REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
JOURNAL OF ELEMENTARY EDUCATION
Vol. 18, No. 3, pp. 305–325, September 2025

ENHANCING LEARNING PERFORMANCE IN PRIMARY EDUCATION: THE ROLES OF PROBLEM SOLVING AND CREATIVE THINKING CHALLENGES

PHAM NGOC THIEN NGUYEN[1,2], KHANH-TRINH TRAN[1,2] & GIAM BUU LE[3]

[1]An Giang University, An Giang, Vietnam
[2]Vietnam National University Ho Chi Minh City, Vietnam
[3]Tan Thanh 2 Primary School, Lai Vung District, Dong Thap Province, Vietnam

CORRESPONDING AUTHOR/KORESPONDENČNI AVTOR
npnthien@agu.edu.vn

Potrjeno/Accepted
31. 7. 2025

Objavljeno/Published
30. 9. 2025

Abstract/Izvleček

This study investigated the roles of problem-solving and creative thinking activities in primary science education. Participants included 64 third-grade and 62 fifth-grade students in Southern Vietnam, with half assigned to experimental groups and the others to control groups. The experimental groups, which received structured lessons, outperformed the control groups, which received traditional instruction. Results highlight the positive impact of integrating these activities on academic performance, supporting the effectiveness of structured support in enhancing learning outcomes.

Keywords:
problem-solving, creativity, learning performance, primary education, vietnamese students.

Izboljšanje učne uspešnosti v osnovnem izobraževanju: Vloge reševanja problemov in izzivov kreativnega mišljenja

V študiji preučujemo vpliv aktivnosti reševanja problemov in kreativnega mišljenja na pouk naravoslovja v osnovni šoli. V raziskavi je sodelovalo 64 učencev tretjega razreda in 62 učencev petega razreda iz Južnega Vietnama, pri čemer je bila polovica razporejena v eksperimentalne skupine, druga polovica pa v kontrolne. Eksperimentalne skupine, ki so prejemale strukturirane učne ure, so dosegle boljše rezultate kot kontrolne skupine, ki so uporabljale tradicionalne učne metode. Rezultati poudarjajo pozitiven vpliv vključevanja teh aktivnosti na učno uspešnost in podpirajo učinkovitost strukturirane podpore pri izboljšanju učnih dosežkov.

Ključne besede:
reševanje problemov, kreativnost, učna uspešnost, osnovnošolsko izobraževanje, Južni Vietnam.

UDK/UDC:
373.3.091.3

DOI https://doi.org/10.18690/rei.4930

University of Maribor Press

Introduction

The integration of problem-solving and creative thinking into educational curricula has gained increasing attention in recent decades, reflecting a broader shift from traditional, rote-based instruction to approaches that emphasize cognitive flexibility and innovation (Kim et al., 2013; Lin and Cho, 2011; Lin et al., 2025; Mumford et al., 1997; van Hooijdonk et al., 2020). These skills are now widely regarded as essential for preparing students to navigate the complexities of modern life and learning environments.

This pedagogical shift is especially relevant in primary education (Abdollahi et al., 2018; Güllühan, 2021; Ramos Salazar and Hayward, 2018). Education systems worldwide increasingly recognize the crucial role of these skills in developing cognitive abilities (Orakci, 2023; Wang, 2021), critical thinking (Kanbay and Okanli, 2017; Song et al., 2022), and overall academic achievement (Erdem, 2022; Guven and Cabakcor, 2013; Karabay and Meşe, 2024; Rodríguez-Fornells and Maydeu-Olivares, 2000). When effectively integrated into the curriculum, these activities enhance both student engagement and adaptability (Elias et al., 2003; Karabay and Meşe, 2024; Kim et al., 2013). However, there are findings that problem-solving and creative thinking skills may not always be beneficial for learners (Avci and Durak, 2023; Stark et al., 1998; Sung, 2017).

Despite the growing body of literature on the topic, there remains a notable gap in empirical research examining the direct impact of problem-solving and creative thinking activities on academic achievement in primary school contexts. Much of the existing research focuses on general benefits or older student populations, leaving limited evidence on how these approaches compare to more traditional, teacher-led instruction at the primary level.

This study seeks to address this gap by examining whether the integration of structured problem-solving and creative thinking activities into classroom instruction can improve academic performance among primary school students. By comparing these approaches to conventional teaching methods, this research aims to provide evidence on their effectiveness in enhancing academic outcomes.

Problem-Solving and Creative Thinking in Education

Problem-solving and creative thinking are essential educational skills that empower students to tackle complex challenges and develop innovative solutions. Problem-solving involves systematically identifying, analysing, and resolving issues (Orakci,

2023; Wang, 2021), while creative thinking supports the generation of original and effective ideas (Redifer et al., 2021; Yang et al., 2022).

Together, these skills build adaptability, critical thinking, and innovation, enabling learners to explore and refine multiple solutions in response to evolving demands (Noh, 2017; Redifer et al., 2021; Rosen et al., 2020; Worwood and Plucker, 2017).

Problem-solving and Creative Thinking Linked to Learning Achievement

Extensive research has shown strong links between both these skills and student achievement. Creative thinking enhances performance by encouraging students to explore diverse solutions and build confidence in their ideas (Fan and Sun, 2024; Yang and Zhao, 2021).

Similarly, problem-solving skills correlate with academic success, particularly in managing complex tasks and sustaining motivation (Byun and Lee, 2014; Elias et al., 2003; Zhang and Hwang, 2023). Students with stronger problem-solving abilities tend to perform better across subjects, demonstrating deeper understanding and persistence in learning (Ginsburg-Block and Fantuzzo, 1998).

