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Research Article

Fostering Divergent Thinking in the Classroom: The Impact of Project-Based Learning on Student Creativity

Harianta Sembiring[1], Nofirman[2], Fini widya fransiska[3], Wahju Dyah Laksmi Wardhani[4], Rina Farah[5]
[1] Sekolah Tinggi Manajemen Informatika dan Komputer Kristen Neumann Indonesia
[2] Universitas Prof. Dr. Hazairin, SH., Bengkulu, Indonesia
[3] Universitas Muhammadiyah Pringsewu, Indonesia
[4] Universitas Muhammadiyah Jember, Indonesia
[5] Universiti Teknologi, Malaysia

Corresponding Author:

Harianta Sembiring,
Sekolah Tinggi Manajemen Informatika dan Komputer Kristen Neumann Indonesia.
Simpang Selayang, Medan Tuntungan, Medan City, North Sumatra
Email: ibu...hariantasembiring12345@gmail.com

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Abstract
The growing demand for 21st-century skills underscores the importance of nurturing students' creativity through educational practices that promote divergent thinking. This study investigates the impact of Project-Based Learning (PBL) on fostering divergent thinking and creative performance among high school students. The research aims to analyze how the integration of PBL facilitates idea fluency, flexibility, originality, and elaboration in learners' creative processes. A quasi-experimental design was employed, involving two groups of students: one receiving traditional instruction and the other exposed to PBL interventions across four project cycles. Data were collected using a validated creativity assessment rubric and analyzed through descriptive and inferential statistics (ANOVA). The findings reveal a significant improvement in divergent thinking indicators among students taught through PBL, particularly in their ability to generate multiple and original ideas. The study concludes that PBL serves as an effective pedagogical framework for cultivating creative and divergent thinking skills essential for innovation-driven learning. Implications emphasize the need for curriculum designers and educators to embed authentic, project-based tasks within classroom instruction.

Keywords: Century Skills, Divergent Thinking, Student Creativity

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INTRODUCTION

Education in the twenty-first century demands the cultivation of creativity as a central competency for students to navigate a rapidly changing and innovation-driven world. Modern classrooms are expected not only to transmit knowledge but also to foster the intellectual flexibility that allows learners to think beyond conventional solutions. In this context, divergent thinking defined as the ability to generate multiple, varied, and original ideas emerges as a critical skill underpinning creativity (Damasevicius & Sidekerskienė, 2024; Panthumas et al., 2024). The shift from rote learning to inquiry-based and constructivist pedagogies has reinforced the necessity for instructional approaches that enable students to explore, hypothesize, and innovate. Teachers and curriculum designers are thus challenged to integrate learning models that stimulate cognitive independence and creative risk-taking in authentic educational settings.

The increasing emphasis on creativity in global educational policies highlights the urgent need to transform classroom practices. Institutions across countries have adopted frameworks such as the Partnership for 21st Century Skills (P21) and UNESCO's Education for Sustainable Development (ESD), which prioritize collaboration, communication, critical thinking, and creativity (the 4Cs). Among these competencies, creativity is recognized as the most complex to nurture, as it requires learners to connect prior knowledge with novel perspectives. Project-Based Learning (PBL) has emerged as a promising pedagogical model capable of addressing this challenge by situating learning in meaningful, interdisciplinary projects that demand sustained inquiry and innovation. Through PBL, students engage with real-world problems that stimulate curiosity and foster both cognitive and emotional engagement.

Contemporary research suggests that creativity cannot flourish in rigid, teacher-centered classrooms that focus predominantly on standardized testing and content mastery. Learners need opportunities to design, reflect, and iterate upon ideas within a socially supportive environment. PBL offers this environment by positioning students as active constructors of knowledge rather than passive recipients. It promotes autonomy, accountability, and collaboration while engaging students in complex problem-solving activities (Barau & El-Kalash, 2024; Fayyaz & Lee, 2025). As education systems worldwide confront the challenge of preparing students for unpredictable futures, the exploration of PBL's role in enhancing divergent thinking becomes both timely and essential.

Despite growing recognition of creativity's importance, many classrooms remain constrained by conventional instructional models that prioritize uniformity and compliance over originality. Students are often evaluated based on convergent thinking the ability to reach one correct answer rather than their capacity to generate diverse and innovative ideas. This tendency limits the development of flexible thought processes essential for creative problem-solving. The challenge lies in creating pedagogical conditions that balance academic rigor with open-ended exploration, enabling students to think divergently within structured learning environments.

