmini et al., 2021). These skills show that effective science learning demands students' active involvement, not merely the reception of information.

The Project-Based Learning Model

Project-based learning is translated into Indonesian as *pembelajaran berbasis proyek* (Santika et al., 2022). It is a learning approach that emphasizes understanding, in which students explore, assess, interpret, and synthesize information in meaningful ways. PjBL derives from constructivist learning theory, in which students actively build knowledge and mental models to understand the world around them. Its characteristics are that it is process-oriented, relatively long-term, problem-focused, and integrative, combining concepts from various components, whether knowledge, disciplines, or field experience (Chen & Yang, 2019; Yuliansyah & Ayu, 2021). It is also described as a comprehensive approach that involves students in cooperative and sustained inquiry (Arwan & Oya, 2023).

PjBL is understood as a way for students to choose, design, and lead their own thinking and work, with the aim of training scientific, logical, and systematic thinking (Guo et al., 2020). The model offers an alternative to teacher-centered learning, which tends to make students passive (Permatasari et al., 2021). Students are given the opportunity to work autonomously, construct their own learning, and produce valuable and realistic products (Davidi et al., 2021). Project work involves complex tasks built on challenging questions and problems, so that students practice designing, solving problems, making decisions, and investigating, either independently or in groups (Amelia & Aisya, 2021).

Critical Thinking

Critical thinking is deciding what to believe or do in a reasoned and reflective manner (Cahya & Juandi, 2021). It includes higher-order thinking activities such as analyzing, applying rationally, synthesizing, recognizing problems and their solutions, inferring, and evaluating (Alsaleh, 2020). Its focus is on determining what is sensible to believe and do (Susilawati et al., 2020).

Critical thinking is also understood as an intellectual process of conceptualizing, applying, analyzing, and evaluating information gathered from observation, experience, and reflection as a basis for action (Misidawati & Sundari, 2021). By analyzing, evaluating, and giving arguments, students show fairness, open-mindedness, and an active attitude (Warsah et al., 2021).

Creativity

Creative children are characterized by great curiosity, frequently asking good questions, offering many ideas, expressing opinions freely, not being easily influenced by others, strong imagination, high originality, and a liking for trying new things (Munar et al., 2021). Creative thinking is a mental activity for building new ideas that involves logic and intuition together (Putri &

Sukenti, 2023). Creativity can be explained in terms of product, person, process, and press (Wardana & Nurfuadi, 2023).

Conceptual Framework: PJBL, Creativity, and Critical Thinking

From a constructivist perspective, knowledge is built by students within the context of their own experience, so a model that provides room for exploration, collaboration, and the production of work, such as PJBL, is expected to strengthen critical thinking. Creativity is positioned as a student characteristic that may strengthen or weaken the influence of the learning model. This relationship is depicted in Figure 1 and organizes the synthesis themes in the results section.

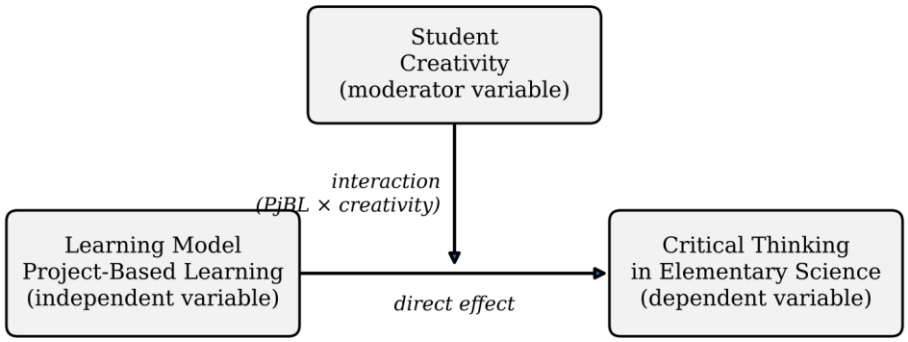


Figure 1. Conceptual Framework of the Review
Source: synthesized by the authors from Khairunnisa et al. (2024) and related theory.