Integration of Problem-solving and Creative Thinking into Primary Education

Effective integration of these skills is evident in various primary education contexts worldwide. For instance, Ginsburg-Block and Fantuzzo (1998) found that primary school students who engaged in problem-solving outperformed peers in both computation and word problems, while also showing higher motivation, self-concept, and social competence. Niu et al. (2022) similarly found that supportive environments for grades 3–6 enhanced both academic achievement and creative capacity, creating a positive feedback loop for performance. Sebastian and Huang (2016) showed that students with high creativity—especially in generating novel solutions—excelled academically, while van Hooijdonk et al. (2020) confirmed that creative problem-solving aligns with divergent thinking and achievement in primary settings.

However, not all studies showed direct effects. Sung (2017) reported no significant relationship between problem-solving ability and achievement, highlighting that contextual factors may mediate outcomes.

Collectively, these findings highlight the value of embedding problem-solving and creative thinking into early education—not only to support academic success but also to foster motivation and socio-emotional development. They also underscore the need for further investigation, particularly in comparing problem-solving and

creative thinking approaches with traditional instructional methods across diverse educational contexts.

Comparison of Problem-Solving and Creative Thinking with Traditional Instructional Methods

Traditional methods, often teacher-centred and content-driven, rely heavily on direct instruction, lectures, and memorization. While effective for delivering standardized content, these approaches may limit student engagement and the development of higher-order thinking skills.

In contrast, research consistently finds that instructional approaches emphasizing problem-solving and creativity lead to stronger cognitive outcomes (Segundo-Marcos et al., 2023; Yang, 2015). Meta-analyses show that student-centred methods significantly enhance creativity and academic performance compared to traditional methods. However, Stark et al. (1998) found that no instructional method proved superior across all outcomes, suggesting the importance of matching teaching strategies to specific learning goals.

These findings support the growing shift toward incorporating creative and problem-based tasks, while also calling for more nuanced understanding of when and how these strategies are most effective. The aims of the study are grounded in established educational theories, including constructivist and discovery learning frameworks.

Constructivist perspectives, including those of Piaget (1970) and Vygotsky (1978), emphasize active, social learning, while Bruner's discovery learning theory promotes engagement with content through exploration rather than passive reception (Ozdem-Yilmaz & Bilican, 2020).

Bruner's theory encourages learning environments that are engaging, efficient, and student-centred, enhancing collaboration and critical thinking through project-based, real-world tasks (Gorbunova et al., 2023). Additionally, reflective practice helps strengthen cognitive flexibility and deepen students' understanding (Murawski, 2014), leading to richer, more impactful learning experiences.

Grounded in constructivist and discovery learning perspectives, this study investigated how structured problem-solving and creative thinking activities could be integrated into primary science education, with a particular focus on the Vietnamese context.

Context of the Study

Vietnamese primary education has undergone significant reforms in recent decades, shifting from a predominantly teacher-centred approach toward more student-centred pedagogies (Ministry of Education and Training [MOET], 2018). The Vietnamese primary curriculum emphasizes core knowledge acquisition, with science education traditionally delivered through direct instruction and memorization techniques (Hoang, 2023; Tran et al., 2022). Primary education spans grades 1-5 (ages 6-11), with science education formally introduced in grade 3 as a distinct subject (MOET, 2018).

Studies in the Vietnamese context have increasingly emphasized the importance of problem-based learning in fostering creativity, critical thinking, and real-life application skills—especially in elementary education (Thu et al., 2024). Although Vietnam has made substantial progress in educational reform, the implementation of student-centred approaches such as problem-solving and creative thinking in general still faces significant systemic challenges (Van Quang, 2023).

Research has been conducted on effective strategies for nurturing students' problem-solving and creative abilities through targeted instructional tasks (Hằng, 2025). These studies highlight the feasibility and effectiveness of implementing creativity-focused instruction across diverse school settings (Dang et al., 2023). Despite ongoing reforms, the structured and content-focused nature of the national curriculum may place constraints on the integration of exploratory learning activities. This tension between curriculum requirements and pedagogical innovation provides the backdrop for the current study, which seeks to evaluate structured problem-solving and creative thinking activities within the constraints of Vietnam's primary science education framework.

Lessons designed in this study

To align with the aims of the study, third and fifth grades were strategically selected, since they represent distinct cognitive stages while providing a suitable age gap for comparison. Third grade marks the transition from basic literacy to comprehension-based learning (Kim et al., 2015), while fifth graders exhibit greater cognitive maturity, making them more receptive to complex learning interventions (e.g., Stefanou and Parkes, 2003; Wijekumar et al., 2014). This age range (8–11) encompasses critical academic and social developments, making it particularly

relevant for evaluating educational interventions (Kim et al., 2015; Stefanou and Parkes, 2003).

Building on a constructivist and discovery learning framework, this study designed two science lessons tailored to Vietnamese primary students, in accordance with the curriculum prescribed by MOET. These lessons explicitly integrated problem-solving and creative thinking activities to promote cognitive engagement, exploration, and real-world application of scientific concepts.

Lesson on the Movement of the Earth for grade 3: This lesson, part of the grade 3 curriculum, aimed to strengthen students' understanding of Earth's movements and their observable effects, such as day and night and seasonal changes. It introduced these abstract scientific concepts through age-appropriate explanations and interactive tasks, encouraging students to think critically and connect learned content to their daily experiences.

Students investigated why the Earth experiences day and night and seasonal variation, which occur due to Earth's rotation on its axis and revolution around the Sun. These processes were simplified to suit the developmental stage of young learners while promoting engagement and conceptual clarity.

A variety of learning activities were incorporated to reinforce these concepts, including observing and comparing the sky during day and night, using models and videos to demonstrate Earth's rotation, identifying Earth's position in the Solar System, exploring the causes of seasonal changes, and constructing simple models to represent the day-night cycle.

In addition to supporting scientific understanding, the lesson emphasized the development of problem-solving and creativity. Students were encouraged to apply their knowledge through hands-on experiments, imaginative model-building, and group discussions. These tasks supported active learning and helped students bridge theoretical knowledge with real-world phenomena.

