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Integration of Creative Problem Solving and Deep Learning in Physics Education to Support SDG-4 Quality Education: A Systematic Literature Review

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Abstract: Physics education in the 21st century requires learning approaches that promote creative thinking and problem-solving skills while fostering meaningful understanding. This study aims to analyze the integration of the Creative Problem Solving (CPS) model and the deep learning approach (as a pedagogical strategy emphasizing conceptual understanding rather than artificial intelligence) in physics education. This study employed a Systematic Literature Review (SLR) method following the PRISMA guidelines. A total of 124 articles published between 2018 and 2025 were identified from the SINTA and Scopus databases, of which 8 articles met the inclusion and quality criteria. The results indicate that the CPS model is effective in enhancing creative thinking skills, problem-solving abilities, and conceptual understanding in physics learning, while the deep learning approach strengthens conceptual understanding through meaningful and reflective learning processes. Furthermore, the integration of CPS and deep learning demonstrates potential in facilitating structured problem-solving processes supported by deeper conceptual engagement. In conclusion, the integration of CPS and deep learning can improve the quality of physics learning and contribute to the achievement of SDG 4 (Quality Education) by promoting higher-order thinking skills and meaningful learning experiences.

Keywords: Creative problem solving; Deep learning; Physics; 21st century skills

Introduction

Quality education is one of the primary goals of the Sustainable Development Goals (SDGs), particularly SDG 4, which emphasizes the importance of inclusive, equitable, and high-quality education as well as lifelong learning opportunities for all (Edwards et al., 2024). In this context, education is not only concerned with access but also with the quality of learning processes and the achievement of competencies relevant to global needs. However, challenges in achieving quality education remain significant, especially in terms of disparities in learning quality across regions and social groups worldwide (González García et al., 2020).

In the 21st century, education is expected to equip students with higher-order thinking skills such as critical thinking, creativity, and problem-solving. These skills are essential as students are increasingly confronted with complex problems that require analytical and innovative solutions. The OECD also highlights that creativity and critical thinking are key competencies that must be developed in modern education to respond to dynamic global changes (OECD, 2019).

In the context of physics education, these challenges become more complex because physics is often perceived as an abstract and difficult subject. Furthermore, physics instruction in schools is still

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largely dominated by teacher-centered approaches and procedural problem-solving. This condition limits students' ability to develop deep conceptual understanding and to connect physics concepts with real-life phenomena. Previous studies indicate that students frequently experience misconceptions and difficulties in understanding physics concepts at a conceptual level (Krijtenburg-Lewerissa et al., 2020).

As a result, students' creative thinking and problem-solving skills in physics learning remain relatively low. Students tend to solve problems based on given examples without fully exploring alternative ideas (Krijtenburg-Lewerissa et al., 2020). This situation reflects a gap between the demands of 21st-century skills and current classroom practices. Therefore, there is a need for learning approaches that not only enhance problem-solving skills but also promote deep and meaningful conceptual understanding (Ena et al., 2025).

One approach that can be applied is Creative Problem Solving (CPS). CPS is a learning model that emphasizes both divergent and convergent thinking processes to generate multiple solution alternatives (Isaksen et al., 2023). Research has shown that the implementation of CPS can significantly improve students' creativity and problem-solving abilities (Hwang et al., 2020).

However, the implementation of CPS needs to be supported by an approach that strengthens conceptual understanding. In this regard, the deep learning approach becomes relevant (Ramadona, 2021). In the context of education, deep learning refers to a learning process that emphasizes conceptual understanding, knowledge integration, and reflective thinking, rather than artificial intelligence (Biggs, 2003). This approach has been shown to have a positive relationship with improvements in students' learning outcomes and conceptual understanding (Qiu et al., 2022).

Conceptually, the integration of Creative Problem Solving (CPS) and deep learning has the potential to create a more comprehensive learning process. CPS plays a role in developing creative thinking and problem-solving skills, while deep learning enhances the quality of conceptual understanding through meaningful learning. The integration of these two approaches has also been shown to improve students' higher-order thinking skills in various learning contexts (Hwang et al., 2020).