Teachers frequently express uncertainty about how to operationalize creativity-oriented teaching due to insufficient training and assessment tools that measure creative growth. Conventional methods such as lectures and worksheets provide limited opportunities for students to engage in deep inquiry or collaborative ideation. Consequently, creativity often remains an abstract educational objective rather than a measurable learning outcome. The lack of systematic implementation of creativity-centered pedagogies prevents educators from fully

realizing the potential of divergent thinking as a driver of innovation and lifelong learning (Li & Yu, 2025; Nunes et al., 2024). Empirical studies have indicated mixed results regarding the effectiveness of PBL in enhancing creativity. While some findings affirm PBL's capacity to improve creative performance, others reveal minimal or context-dependent impacts. The inconsistencies may arise from variations in project design, duration, and teacher facilitation skills. Therefore, there is a pressing need for research that examines how PBL specifically fosters divergent thinking processes across different learning contexts. This investigation aims to address these gaps by empirically analyzing the relationship between PBL implementation and the enhancement of students' creative thinking dimensions, such as fluency, flexibility, originality, and elaboration.

This study aims to investigate the impact of Project-Based Learning on students' divergent thinking abilities within classroom settings. The central objective is to determine how engagement in PBL influences students' capacity to produce multiple and original ideas when confronted with open-ended learning tasks. By examining this relationship, the research seeks to provide empirical evidence supporting the integration of project-based pedagogies in creativity-oriented education. The focus lies in understanding the mechanisms through which PBL promotes creative cognition and identifying classroom conditions that optimize its effects (Kayyali, 2025; Nunes et al., 2024). Beyond measuring quantitative outcomes, the study also seeks to capture qualitative dimensions of student experiences during PBL implementation. Observations, reflective journals, and interviews will be employed to explore how learners perceive their own creative growth and collaborative problem-solving processes. These insights are expected to reveal the affective and motivational factors that accompany cognitive development in creative learning environments. In doing so, the research will provide a holistic view of how PBL fosters not only intellectual but also emotional engagement, thereby enriching the overall educational experience.

The ultimate goal of this study is to inform educators, policymakers, and curriculum designers about effective strategies to cultivate creativity in formal education. The findings are expected to contribute to evidence-based pedagogical frameworks that align with 21st-century learning imperatives. By articulating a clear model of how PBL enhances divergent thinking, this research intends to support the systemic adoption of innovative teaching methods capable of transforming traditional classrooms into dynamic spaces for creative exploration and knowledge construction. Existing literature has provided substantial evidence on the cognitive benefits of PBL, such as improvements in critical thinking, motivation, and academic achievement. However, the relationship between PBL and divergent thinking remains underexplored, particularly concerning how specific project features such as autonomy, collaboration, and real-world relevance interact to foster creativity (Al-Thani & Ahmad, 2025; Vinco et al., 2025). Many studies focus on general creativity outcomes without dissecting the cognitive mechanisms underlying divergent idea generation. This oversight limits the understanding of how PBL's experiential nature translates into measurable creative competencies.

Research in creativity education has also been fragmented by disciplinary silos. While psychology emphasizes cognitive theories of creativity, education studies often highlight pedagogical frameworks without fully integrating cognitive science insights. This separation has resulted in a lack of comprehensive models explaining how teaching strategies such as PBL concretely influence creative thought processes (Hegde et al., 2025; Supakwong, 2025).

Furthermore, few studies have systematically compared the impact of PBL with other constructivist approaches like inquiry-based or problem-based learning, leaving a conceptual gap in the empirical literature. Another gap concerns the assessment of creativity itself. Current evaluation methods often rely on subjective teacher judgments or self-report instruments that fail to capture the complexity of divergent thinking. There is a need for standardized, multi-dimensional tools capable of assessing creativity across domains and instructional contexts. Addressing this methodological limitation will not only strengthen the empirical rigor of creativity research but also provide educators with actionable insights for classroom implementation (Marić & Rani, 2025; Yadav & Vatta, 2025). This study aims to bridge these gaps by combining quantitative and qualitative approaches to assess the multifaceted impact of PBL on student creativity.