Solar-Powered Vehicles for grade 5: This lesson introduced students to renewable energy concepts within the grade 5 curriculum, focusing specifically on the application of solar energy in technology. Through the design and construction of a solar-powered vehicle, students explored how scientific knowledge could be translated into technological solutions.

The lesson guided students through foundational concepts related to electricity and energy efficiency. They learned to describe how electrical circuits operate in solar-powered cars, explain the roles of conductors and insulators, demonstrate how

sunlight generates electricity through solar panels, assemble and test a simple solar-powered vehicle, while identifing ways to conserve energy at home and school.

Beyond the acquisition of technical knowledge, the lesson promoted 21st-century competences, including self-directed learning, collaboration, creativity, and responsibility. Students participated in a range of activities such as analysing circuit components, experimenting with various materials, and discussing how solar panels convert light into electricity.

They then applied their understanding in a practical task—constructing and testing solar-powered cars—where assessment focused on both process (engagement, teamwork, problem-solving) and product (functionality of the model). These experiential learning opportunities not only deepened content comprehension but also enhanced critical thinking and collaborative skills.

Research Hypotheses

Drawing on the literature review, this study formulates hypotheses to address critical gaps in understanding how problem-solving and creative thinking activities influence primary school students' academic achievement. While previous research has highlighted the general benefits of these approaches in education (Fan and Sun, 2024; Yang and Zhao, 2021), their specific impact on primary school students' academic performance—particularly in the Vietnamese context—remains underexplored. Moreover, although positive outcomes have been observed across various educational levels (Sebastian and Huang, 2016), examining these relationships within Vietnam's primary education system contributes to understanding their effectiveness in diverse cultural and educational settings.

These research directions are grounded in constructivist theories and discovery learning principles (Ozdem-Yilmaz and Bilican, 2020) and seek to address context-specific implementation challenges identified in previous studies (van Hooijdonk et al., 2020).

Building on evidence that active learning approaches enhance student engagement and understanding compared to traditional methods (Segundo-Marcos et al., 2023; Yang, 2015), the first hypothesis is proposed:

Hypothesis 1: Primary school students who receive structured instructional support incorporating problem-solving and creative thinking activities will demonstrate significantly better academic performance compared to those receiving traditional teacher-directed instruction.

The second hypothesis is informed by research showing that problem-solving and creative thinking activities can enhance academic motivation (Ginsburg-Block and Fantuzzo, 1998) and improve achievement (Niu et al., 2022). These findings suggest that similar benefits may extend to academic areas within the Vietnamese primary education context.

Hypothesis 2: The integration of problem-solving and creative thinking activities into instructional lessons will have a significant positive effect on primary school students' academic achievement.

These hypotheses will be tested through a comparative analysis of student performance under different instructional approaches, providing empirical evidence for the efficacy of integrating problem-solving and creative thinking activities into primary education.

Method

Participants

The study sample comprised students from grades 3 (aged 8) and 5 (aged 10) at a primary school in southern Vietnam. Participation was voluntary, with informed consent obtained from both students and their legal guardians.

Given the requirement for informed consent, convenience sampling was employed. Specifically, grade 3C (n = 32) and grade 5D (n = 31) were designated as the control groups. Within each grade level, group assignment (experimental vs. control) was conducted at the class level to ensure balanced representation and comparable sample sizes for the instructional interventions.

Procedure

General Procedure: Before the lessons, students were asked to prepare in advance and complete a pre-test (for the experimental groups). During the lessons, both experimental and control group students followed their teacher's instructions and the lesson procedures. After the lessons, students in both groups completed the same test again to measure learning achievement. Each lesson was conducted within the standard 35 to 45-minute period, which is typical of Vietnamese primary school classes.

Procedure for Teaching the Lesson on "The Movement of the Earth": The lesson began with introductory activities designed to spark student curiosity about the

Earth's movements. Through guided questions on day-night cycles and seasonal changes, students began exploring fundamental astronomical concepts.

The first activity focused on understanding the phenomena of day and night through hands-on investigation. Using globes and flashlights, students explored why the sky appeared bright during the day and dark at night. They then engaged in artistic exercises, comparing day and night scenes and illustrating key elements such as the Sun, stars, and shadows.

The second activity introduced seasonal changes by examining Earth's orbital positions. Students practiced critical thinking by identifying the seasons corresponding to Vietnam's position in its orbit and discussing suitable clothing for each season. In the creative extension, they assumed the role of fashion designers, creating and presenting seasonal outfits appropriate for Vietnam's climate.

The third activity delved into Earth's rotation and revolution. With a globe, students observed how Vietnam's position relative to the Sun generated day-night cycles. They developed an understanding of the 24-hour day and expressed their learning by writing narratives from the perspective of characters experiencing daily light and darkness in Vietnam.

The next activity expanded the scope to explore Earth's place in the Solar System. Students imagined themselves as astronauts, discussed Earth's location and movement in space, and constructed Solar System models using craft materials to represent planetary positions and orbits.

The lesson concluded with a comprehensive review of key concepts: Earth's rotation causing day-night cycles, its revolution leading to seasonal changes, and its placement in the Solar System. Assessment encompassed student participation, problem-solving abilities, and creative output. Finally, students were encouraged to observe and identify astronomical phenomena in their everyday lives.

Procedure for Teaching the Lesson on "Solar-Powered Vehicles": The lesson began by introducing renewable energy, with a focus on solar power as a sustainable alternative to conventional energy sources. Visual demonstrations of solar-powered devices and guided discussion helped students develop a foundational understanding of solar energy applications in daily life.