In the context of SDG 4, the integration of CPS and deep learning can serve as an effective strategy to improve the quality of education, particularly in physics learning. This approach not only supports the development of 21st-century skills but also contributes to more inclusive, relevant, and meaningful learning experiences for students (Affandy et al., 2024; Haris & Mahir, 2025; Prayogi & Verawati, 2024).

Despite the growing number of studies on CPS and deep learning, research that explicitly integrates these two approaches in physics education remains limited. Most studies tend to examine them separately, thus failing to provide a comprehensive understanding of their combined potential in improving the quality of physics learning. Therefore, a systematic study is needed to b an effort to support the achievement of SDG 4 (Quality Education). This study not only examines the effectiveness of each approach but also maps their conceptual relationship and integration potential in enhancing the quality of physics learning. Based on the above considerations, this study aims to analyze the integration of Creative Problem Solving (CPS) and deep learning in physics education through a Systematic Literature Review, as well as to examine its contribution to achieving SDG 4 (Quality Education).

Method

This study employed a Systematic Literature Review (SLR) approach following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Tricco et al., 2018). The purpose of this study was to identify, evaluate, and synthesize research related to the implementation of the Creative Problem Solving (CPS) model and the deep learning approach in physics education.

Data collection was conducted using the Publish or Perish (PoP) software by accessing the Scopus and SINTA databases. The search was performed using the keywords "Creative Problem Solving," "CPS model," "deep learning," and "physics learning." The selected articles were limited to publications from 2018 to 2025 and were sourced from reputable journals indexed in Scopus (Q1–Q4) and SINTA (S1–S4).

The article selection process followed the PRISMA flow, as illustrated in Figure 1. In the identification stage, a total of 124 articles were obtained. After removing duplicate records, 98 articles remained. During the screening stage, articles were selected based on titles and abstracts, resulting in 27 relevant articles. In the eligibility stage, a full-text review was conducted to assess the relevance and quality of the articles. Articles that did not meet the inclusion criteria, such as those not related to physics education or not classified as empirical studies, were excluded. As a result, 11 articles met all inclusion criteria and were included in the final analysis.

The inclusion criteria of this study consisted of empirical research focusing on the implementation of the CPS model or the deep learning approach in physics education, published in Scopus- or SINTA-indexed journals, and available in full-text format. Articles that were conceptual in nature, irrelevant to physics education, not indexed, or lacking clear descriptions of learning implementation were excluded.

Data analysis was conducted using descriptive and comparative approaches by examining research objectives, instructional design, physics content context, and main findings of each study. The analysis also focused on identifying patterns of implementation, similarities and differences among studies, and the potential integration of CPS and deep learning approaches in physics education. The results were then synthesized to construct a conceptual understanding of the integration between these two approaches.