This research offers a novel contribution by directly linking the pedagogical design of PBL with the measurable development of divergent thinking skills. Unlike prior studies that treat creativity as a broad or static trait, this study conceptualizes it as a dynamic, learnable process that evolves through iterative engagement in project-based tasks. By employing a mixed-methods design, it captures both the cognitive and affective dimensions of creativity, providing a more comprehensive understanding of how students learn to think divergently (Chodasová & Takáčová, 2025; Yusuf, 2025). The focus on divergent thinking as an operational construct distinguishes this research from existing work that often generalizes creativity outcomes without addressing its subcomponents. The justification for this study rests on its potential to inform pedagogical innovation within mainstream education.

As societies increasingly demand creative problem-solvers, schools must adopt evidence-based strategies that align with global educational reforms emphasizing innovation, adaptability, and interdisciplinary learning. Project-Based Learning, when empirically validated as a catalyst for divergent thinking, can serve as a cornerstone for curriculum transformation. This study's findings will thus offer actionable recommendations for teacher training, curriculum development, and assessment reform. The novelty of this research also lies in its contextual relevance. Conducted within an educational environment where creativity is often undervalued in favor of standardized outcomes, this study seeks to demonstrate that fostering divergent thinking does not compromise academic rigor but rather enhances intellectual depth and motivation (Haim & Aschauer, 2024; Ochoa et al., 2025). The integration of cognitive psychology, constructivist pedagogy, and creativity assessment within one coherent research framework positions this study as a meaningful contribution to both theory and practice. By doing so, it paves the way for reimagining classrooms as creative ecosystems where students are empowered to generate, evaluate, and refine ideas for future innovation.

RESEARCH METHOD

This study employed a mixed-methods approach to investigate the effect of Project-Based Learning (PBL) on students' divergent thinking and creativity in classroom learning environments. The integration of quantitative and qualitative methods was intended to provide a comprehensive understanding of how PBL contributes to the development of creative cognition among students. The research focused on measuring changes in divergent thinking skills, including fluency, flexibility, originality, and elaboration, while also exploring students' learning experiences during project-based activities. The study was conducted in natural

classroom settings to maintain ecological validity and ensure that the learning process reflected authentic educational practices (Lestari et al., 2024; Mamani-Choque et al., 2025).

Research Design

The research applied a quasi-experimental design using a non-equivalent control group structure. This design was selected to compare the learning outcomes of students who received Project-Based Learning instruction with those who experienced conventional teaching methods. The study utilized a pretest posttest format to examine changes in students' divergent thinking abilities before and after the intervention. The experimental group participated in PBL activities, while the control group followed teacher-centered instruction through lectures and exercises. The inclusion of qualitative observation methods complemented the quantitative data by providing deeper insights into classroom interactions and students' creative engagement during the learning process (Lestari et al., 2024; Mamani-Choque et al., 2025).

Research Target/Subject

The target population of this study consisted of senior high school students enrolled in subjects that emphasize creativity and project-oriented learning, such as art, design, and science project classes. The research was conducted in an urban educational district involving two schools with relatively similar academic performance and educational facilities. These schools were purposively selected to ensure comparability between the experimental and control groups. A total of 120 students participated in the research, with 60 students assigned to the experimental group and 60 students assigned to the control group. Before the implementation phase, teachers received training related to Project-Based Learning strategies to ensure consistency in instructional delivery and adherence to the research procedures (King & McCall, 2024; Kuncoro et al., 2025).

Research Procedure

The research procedures were organized into four main phases, namely preparation, implementation, data collection, and data analysis. During the preparation phase, researchers collaborated with teachers to design lesson plans, learning projects, and classroom activities aligned with PBL principles. Teachers participating in the experimental group received prior training regarding PBL implementation techniques. Data collection was conducted before and after the intervention through pretests and posttests to measure changes in students' divergent thinking performance. Qualitative data were also gathered continuously throughout the intervention period using observations, interviews, and student reflection journals. The systematic sequence of procedures ensured consistency in the intervention process and strengthened the validity of the research findings (Bilgin, 2024; den Ouden et al., 2025).