In the first activity, students worked in groups to assemble basic lighting circuits using solar panels, bulbs, and wire. This experience developed their troubleshooting skills as they encountered and resolved common technical challenges. They then

applied their learning by designing solar-powered solutions to address local community needs, which they shared through presentations and group discussion.
The second activity involved constructing solar-powered model vehicles. Students collaborated to assemble the cars, explored how the components functioned, and tested their performance under varying light conditions. They added creative flair by personalizing their vehicles and writing imaginative stories about their cars' purpose and journeys.
The third activity focused on managing electricity safely. Students identified unsafe electrical practices and collaborated to develop guidelines for responsible energy use. They communicated these safety principles creatively through posters and diagrams, incorporating symbols, slogans, and clear visuals.
The lesson concluded by consolidating knowledge across solar energy use, device construction, and electrical safety. In closing discussions, students reflected on how they could implement renewable energy solutions and safe practices in their daily environments, bridging classroom learning with real-world application.

Data Collection and Analysis

Academic performance was measured by the total score on a structured test based on Bloom's taxonomy.
In the experimental group, a pre-test was given at the start of each lesson to gauge prior understanding, followed by a post-test to measure learning gains. These lessons incorporated problem-solving and creative thinking tasks. The control group received traditional instruction on the same content without such activities and completed the same post-test to allow comparison.
The test, based on Bloom's taxonomy, assessed key concepts at multiple cognitive levels. Each test (for "The Movement of the Earth" and "Solar-Powered Vehicles") included five questions—three multiple-choice and two short-answer: two targeting knowledge, two comprehension, and one application. Each item was scored out of 2 points, resulting in a maximum total score of 10. Questions were scored using a rubric, and total scores were used for analysis. Using identical assessment across groups ensured valid comparison.
For data analysis, independent samples t-tests were used to compare post-test scores between groups (testing Hypothesis 1), while paired samples t-tests compared pre- and post-test scores within the experimental group to assess individual progress (testing Hypothesis 2).

Results

The pre- and post-test results are presented in Table 1. The results indicate significant improvement in the experimental group's performance on both science topics after the intervention.

Within the topic about the Movement of the Earth, the experimental group showed a substantial increase from pre-test (M = 3.4, SD = 1.4) to post-test (M = 8.8, SD = 2.1). This upward tendency indicates that the experimental intervention had a powerful effect on participants' understanding of concepts related to the Earth's Movement. When comparing post-test scores, the experimental group's mean was significantly higher than the control group's mean (M = 6.2, SD = 1.9), highlighting the intervention's effectiveness.

Regarding the topic about Solar-Powered Vehicles, the experimental group demonstrated a considerable improvement from pre-test (M = 4.9, SD = 1.6) to post-test (M = 9.4, SD = 1.4). This positive progression suggests that the experimental intervention substantially enhanced participants' comprehension of concepts related to Solar-Powered Vehicles. When comparing post-test scores, the experimental group's mean was significantly higher than the control group's mean (M = 5.5, SD = 1.5), further supporting the intervention's efficacy.

Table 1.

Pre- and post-test results of academic performance

Academic performance	Pre-test of experimental group	Post-test of experimental group	Post-test of control group
Earth's Movement			
M	3.4	8.8	6.2
SD	1.4	2.1	1.9
	Paired t-test results: $df = 31$; $t = 11.7$; $p < .001$		
		Independent t-tests results: $df = 31$; $t = 5.2$; $p < .001$	
Solar-Powered Vehicles			
M	4.9	9.4	5.5
SD	1.6	1.4	1.5
	Paired t-test results: $df = 30$; $t = 12.5$; $p < .001$		
		Independent t-tests results: $df = 30$; $t = 9.1$; $p < .001$	

Regarding hypotheses testing, an independent-samples t-test revealed that the post-test scores of the experimental group were significantly higher than those of the control group for the Movement of the Earth, $t(31) = 5.2$, $p < .001$. Similarly, independent-samples t-test results indicated a significant difference between the experimental group and the control group's post-test scores for Solar-Powered Vehicles, $t(30) = 9.1$, $p < .001$. These findings demonstrate that primary school students who received structured instructional support incorporating problem-solving and creative thinking activities achieved significantly higher academic performance compared to those receiving traditional teacher-directed instruction, thus confirming *Hypothesis 1*.

For the topic of the Movement of the Earth, a paired-samples t-test showed a statistically significant increase from pre-test to post-test, $t(31) = 11.7$, $p < .001$. Similarly, for the topic of Solar-Powered Vehicles, the experimental group's post-test scores ($M = 9.4$, $SD = 1.4$) were significantly higher than their pre-test scores, $t(30) = 12.5$, $p < .001$. The significant improvement in test scores from pre-test to post-test confirms that the integration of problem-solving and creative thinking activities into instructional lessons had a substantial positive effect on primary school students' academic achievement, supporting *Hypothesis 2*.

Discussion

The findings of this study demonstrate that incorporating problem-solving and creativity-focused activities into science education significantly enhances student learning outcomes. Across both topics—"The Movement of the Earth" and "Solar-Powered Vehicles"—students in the experimental groups consistently outperformed their peers in the control groups, with statistically significant gains in post-test scores. This improvement mirrors findings from previous studies (e.g., Segundo-Marcos et al., 2023; Yang, 2015), which suggest that integrating problem-solving and creative thinking activities leads to better cognitive development than traditional teaching methods. These enhancements are likely due to how such activities support active learning, collaboration, and student engagement—key principles of effective instruction in primary education. For example, Niu et al. (2022) found that active, supportive classroom environments significantly improve academic achievement among students in grades 3–6.

Specifically, problem-solving activities had a substantial positive impact on academic performance. Students in the experimental group, who engaged in structured problem-solving tasks, achieved higher post-test scores than those in traditional settings. This finding aligns with constructivist learning theories, which emphasize active student involvement in building knowledge. However, it is important to note that while performance improved, some studies (e.g., Kopp et al., 2014; Stark et al., 1998) point to a possible trade-off with students' self-perception. Thus, educators should ensure that cognitively demanding activities are delivered in emotionally supportive environments.