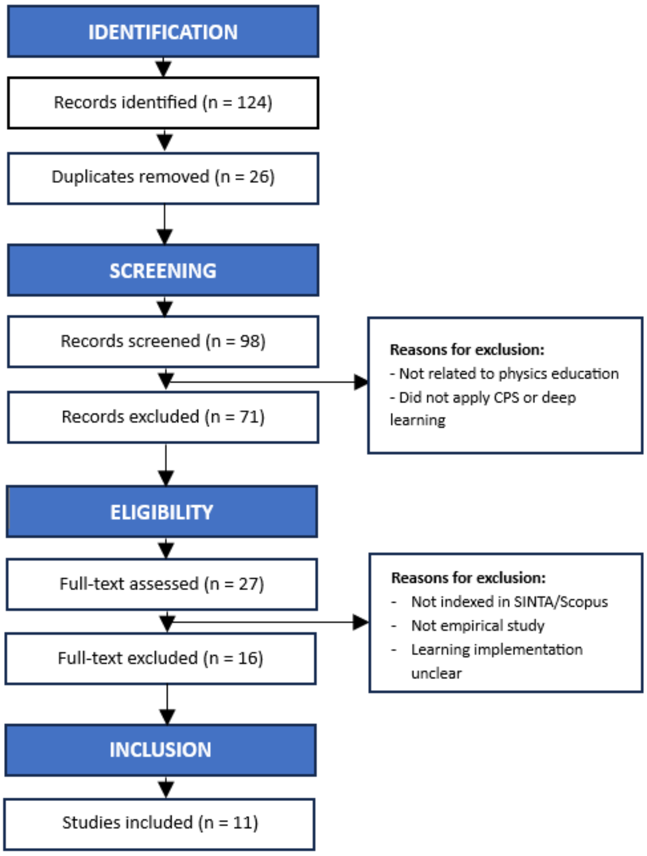

Figure 1. PRISMA diagram

Result and Discussion

RQ1: Publication Trends of CPS and Deep Learning

A total of 11 empirical articles published between 2018 and 2025 were analyzed in this study. These articles focused on the implementation of the Creative Problem Solving (CPS) model and the deep learning approach in physics education.

The results indicate that the selected articles are unevenly distributed across the years. In 2018, one article was identified, followed by an increase to two articles in 2020. No eligible articles were found in 2019, 2021, and 2022. The number of publications increased again in 2023 with two articles, followed by one article in 2024, and reached the highest number in 2025 with five articles. This trend reflects a growing research interest in recent years, particularly in 2025. The increase in publications indicates that the integration of CPS and deep learning is gaining attention in the development of physics learning oriented toward higher-order thinking skills.

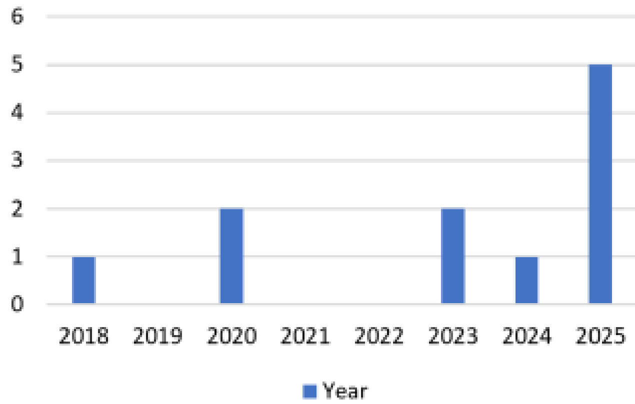

Figure 2. Annual publication

Most of the reviewed studies were conducted at the senior high school level, with one study conducted at the vocational level. This indicates that the implementation of CPS and deep learning is predominantly applied in secondary education contexts.

The characteristics of the reviewed articles, including the level of education, science topics, and research findings, are summarized in Table 1. Following Table 1, the findings reveal a clear pattern in the implementation of the CPS model and the deep learning approach in physics education. Most studies consistently demonstrate that CPS is effective in improving students' creative thinking and structured problem-solving skills. For instance, Syam et al. (2018), Ena et al.(2025) and Indraswati et al. (2020) report that CPS enhances students' ability to generate ideas and solve problems systematically, indicating its strong role in developing higher-order thinking skills.

Furthermore, CPS is not only implemented as a standalone model but is also frequently integrated with learning tools and media to enhance its effectiveness. Studies by Wiharza et al. (2020) and Ulfa et al. (2025) show that CPS-based learning tools and modules contribute to improving students' conceptual understanding and engagement. Similarly, Widya et al. (2023) demonstrate that CPS-based e-modules integrated with 21st-century skills significantly improve learning outcomes. This indicates that the effectiveness of CPS is strengthened when supported by appropriate instructional media.