METHODOLOGY

This study uses a library research method, that is, research whose main data come from library materials without field data collection (Zed, 2004). The approach is a narrative-thematic literature review that aims to synthesize findings from various sources to build conceptual understanding (Snyder, 2019).

The primary data source is a quasi-experimental article on the influence of PjBL and creativity on the critical thinking of Grade V elementary students (Khairunnisa et al., 2024). The secondary sources are journal articles, meta-analyses, and literature reviews cited in that article that are relevant to the three concepts under study, namely PjBL, critical thinking, and creativity, together with supporting methodological literature. Sources were selected using the following criteria: (a) they address PjBL, critical thinking, creativity, or science learning; (b) they are published scholarly articles, mostly from 2018–2024; and (c) they contain conceptual definitions or empirical findings that can be traced.

Data were analyzed through thematic content analysis in five steps: (1) reading and identifying the content of each source; (2) coding findings according to the concepts of PjBL, critical thinking, and creativity; (3) grouping codes into themes; (4) comparing agreements and differences among findings; and (5) drawing conclusions aligned with the research objectives. For the quantitative findings of the primary source, the summary statistics are presented as reported by the original authors, whose testing used two-way

analysis of variance (ANOVA) with a 2 × 2 factorial design (Gopalan et al., 2020; Miari et al., 2022).

RESULTS AND DISCUSSION

Thematic Synthesis of the Literature

The review of the literature was grouped into six themes, summarized in Table 1.

Table 1. Thematic Synthesis of the Literature

Theme	Sources	Main findings
PjBL and science achievement	Balemen & Keskin (2018); Fahrezi & Taufiq (2020); Chen & Yang (2019); Fatmawati (2023)	PjBL has a positive effect on science achievement and learning outcomes; meta-analyses also examine moderating factors, and applying PjBL increases activity and mastery of learning.
PjBL and creativity	Mustika & Ain (2020); Chen et al. (2022); Yustina et al. (2020)	PjBL increases creativity, shown among others by increased activity from cycle I to cycle II and by its effect on creative thinking.
PjBL and critical thinking	Eliyasni et al. (2019); Riskayanti (2021); Davidi et al. (2021); Misidawati & Sundari (2021); Khairunnisa et al. (2024)	Project- or problem-based learning and integrated approaches encourage higher-order and critical thinking; in Grade V, the mean critical thinking score of the PjBL group was higher than that of the direct interaction group.
Collaboration and motivation	Mora et al. (2020); Almulla (2020); Owens et al. (2020); Warsah et al. (2021)	PjBL involves cooperation and information sharing in discussion; collaborative learning has an impact on critical thinking.
Implementation challenges	Markula & Aksela (2022)	Teachers face challenges in designing guiding discussion questions, learning objectives, and project integrity, and in ensuring that content remains at the center of learning.
PjBL × creativity interaction	Khairunnisa et al. (2024)	There is a significant interaction between learning model and creativity on critical thinking ($F = 8.807$; $p = .014$).

Source: Literature Analysis Results (2026).

Empirical Data from the Primary Source

Because the primary source contains the quantitative data underlying the sixth theme, its summary statistics are presented in Table 2 and Table 3. The sample consisted of 48 Grade V students (24 in the experimental class and 24 in the control class).

Table 2. Summary of Critical Thinking and Creativity Scores (Primary Source)

Variable/group	PjBL class (n = 24)	Direct interaction class (n = 24)
Critical thinking, mean (SD)	92.88 (5.85)	88.63 (8.37)
Creativity, mean (SD)	89.17 (8.57)	87.54 (6.41)
Critical thinking, high creativity: n; mean (SD)	14; 96.7 (3.05)	9; 96.1 (4.26)
Critical thinking, low creativity: n; mean (SD)	10; 87.7 (4.81)	15; 84.0 (6.54)

Source: adapted from Khairunnisa et al. (2024).