Instruments and Data Collection Techniques

Several research instruments were used to collect both quantitative and qualitative data in this study. The primary quantitative instrument was the Torrance Tests of Creative Thinking (TTCT), which was adapted to suit classroom learning contexts. The TTCT focused on measuring four dimensions of divergent thinking, namely fluency, flexibility, originality, and elaboration. Quantitative data were obtained through pretest and posttest assessments administered before and after the intervention period. Qualitative data were collected through direct observations, reflective writing activities, and interviews conducted during and after the implementation phase. Instrument reliability was tested through pilot testing, resulting in a Cronbach's alpha coefficient of 0.87, indicating a high level of internal consistency and

reliability. The combination of multiple instruments enabled the researcher to obtain a more comprehensive understanding of students' creativity development during the learning process.

Data Analysis Technique

The data analysis process combined quantitative and qualitative analytical techniques to provide a comprehensive interpretation of the research findings. Quantitative data obtained from the TTCT scores were analyzed using paired-sample t-tests and Analysis of Variance (ANOVA) to identify significant differences between the experimental and control groups before and after the intervention. This analysis aimed to identify recurring themes, patterns, and student perceptions related to creative thinking development during the PBL process. The integration of quantitative and qualitative findings allowed the study to achieve methodological triangulation and strengthen the validity of the conclusions. Through this approach, the research was able to provide both statistical evidence and contextual explanations regarding the role of Project-Based Learning in enhancing creativity and divergent thinking among students (Manikutty et al., 2024; Tsakeni, 2024).

RESULTS AND DISCUSSION

The data collected from 120 students across the experimental and control groups were analyzed quantitatively and qualitatively to determine the effect of Project-Based Learning (PBL) on divergent thinking and creativity. Table 1 presents the descriptive statistics of students' creativity scores, indicating mean differences between the two groups before and after the intervention. The experimental group displayed a substantial increase in post-test mean scores across all four indicators fluency, flexibility, originality, and elaboration compared to the control group, which showed minimal improvement.

Table 1. Mean Scores of Divergent Thinking Indicators (Pretest Posttest)

Indicator	Control Group (Mean ± SD)	Experimental Group (Mean ± SD)	Mean Difference	p-value
Fluency	45.23 ± 7.11	61.47 ± 6.89	+16.24	<0.001
Flexibility	43.16 ± 6.98	59.02 ± 7.35	+15.86	<0.001
Originality	41.72 ± 7.52	58.94 ± 8.01	+17.22	<0.001
Elaboration	46.03 ± 7.43	63.18 ± 6.84	+17.15	<0.001

The data show that the experimental group experienced consistent and statistically significant gains in all aspects of divergent thinking, confirming that PBL fosters a richer and more flexible thought process among students. The mean improvement exceeded 15 points for every indicator, signifying not only enhanced idea generation but also improved capacity for complex elaboration and originality. The control group, by contrast, demonstrated only modest gains attributable to general learning exposure, suggesting that traditional instruction does not sufficiently stimulate creative expansion. The explanation of these findings reveals that students exposed to PBL benefitted from multiple opportunities to explore problems, formulate hypotheses, and engage in iterative design cycles. The process-oriented structure of PBL encouraged divergent thinking by prompting learners to analyze problems from multiple perspectives. The collaborative nature of project tasks allowed for continuous peer feedback and reflection, which reinforced idea refinement and creative elaboration. This pattern was consistently observed during classroom observation sessions and recorded in reflective journals.

A deeper descriptive analysis of the data underscores how each dimension of divergent thinking responded differently to the PBL approach. Fluency increased due to repeated brainstorming and open-ended questioning; flexibility improved as students learned to shift between cognitive categories; originality grew from exposure to authentic problems requiring innovative solutions; and elaboration developed as learners were required to present, defend, and refine their projects. The sustained engagement with real-world challenges and iterative evaluation cycles allowed students to internalize creativity as both a process and an outcome. Inferential statistical analysis using a paired-sample t-test and ANOVA confirmed the significance of the observed differences. The overall F-ratio ($F = 24.63$, $p < 0.001$) indicated a strong effect of the PBL intervention on creativity outcomes, with a calculated effect size (Cohen's $d = 1.34$) denoting a large practical impact. The consistency across all indicators validated the robustness of the results, and no significant interaction effects were found across gender or prior academic achievement levels. The results affirm that PBL contributes meaningfully to cognitive expansion regardless of demographic background, suggesting its inclusivity as an instructional model.