Creative thinking activities also played a crucial role in enhancing student outcomes. As demonstrated by Nguyen et al. (2024), interdisciplinary and imaginative approaches fostered both competence and engagement. These methods helped students connect abstract scientific concepts to real-life contexts, improving both comprehension and retention. This aligns with findings by Segundo-Marcos et al. (2023) and Sebastian and Huang (2016), who emphasized the role of creative thinking in developing cognitive flexibility and academic achievement. In particular, Fan and Sun (2024), found that creative engagement boosted student confidence and motivation, which in turn contributed to improved learning. When given opportunities to explore and express ideas creatively, students produced more original solutions and demonstrated a deeper understanding of content, making the learning experience both effective and memorable (Denervaud et al., 2021; Sebastian and Huang, 2016; Segundo-Marcos et al., 2023). These findings align with constructivist and discovery learning theories, which emphasize that students build knowledge most effectively through active participation.

The cognitive benefits of problem-solving and creative tasks are supported by several mechanisms. These include deeper information processing, which aids in long-term memory and retention (Chi, 2009; Roediger and Butler, 2011), and improved conceptual understanding through application in varied contexts (Hmelo-Silver, 2004; Jonassen, 2010). Additionally, such tasks encourage critical thinking and analytical reasoning, as students engage in structured approaches to complex challenges (Xu et al., 2023). Together, these mechanisms help explain the performance gains observed in the experimental group.

Nonetheless, the effectiveness of these methods depends on thoughtful implementation. While their benefits are well-documented, some studies have reported mixed or negative outcomes. For instance, Avci and Durak (2023) found

that poorly structured problem-based learning activities—especially in tech-enhanced environments—led to confusion and disengagement when students lacked background knowledge. Similarly, individual factors like cognitive readiness, prior knowledge, and motivation are critical to the success of open-ended tasks (Kalyuga, 2007; Kanfer, 1990; Zhang et al., 2022).

Teacher readiness is another crucial factor. Effective implementation of creative and inquiry-based approaches requires educators to have strong content knowledge, instructional confidence, and positive beliefs about student learning. Studies on pre-service teachers show that those who meet these criteria are more successful in guiding students through innovative learning (Dobber et al., 2017; Ertmer and Simons, 2006; Gholam, 2019; Letina and Kegel, 2024). Furthermore, balancing guided instruction with open-ended inquiry is essential to avoid overwhelming students while still promoting higher-order thinking (Chaojing, 2023; Kirschner et al., 2006; Mangtani, 2024).

In sum, while problem-solving and creativity-focused strategies hold great promise, their success hinges on context-sensitive implementation. This includes aligning instructional design with learner needs, supporting teacher development, and providing sufficient scaffolding to help all students benefit from cognitively challenging, engaging tasks.

Implications and limitations

The findings of this study have significant implications for educational practice and policy while acknowledging certain limitations.

At the institutional level, school administrators should prioritize the development of problem-solving and creativity-oriented learning environments starting in primary education. This includes providing necessary materials, access to technology, and adaptable classroom spaces that support collaboration and creative expression. Timetabling should also allow for extended engagement in complex tasks, moving beyond rigid, traditional lesson periods.

For classroom practice, teachers should integrate structured problem-solving and creative thinking into appropriate subjects—particularly science, where this study has demonstrated clear benefits. Successful integration requires deliberate planning and professional development to equip teachers with the skills and resources needed. Educators should cultivate supportive environments where students feel safe to

share ideas, conduct simple experiments, and engage in exploratory activities. Active learning strategies, such as project-based learning and collaborative group tasks, can strengthen students' critical thinking and creative capacity.

Assessment methods should be adapted to reflect broader learning goals. In addition to factual recall, assessments should evaluate students' ability to apply knowledge creatively and solve problems. This can include open-ended questions, rubric-based evaluations of creative processes, and multi-stage tasks that document students' problem-solving journeys. For instance, science tests might include a section where students design an experiment to address a new problem, with scoring based on both scientific accuracy and originality.

At the policy level, education authorities should support the integration of problem-solving and creativity across subjects. This could involve professional development frameworks focused on balancing direct instruction with inquiry-based methods, incentive systems for schools demonstrating innovative pedagogy, and curriculum guidelines that allocate time for open-ended exploration alongside core content.

Despite these promising implications, several limitations must be noted. The study was conducted in a single school in Vietnam, which limits the generalizability of the results. Cultural and systemic factors, such as an emphasis on rote learning or standardized testing, may impact the feasibility of implementing these methods elsewhere. Schools in such contexts may require a gradual transition and stronger institutional support. Additionally, socioeconomic disparities may restrict access to essential resources, influencing the equity of implementation across different school settings.

Future research should explore the long-term impact of problem-solving and creative teaching approaches across varied educational contexts. Qualitative data, including classroom observation, student interviews on metacognitive strategies, and teacher reflection journals, could yield richer insights into how these strategies shape learning experiences and outcomes.

Conclusion

This study offers strong evidence that integrating problem-solving and creativity-focused activities into primary science education significantly enhances student learning outcomes.

The consistent outperformance of experimental groups underscores the effectiveness of this instructional approach and supports a growing body of literature advocating active, student-centred learning.

The success of this method can be attributed to its alignment with how children naturally learn—through exploration, experimentation, and imaginative thinking. By combining structured problem-solving with opportunities for creative expression, educators can design classrooms that not only improve academic achievement but also nurture essential skills such as critical thinking, collaboration, and innovation.

Looking ahead, future research should examine the long-term effects of these strategies across different grade levels and subject areas. Investigating which specific elements—such as task design, scaffolding techniques, or the balance between guidance and autonomy—contribute most to improved outcomes can help refine instructional practices. As education systems continue to evolve, the findings of this study provide practical insights for creating more engaging and effective learning environments, while reinforcing the importance of balancing open-ended exploration with structured support to foster higher-order thinking without overwhelming learners.