Table 3. Summary of Two-Way ANOVA with Critical Thinking as the Dependent Variable

Source of variation	F	Sig.	Decision
Learning model	6.939	.012	H0 rejected
Creativity	25.231	< .001	H0 rejected
Learning model × creativity	8.807	.014	H0 rejected

Note: error df = 44; R^2 = .420 (adjusted R^2 = .380). Source: adapted from Khairunnisa et al. (2024).

Table 2 shows that the PjBL group had a mean critical thinking score 4.25 points higher than the direct interaction group. Among students with high creativity, the difference between the two models was only 0.6 points (96.7 versus 96.1), whereas among students with low creativity it was 3.7 points (87.7 versus 84.0). Table 3 confirms that the learning model, creativity, and their interaction each had a significant effect at the 0.05 level.

The synthesis shows that PjBL has the potential to improve critical thinking because students are confronted with problems that they must examine in order to find solutions (Eliyasni et al., 2019). This pattern is consistent with the constructivist foundation of PjBL and with the primary source's finding that the PjBL group obtained a higher mean critical thinking score than the direct interaction group (Khairunnisa et al., 2024). Project work that requires students to design, solve problems, and make decisions (Amelia & Aisya, 2021) provides direct practice in critical thinking indicators such as analyzing, inferring, and evaluating (Alsaleh, 2020).

The collaborative dimension of PjBL also appears important. PjBL allows students to share information and knowledge in discussion (Almulla, 2020) and to work together in groups (Mora et al., 2020), in line with findings that collaborative learning has an impact on critical thinking (Warsah et al., 2021). In science learning, students can be asked to create projects using resources in their surroundings, so that completing them requires critical and creative thinking as well as collaboration.

Regarding creativity, the literature reports that PjBL improves creativity (Mustika & Ain, 2020; Chen et al., 2022), and the data from the primary source show that creativity has a significant effect on critical thinking (F = 25.231; p

< .001). This is plausible because creative thinking involves both logic and intuition (Putri & Sukenti, 2023): students who generate many ideas have more alternatives to analyze and evaluate.

An interesting result is the interaction between PjBL and creativity. Based on the means in Table 2, the advantage of PjBL appears larger for students with low creativity (3.7 points) than for those with high creativity (0.6 points). This reading is the authors' interpretation of summary figures, not a further analysis, and still needs to be tested with raw data. Conceptually, the pattern can be explained by the idea that highly creative students are already relatively able to think critically under any kind of instruction, whereas students with low creativity benefit more from the structure of projects, group tasks, and peer support. PjBL thus not only benefits students who are already creative but can serve as a means of helping others catch up.

In practice, the literature cautions that implementing PjBL is not easy for teachers. Teachers must design guiding discussion questions, learning objectives, and project integrity, and ensure that content remains the center of learning (Markula & Aksela, 2022). Students' motivation and resistance to active learning also need attention (Owens et al., 2020). In addition, the strength of the evidence should be read with caution: some sources examine different educational levels, subjects, or models (for example, higher education, problem-based learning, or STEM), so the similarity of findings is an indication rather than uniform evidence for the elementary science context.

CONCLUSIONS AND RECOMMENDATIONS

Based on this library research, it can be concluded that (1) PjBL is consistently reported to have a positive effect on learning achievement, creativity, and critical thinking, including in elementary science learning; (2) creativity is positively related to critical thinking; and (3) there are indications of an interaction between PjBL and creativity, in which the benefit of PjBL appears larger for students with low creativity.

Teachers are advised to apply PjBL in science learning with contextual projects that use local resources, to form groups that encourage all members to participate actively, and to provide activities that nurture creativity. Curriculum designers and teacher-training providers are advised to equip teachers with skills in designing projects, guiding questions, and process assessment.

ADVANCED RESEARCH

This review has limitations. Its data sources are limited to the literature available in the reference corpus of the primary source, so it does not yet include a systematic search across databases, and the evidence for the PjBL × creativity interaction rests on a single study with a sample of 48 students in one school. Further research is recommended in the form of a systematic review or meta-analysis with an explicit search protocol, as well as experimental studies with larger and more diverse samples to test the interaction.

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