Table 1. Characteristics of the Reviewed Articles and Summary of Research Findings

Author	Level	Science Topic	Research Result
Syam et al., (2018)	High School	Physics learning	The CPS model improved students' creative thinking skills in physics learning.
Wiharza & Fauzi, (2020)	High School	Dynamic fluid	CPS-based learning tools using the PQ4R strategy improved students' conceptual understanding.
(Hakiki & Fadli, 2020)	Vocational School	Physics learning	The CPS model improved students' learning outcomes in vocational education.
(Panergayo & Pelgone, 2023)	High School	Physics classroom practice	CPS-based instruction enhanced students' creativity and problem-solving skills.
(Xu et al., 2023)	High School	Momentum	Conceptual framework instruction supported knowledge integration and deep learning.
(Widya et al., 2023.)	High School	Dynamic fluid	CPS-based e-modules integrated with 21st-century skills significantly improved students' learning outcomes and skills mastery.
(Dewi et al., 2024)	High School	Static fluid	The CPS model significantly improved students' scientific creativity.
(Ena et al., 2025)	High School	Sound waves	The CPS model significantly improved students' creative thinking skills in physics learning.
(Taufik et al., 2025)	Mixed Level	Sound waves	Deep learning-based PjBL showed a high effect size (d = 0.88) in improving students' scientific and critical thinking skills.
(Ulfa et al., 2025)	High School	Physics module development	CPS-based modules were valid and effective in improving students' creative thinking skills.
(Hidayatullah et al., 2025)	High School	Force and motion	PhET-assisted deep learning improved students' problem-solving skills.

In addition, the findings also show that CPS is effective across various physics topics, including dynamic fluid, static fluid, and sound waves, indicating its adaptability in different learning contexts. Furthermore, studies such as Hakiki et al. (2020) demonstrate that CPS also contributes to improving students' learning outcomes, including in vocational education settings. This suggests that the effectiveness of CPS is not limited to academic contexts but can also be applied in practical and technical learning environments.

In contrast, studies on deep learning highlight its role in promoting deeper conceptual understanding and knowledge integration. Xu et al. (2023) emphasize that conceptual framework-based instruction supports meaningful learning and knowledge integration, while Hidayatullah et al. (2025) show that simulation-assisted deep learning enhances students' problem-solving abilities. These findings suggest that deep learning is particularly effective in strengthening the quality of conceptual understanding and reflective thinking processes.

Overall, the results indicate a complementary relationship between CPS and deep learning. CPS primarily contributes to the development of creative thinking and structured problem-solving processes, whereas deep learning strengthens conceptual understanding and knowledge integration. This distinction suggests that the integration of both approaches is essential to create a more comprehensive learning process that combines procedural problem solving with meaningful conceptual understanding. These findings imply that the effectiveness of physics learning can be maximized by combining CPS as a structured problem-solving framework with deep learning as a conceptual reinforcement approach.

RQ2: Integration of CPS and Deep Learning

The synthesis of the 11 reviewed articles indicates that the Creative Problem Solving (CPS) model and the deep learning approach have complementary characteristics and can be integrated into a coherent instructional framework in physics education. The proposed integration model is presented in Figure 3.

The integration demonstrates a systematic relationship between the stages of CPS and the processes of deep learning. In the initial stage of CPS, namely understanding the challenge, students are guided to identify and comprehend the problem. This stage aligns with the understanding phase in deep learning, where students construct meaningful conceptual knowledge through active engagement and prior knowledge activation.

In the next stage, generating ideas, students are encouraged to explore multiple solution alternatives. This stage corresponds to the applying phase in deep learning, as students begin to use their conceptual understanding to propose and test possible solutions. The process promotes active participation and supports meaningful learning experiences.