References

Abdollahi, A., Abu Talib, M., Carlbring, P., Harvey, R., Yaacob, S. N., and Ismail, Z. (2018). Problem-solving skills and perceived stress among undergraduate students: The moderating role of hardiness. *Journal of Health Psychology*, *23*(10), 1321-1331. https://doi.org/10.1177/1359105316653265

Avci, U., and Durak, H. Y. (2023). Innovative thinking skills and creative thinking dispositions in learning environments: Antecedents and consequences. *Thinking Skills and Creativity*, *47*, Article 101225. https://doi.org/10.1016/j.tsc.2022.101225

Byun, T., and Lee, G. (2014). Why students still can't solve physics problems after solving over 2000 problems. *American Journal of Physics*, *82*(9), 906-913. https://doi.org/10.1119/1.4881606

Chaojing, M. (2023). A study on strategies for cultivating higher-order thinking skills in primary and secondary school students. *Frontiers in Educational Research*, *6*(20), 67-71.

Chi, M. T. (2009). Active-constructive-interactive: a conceptual framework for differentiating learning activities. *Topics in Cognitive Science*, *1*(1), 73-105. https://doi.org/10.1111/j.1756-8765.2008.01005.x

Dang, H. T. T., Thi Bui, D., and Nhan, T. T. (2023). Enhancing creativity in secondary school mathematics: A quasi-experimental, mixed methods study in Vietnam. *Issues in Educational Research*, *33*(2), 488-509.

Denervaud, S., Christensen, A. P., Kenett, Y. N., and Beaty, R. E. (2021). Education shapes the structure of semantic memory and impacts creative thinking. *NPJ Science of Learning*, *6*(1), Article 35. https://doi.org/10.1038/s41539-021-00113-8

Dobber, M., Zwart, R., Tanis, M., and van Oers, B. (2017). Literature review: The role of the teacher in inquiry-based education. *Educational Research Review*, *22*, 194-214.

Elias, L. C. D., Marturano, E. M., Motta, A. M. D., and Giurlani, A. G. (2003). Treating boys with low school achievement and behavior problems: Comparison of two kinds of intervention. *Psychological Reports*, *92*(1), 105-116. https://doi.org/10.2466/PR0.92.1.105-116

Erdem, C. (2022). A comparative meta-analysis of the effects of problem-based learning model on K-12 students' cognitive outputs. *Educational Studies, 50* (6), 1498-1519. https://doi.org/10.1080/03055698.2022.2103650

Ertmer, P., and Simons, K. (2006). Jumping the PBL Implementation Hurdle: Supporting the Efforts of K–12 Teachers. *Interdisciplinary Journal of Problem-based Learning*, *1*. https://doi.org/10.7771/1541-5015.1005

Fan, L. J., and Sun, L. (2024). Associations between personality, creative thinking and learning, self-efficacy and academic achievement: a cross-sectional survey of coaches in Chinese art schools. *Kybernetes*. https://doi.org/10.1108/K-04-2024-0904

Gholam, A. P. (2019). Inquiry-based learning: Student teachers' challenges and perceptions. *Journal of Inquiry and Action in Education*, *10*(2), 6.

Ginsburg-Block, M. D., and Fantuzzo, J. W. (1998). An evaluation of the relative effectiveness of NCTM standards-based interventions for low-achieving urban elementary students. *Journal of Educational Psychology*, *90*(3), 560-569. https://doi.org/10.1037/0022-0663.90.3.560

Gorbunova, A., van Merrienboer, J. J. G., and Costley, J. (2023). Are Inductive Teaching Methods Compatible with Cognitive Load Theory? *Educational Psychology Review*, *35*(4), Article 111. https://doi.org/10.1007/s10648-023-09828-z

Güllühan, N. U. (2021). Social Problem-Solving Activities in The Life Skills Course: Do Primary School Students Have Difficulty Solving Daily Life Problems? *Egitim ve Bilim – Education and Science*, *46*(207), 63-84. https://doi.org/10.15390/EB.2021.9396

Guven, B., and Cabakcor, B. O. (2013). Factors influencing mathematical problem-solving achievement of seventh grade Turkish students. *Learning and Individual Differences*, *23*, 131-137. https://doi.org/10.1016/j.lindif.2012.10.003

Hằng, N. V. T. (2025). Educating Vietnamese primary students about creativity competency through teaching theme-based lessons. *Pastoral Care in Education*, 1-26. https://doi.org/10.1080/02643944.2025.2470842

Hmelo-Silver, C. E. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, *16*(3), 235-266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

Hoang, V. V. (2023). Interpreting MoET's 2018 General Education English Curriculum. *VNU Journal of Foreign Studies*, *38*, 1-22. https://doi.org/10.25073/2525-2445/vnuf.4866

Jonassen, D. (2010). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge. https://doi.org/10.4324/9780203847527

Kalyuga, S. (2007). Expertise Reversal Effect and Its Implications for Learner-Tailored Instruction. *Educational Psychology Review*, *19*(4), 509-539. https://doi.org/10.1007/s10648-007-9054-3

Kanbay, Y., and Okanli, A. (2017). The effect of critical thinking education on nursing students' problem-solving skills. *Contemporary Nurse*, *53*(3), 313-321. https://doi.org/10.1080/10376178.2017.1339567

Kanfer, R. (1990). Motivation and individual differences in learning: An integration of developmental, differential and cognitive perspectives. *Learning and Individual Differences*, *2*(2), 221-239. https://doi.org/https://doi.org/10.1016/1041-6080(90)90023-A

Karabay, F. H., and Meşe, C. (2024). The effect of mobile scaffolding on academic achievement and cognitive load of third grade students in mathematical problem solving. *Asia Pacific Education Review*, *26*, 227-246. https://doi.org/10.1007/s12564-024-09951-8

Kim, S., Chung, K., and Yu, H. (2013). Enhancing Digital Fluency through a Training Program for Creative Problem Solving Using Computer Programming. *Journal of Creative Behavior*, *47*(3), 171-199. https://doi.org/10.1002/jocb.30

Kim, Y. S., Al Otaiba, S., and Wanzek, J. (2015). Kindergarten predictors of third grade writing. *Learning and Individual Differences*, *37*, 27-37. https://doi.org/10.1016/j.lindif.2014.11.009

Kirschner, P., Sweller, J., and Clark, R. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*, *41*. https://doi.org/10.1207/s15326985ep4102_1

Kopp, B., Hasenbein, M., and Mandl, H. (2014). Case-based learning in virtual groups - collaborative problem solving activities and learning outcomes in a virtual professional training course. *Interactive Learning Environments*, *22*(3), 351-372. https://doi.org/10.1080/10494820.2012.680964

Letina, A., and Kegel, L. (2024). Learning and Teaching Historical Content in Primary Education. *Journal of Elementary Education*, *17*(3), 259-274.