The relational data analysis revealed strong intercorrelations among the four divergent thinking components within the experimental group. Correlation coefficients between fluency and flexibility ($r = 0.78$), originality and elaboration ($r = 0.81$), and fluency and originality ($r = 0.74$) demonstrated a cohesive development pattern in creative cognition. This indicates that improvements in one dimension, such as fluency, tend to reinforce gains in others, particularly originality and elaboration. The integrative nature of PBL promotes such interconnected development by linking conceptual thinking, creative synthesis, and reflective evaluation within a single pedagogical framework. The qualitative case data further illuminate these patterns through classroom-based examples. In one case, a group of students tasked with designing sustainable community gardens demonstrated enhanced creativity by integrating local environmental data, traditional agricultural practices, and innovative irrigation designs. Their project reports showed higher scores in originality and elaboration due to the integration of scientific reasoning with social awareness. Another student team, assigned to develop an educational game for science learning, produced multiple prototypes through iterative testing, reflecting high levels of flexibility and problem-solving creativity.

The explanatory analysis of the qualitative findings underscores that student engagement in authentic, real-world projects heightened intrinsic motivation and ownership of learning (Cuesta-Hincapie & Camargo Salamanca, 2025; Vithanage & Nakashima, 2025). Students reported that PBL provided a safe environment for risk-taking and idea experimentation, which directly nurtured divergent thinking. Teacher interviews corroborated this perception, emphasizing that the shift from content delivery to facilitation allowed learners to exercise greater autonomy and self-regulation. The synergy between teacher scaffolding and student independence emerged as a key factor in sustaining creative momentum throughout the project phases. The brief interpretation of the combined results indicates that PBL significantly enhances divergent thinking and overall creativity through its constructivist, experiential, and collaborative nature. The integration of hands-on inquiry, reflection, and feedback created a learning ecosystem conducive to cognitive flexibility and creative output. The evidence from both quantitative and qualitative analyses confirms that PBL not only raises measurable creativity scores but also transforms classroom dynamics into fertile grounds for innovation (Ramdani et al., 2025; Rashid & Khurshid, 2025). These findings substantiate the pedagogical

claim that fostering divergent thinking through PBL equips students with essential competencies for complex problem-solving and lifelong learning.

The results of this study indicate that Project-Based Learning (PBL) significantly enhances students' divergent thinking and creative performance across all measured dimensions fluency, flexibility, originality, and elaboration. Quantitative data revealed a notable increase in post-test scores for the experimental group, demonstrating that students exposed to PBL generated a higher quantity and quality of ideas compared to those in traditional instruction. The qualitative findings reinforced this pattern, showing that students engaged more deeply in idea exploration, problem-solving, and reflective discussion throughout project cycles. The data confirm that PBL not only improves measurable creative outcomes but also cultivates essential dispositions such as curiosity, persistence, and cognitive adaptability (Lapisa et al., 2025; Sukardi et al., 2024). The alignment between statistical and observational results strengthens the claim that PBL provides a fertile environment for nurturing divergent thinking. Comparison with prior research underscores both congruence and differentiation.

Studies by Bell (2010) and Kokotsaki et al. (2016) similarly reported that PBL promotes creativity by integrating inquiry, collaboration, and authentic problem-solving. The current findings extend this understanding by isolating divergent thinking as a specific cognitive outcome, thereby deepening theoretical clarity on the creative mechanisms activated through PBL. While previous research often emphasized the general enhancement of creativity, this study reveals the structural relationship between task design, student autonomy, and the stimulation of multiple idea pathways. The observed gains surpass those found in traditional or hybrid instructional models, confirming that active project engagement, rather than content transmission, drives cognitive expansion. The distinct focus on divergent thinking sets this research apart by demonstrating creativity as a measurable and learnable competence rather than a fixed trait.

The results signify an important pedagogical reflection for modern education. The enhancement of divergent thinking through PBL suggests that creativity is not incidental but rather the product of intentional instructional design (Lapisa et al., 2025; Shek et al., 2025). The findings serve as an indicator of how student-centered methodologies can shift learning from memorization to exploration and from product-oriented to process-oriented paradigms. The growth in students' originality and elaboration reflects a broader transformation in cognitive behavior one where learners assume ownership of ideas and display willingness to take intellectual risks. The consistency of improvements across diverse learners also reveals that creative growth can be democratized when classrooms are structured around authentic inquiry rather than conformity to predetermined answers. This reflection highlights that education systems must reconsider how they define, measure, and value creativity within curricular frameworks.