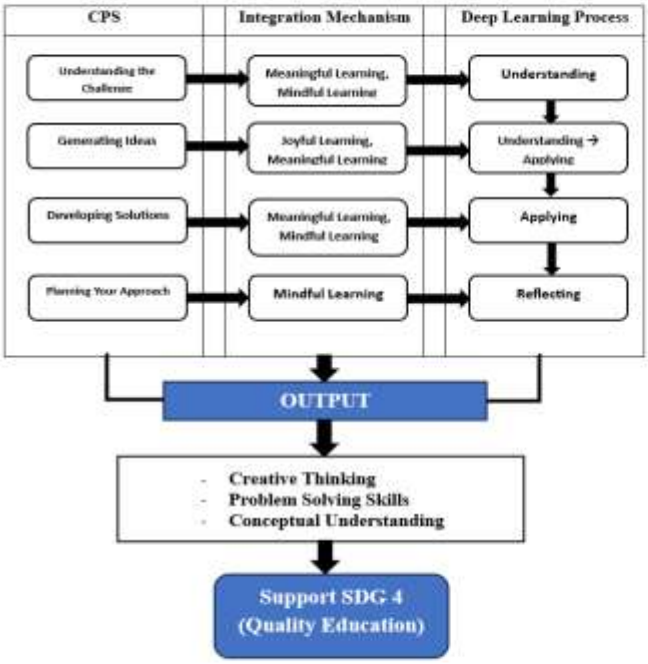

Figure 3. Integration model of CPS and deep learning

The developing solutions stage involves analyzing and selecting the most appropriate solution based on scientific reasoning. At this stage, the applying process becomes more complex, as students integrate conceptual knowledge with problem-solving strategies. This stage strengthens students' ability to apply physics concepts in different contexts. Finally, the planning your approach stage is closely related to the reflecting phase in deep learning. In this stage, students evaluate their solutions, reflect on the learning process, and connect their understanding to broader contexts. Reflection plays a crucial role in reinforcing conceptual understanding and enabling knowledge transfer.

The relationship between these stages forms a structured and layered learning process. CPS provides a procedural framework that guides students through problem-solving steps, while deep learning ensures that each step involves meaningful understanding, application, and reflection. This integration creates a balanced learning process that combines cognitive structure and conceptual depth. Based on this integration, a clear learning pattern can be identified. CPS facilitates the development of creative thinking and systematic problem-solving, whereas deep learning strengthens conceptual understanding and knowledge integration. The combination of these approaches results in improved higher-order thinking skills, including creativity, problem-solving ability, and conceptual mastery.

Therefore, the integration of CPS and deep learning is not merely theoretical but represents an operational instructional model that can be applied in physics learning. This model supports meaningful learning and contributes to the development of students' competencies in line with the goals of SDG 4, particularly in enhancing the quality of education through higher-order thinking skills.

Conclusion

The synthesis of the reviewed studies shows that CPS is most effective in enhancing creative thinking and structured problem-solving processes across various physics topics, including dynamic fluid, static fluid, and sound waves. CPS is also effective when integrated with learning media, such as e-modules and instructional tools, which further improve students' learning outcomes and engagement. In contrast, the deep learning approach is particularly effective in strengthening conceptual understanding and knowledge integration, especially when supported by instructional strategies such as conceptual frameworks and simulation-based learning. Furthermore, the integration of CPS and deep learning forms a complementary instructional model in which CPS provides a structured problem-solving framework, while deep learning ensures meaningful understanding through processes of understanding, applying, and reflecting. This integration results in a more comprehensive learning process that supports both procedural and conceptual aspects of physics learning. However, this study has several limitations. First, the number of selected articles is relatively limited, which may not fully represent all research related to CPS and deep learning integration. Second, most studies were conducted at the senior high school level, limiting the generalizability of the findings to other educational levels. Third, variations in research design, learning implementation, and physics topics across studies may influence the consistency of the results. Based on these findings, future research is recommended to explore the implementation of CPS and deep learning integration across different educational levels and a wider range of physics topics. Further studies are also needed to develop and validate instructional models that explicitly integrate CPS stages with deep learning processes. In addition, longitudinal research is suggested to examine the long-term impact of this integration on students' learning outcomes and higher-order thinking skills.

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Author Contributions

Conceptualization, MRC and EP.; methodology, MRC; validation, EP. and S.; formal analysis, MRC; investigation, MRC; resources, MRC; data curation, MRC; writing—original

draft preparation, Monika Ruth Cahayana; writing—review and editing, MRC; visualization, MRC. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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