Lin, C. Y., and Cho, S. (2011). Predicting Creative Problem-Solving in Math From a Dynamic System Model of Creative Problem Solving Ability. *Creativity Research Journal*, *23*(3), 255-261. https://doi.org/10.1080/10400419.2011.595986

Lin, Y. N., Hsia, L. H., and Hwang, G. J. (2025). Developing students' creative problem-solving strategies in the context of blended sports education. *British Journal of Educational Technology, 56(1),* 190-207. https://doi.org/10.1111/bjet.13495

Mangtani, A. J. (2024). Pedagogical, andragogical, and heutagogical approaches. In *Instructional Design Unleashed: Unlocking Professional Learning Potential with UX, Agile and AI Methods* (pp. 155-250). Springer.

MOET. (2018). *Chương trình tổng thể Chương trình giáo dục phổ thông 2018 (General Framework of the General Education Curriculum 2018).* Retrieved from https://moet.gov.vn/tintuc/Pages/CT-GDPT-Tong-The.aspx?ItemID=8421

Mumford, M. D., Supinski, E. P., Baughman, W. A., Costanza, D. P., and Threlfall, K. V. (1997). Process-based measures of creative problem-solving skills .5. Overall prediction. *Creativity Research Journal*, *10*(1), 73-85. https://doi.org/10.1207/s15326934crj1001_8

Murawski, L. M. (2014). Critical Thinking in the Classroom…and Beyond. *Journal of Learning in Higher Education*, *10*(1), 25-30.

Nguyen, H.-N., Nguyen, H.-D., and Ta, T.-T. (2024). Enhancing technology competence among primary students through STEAM lessons applying the design thinking process. *Journal of Elementary Education*, *17*(2), 189-207.

Niu, W. H., Cheng, L., Duan, D. A., and Zhang, Q. Y. (2022). Impact of Perceived Supportive Learning Environment on Mathematical Achievement: The Mediating Roles of Autonomous Self-Regulation and Creative Thinking. *Frontiers in Psychology*, *12*, Article 781594. https://doi.org/10.3389/fpsyg.2021.781594

Noh, Y. (2017). A study of the effects of library creative zone programs on creative thinking abilities. *Journal of Librarianship and Information Science*, *49*(4), 380-396. https://doi.org/10.1177/0961000616650933

Orakci, S. (2023). Structural relationship among academic motivation, academic self-efficacy, problem solving skills, creative thinking skills, and critical thinking skills. *Psychology in the Schools*, *60*(7), 2173-2194. https://doi.org/10.1002/pits.22851

Ozdem-Yilmaz, Y., and Bilican, K. (2020). Discovery Learning—Jerome Bruner. In B. Akpan and T. J. Kennedy (Eds.), *Science Education in Theory and Practice: An Introductory Guide to Learning Theory* (pp. 177-190). Springer International Publishing. https://doi.org/10.1007/978-3-030-43620-9_13

Piaget, J. (1970). *Science of Education and the Psychology of the Child.* Orion.

Ramos Salazar, L., and Hayward, S. (2018). An Examination of College Students' Problem-Solving Self-Efficacy, Academic Self-Efficacy, Motivation, Test Performance, and Expected Grade in Introductory-Level Economics Courses. *Decision Sciences Journal of Innovative Education*, *16*. https://doi.org/10.1111/dsji.12161

Redifer, J. L., Bae, C. L., and Zhao, Q. (2021). Self-efficacy and performance feedback: Impacts on cognitive load during creative thinking. *Learning and Instruction*, *71*, Article 101395. https://doi.org/10.1016/j.learninstruc.2020.101395

Rodríguez-Fornells, A., and Maydeu-Olivares, A. (2000). Impulsive/careless problem solving style as predictor of subsequent academic achievement. *Personality and Individual Differences*, *28*(4), 639-645. https://doi.org/10.1016/S0191-8869(99)00127-0

Roediger, H. L., 3rd, and Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, *15*(1), 20-27. https://doi.org/10.1016/j.tics.2010.09.003

Rosen, Y., Stoeffler, K., and Simmering, V. (2020). Imagine: Design for Creative Thinking, Learning, and Assessment in Schools. *Journal of Intelligence*, *8*(2), Article 16. https://doi.org/10.3390/jintelligence8020016

Sebastian, J., and Huang, H. (2016). Examining the relationship of a survey based measure of math creativity with math achievement: Cross-national evidence from PISA 2012. *International Journal of Educational Research*, *80*, 74-92. https://doi.org/10.1016/j.ijer.2016.08.010

Segundo-Marcos, R., Carrillo, A. M., Fernández, V. L., and González, M. T. D. (2023). Age-related changes in creative thinking during late childhood: The contribution of cooperative learning. *Thinking Skills and Creativity*, *49*, Article 101331. https://doi.org/10.1016/j.tsc.2023.101331

Song, Y., Lee, Y., and Lee, J. (2022). Mediating effects of self-directed learning on the relationship between critical thinking and problem-solving in student nurses attending online classes: A cross-sectional descriptive study. *Nurse Education Today*, *109*, Article 105227. https://doi.org/10.1016/j.nedt.2021.105227