The implications of these findings are multidimensional, extending to pedagogy, curriculum design, and educational policy. The demonstrated effectiveness of PBL reinforces its potential as a core instructional strategy for cultivating 21st-century skills. Teachers should integrate open-ended projects that connect learning with real-world contexts, thereby promoting interdisciplinary thinking and sustained engagement. Curriculum developers must embed creativity as an explicit learning goal, supported by assessment rubrics that value divergent thinking processes alongside knowledge acquisition. Policymakers should view

creativity not as an extracurricular privilege but as a national educational priority. The study's evidence provides a concrete basis for reimagining classrooms as collaborative innovation spaces where learners actively construct knowledge through exploration and reflection.

The observed outcomes occur because PBL creates a learning ecosystem that balances autonomy, structure, and collaboration. Students gain ownership of the learning process by defining problems, generating hypotheses, and testing solutions through iterative cycles. This autonomy encourages intrinsic motivation and persistence, essential conditions for creative thought. The collaborative component allows ideas to evolve through dialogue and feedback, stimulating flexibility and elaboration. The cognitive challenge embedded in PBL projects triggers higher-order thinking by requiring learners to integrate multiple perspectives and disciplines (Kayhan & Korkmaz, 2024; Shek et al., 2025). These combined elements explain why PBL consistently produced stronger divergent thinking outcomes than traditional instruction. The learning model operationalizes constructivist and sociocultural theories of creativity, translating abstract pedagogical ideals into tangible learning experiences.

The implications for future practice and research are substantial. The evidence suggests that educators must adopt a design-oriented approach, treating classrooms as innovation laboratories where creativity is continuously practiced, assessed, and refined. Future research should investigate longitudinal effects of PBL on creative resilience and transferability across disciplines. Technology-enhanced PBL, integrating digital collaboration tools and AI-assisted design thinking platforms, also represents an avenue for deepening creative engagement (Kayhan & Korkmaz, 2024; Šimunović & Vekić-Kljaić, 2024). The current study contributes to a growing movement advocating for creativity as the cornerstone of educational reform. The findings call for sustained institutional commitment to teacher professional development, resource provision, and assessment reform aligned with creative learning outcomes. This research thus provides both empirical and conceptual grounding for the continued evolution of education toward fostering divergent, adaptive, and inventive thinkers prepared to address complex global challenges.

CONCLUSION

The most significant finding of this research lies in the confirmation that Project-Based Learning (PBL) substantially enhances divergent thinking and creativity through authentic, student-centered learning experiences. The empirical data revealed that students engaged in PBL demonstrated measurable improvements in fluency, flexibility, originality, and elaboration core dimensions of creative cognition. This outcome differs from prior studies by specifically isolating divergent thinking as a quantifiable construct rather than treating creativity as a broad, abstract quality. The study's mixed-method approach captured not only numerical gains in creativity scores but also qualitative evidence of transformed classroom dynamics, where learners exhibited higher motivation, autonomy, and collaborative synergy. The novelty of this finding underscores that divergent thinking can be intentionally cultivated through structured project-based pedagogy rather than emerging as an incidental byproduct of learning. The principal contribution of this research rests in both conceptual and methodological innovation. Conceptually, it advances a framework that positions divergent thinking as an attainable and assessable educational objective within the PBL paradigm. Theoretically, it bridges cognitive psychology and pedagogical design by articulating how inquiry, reflection, and collaboration function as catalysts for creative thought.

Methodologically, it integrates quantitative assessment tools with qualitative observations to provide a holistic depiction of how creativity develops in classroom ecosystems. This multidimensional approach offers educators and researchers a replicable model for evaluating and nurturing creativity through experiential learning environments, marking a significant step toward evidence-based creativity education.

The study acknowledges certain limitations that open pathways for future inquiry. The quasi-experimental design, while effective for ecological validity, limits causal generalization due to potential contextual variations among schools. The duration of the intervention was relatively short, which may not capture the long-term development of creative dispositions. Future research should extend longitudinally to examine the persistence and transferability of divergent thinking skills beyond the immediate learning context. Further exploration into digital-enhanced PBL and cross-disciplinary applications would also enrich understanding of how creativity evolves under different technological and cultural conditions. Addressing these limitations will enable deeper insights into the sustainability and scalability of PBL as a transformative framework for fostering creative and adaptive learners in the 21st-century classroom.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.
Author 5: Supervision; Validation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

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