Stark, R., Gruber, H., Renkl, A., and Mandl, H. (1998). Instructional effects in complex learning: Do objective and subjective learning outcomes converge? *Learning and Instruction*, *8*(2), 117-129. https://doi.org/10.1016/S0959-4752(97)00005-4

Stefanou, C., and Parkes, J. (2003). Effects of Classroom Assessment on Student Motivation in Fifth-Grade Science. *The Journal of Educational Research*, *96*(3), 152-162. https://doi.org/10.1080/00220670309598803

Sung, E. (2017). The influence of visualization tendency on problem-solving ability and learning achievement of primary school students in South Korea. *Thinking Skills and Creativity*, *26*, 168-175. https://doi.org/10.1016/j.tsc.2017.10.007

Thu, H. N. T., Kim, P. D. T., and Le Thi, D. (2024). Using Problem-Based Situations in Teaching for Elementary School Students: A Study on the Vietnamese Curriculum. *European Journal of Social Sciences Studies*, *9*(5).

Tran, T., Nguyen, C., and Nguyen, L. (2022). *Educational Innovation in Vietnam: Opportunities and Challenges of the Fourth Industrial Revolution*. https://doi.org/10.4324/9781003202424

van Hooijdonk, M., Mainhard, T., Kroesbergen, E. H., and van Tartwijk, J. (2020). Creative problem solving in primary education: Exploring the role of fact finding, problem finding, and solution finding across tasks. *Thinking Skills and Creativity*, *37*. https://doi.org/10.1016/j.tsc.2020.100665

Van Quang, N. (2023). Developing problem-solving and creativity skills in high school students through chemistry teaching in Vietnam: Current status and solution. *International Journal of Multidisciplinary Research and Growth Evaluation*, *4*(6), 321-327.

Vygotsky, L. S. (1978). *Mind in Society Development of Higher Psychological Processes*. Harvard University Press. https://doi.org/10.2307/j.ctvjf9vz4

Wang, Y.-P. (2021). Effects of Online Problem-Solving Instruction and Identification Attitude Toward Instructional Strategies on Students' Creativity. *Frontiers in Psychology*, *12*, 771128. https://doi.org/10.3389/fpsyg.2021.771128

Wijekumar, K., Meyer, B. J. F., Lei, P. W., Lin, Y. C., Johnson, L. A., Spielvogel, J. A., and Shurmatz, K. M. (2014). Multisite Randomized Controlled Trial Examining Intelligent Tutoring of Structure Strategy for Fifth-Grade Readers. *Journal of Research on Educational Effectiveness*, *7*(4), 331-357. https://doi.org/10.1080/19345747.2013.853333

Worwood, M., and Plucker, J. A. (2017). Domain Generality and Specificity in Creative Design Thinking. In F. Darbellay, Z. Moody, & T. Lubart (Eds.), *Creativity, Design Thinking and Interdisciplinarity* (pp. 83-97). Springer Singapore. https://doi.org/10.1007/978-981-10-7524-7_6

Xu, E., Wang, W., and Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications*, *10*(1), 16. https://doi.org/10.1057/s41599-023-01508-1

Yang, J., and Zhao, X. H. (2021). The effect of creative thinking on academic performance: Mechanisms, heterogeneity, and implication. *Thinking Skills and Creativity*, *40*, Article 100831. https://doi.org/10.1016/j.tsc.2021.100831

Yang, X. T., Zhang, M. M., Zhao, Y. H., Wang, Q., and Hong, J. C. (2022). Relationship between creative thinking and experimental design thinking in science education: Independent or related. *Thinking Skills and Creativity*, *46*, Article 101183. https://doi.org/10.1016/j.tsc.2022.101183

Yang, Y. T. C. (2015). Virtual CEOs: A blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students. *Computers & Education*, *81*, 281-295. https://doi.org/10.1016/j.compedu.2014.10.004

Zhang, D., and Hwang, G. J. (2023). Effects of Interaction between Peer Assessment and Problem-Solving Tendencies on Students' Learning Achievements and Collaboration in Mobile Technology-Supported Project-Based Learning. *Journal of Educational Computing Research*, *61*(1), 208-234, Article 07356331221094250. https://doi.org/10.1177/07356331221094250

Zhang, Y., Paquette, L., Bosch, N., Ocumpaugh, J., Biswas, G., Hutt, S., and Baker, R. S. (2022). The evolution of metacognitive strategy use in an open-ended learning environment: Do prior domain knowledge and motivation play a role? *Contemporary Educational Psychology*, *69*, 102064. https://doi.org/https://doi.org/10.1016/j.cedpsych.2022.102064

Authors:

Pham Ngoc Thien Nguyen, PhD
Lecturer, Faculty of Education, An Giang University (VNU-HCM), No. 18 Ung Van Khiem Street, Long Xuyen, An Giang, Vietnam, e-mail: npnthien@agu.edu.vn
Predavatelj, Pedagoška fakulteta, Univerza An Giang (VNU-HCM), št. 18 Ung Van Khiem Street, Long Xuyen, An Giang, Vietnam, e-pošta: npnthien@agu.edu.vn

Khanh-Trinh Tran, MA
Lecturer, Faculty of Education, An Giang University (VNU-HCM), No. 18 Ung Van Khiem Street, Long Xuyen, An Giang, Vietnam, e-mail: tktrinh@agu.edu.vn
Predavatelj, Pedagoška fakulteta, Univerza An Giang (VNU-HCM), št. 18 Ung Van Khiem Street, Long Xuyen, An Giang, Vietnam, e-pošta: tktrinh@agu.edu.v

Giam Buu Le, BA
Teacher, Tan Thanh 2 Primary School, Lai Vung District, Dong Thap Province, Vietnam, e-mail: lbgiam.c1tanthanh2@laivung.edu.vn
Učitelj, osnovna šola Tan Thanh 2, okrožje Lai Vung, provinca Dong Thap, Vietnam, e-naslov: lbgiam.c1tanthanh2@laivung.edu.vn