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Trends in the Use of Creative Thinking Skills in Physics Education (2015-2024): A Systematic Literature Review

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Abstract

This study aims to investigate the trends and efforts to enhance creative thinking skills in physics education through a systematic literature review (SLR). While various instructional models have been implemented, empirical evidence regarding creative thinking in the Indonesian physics context remains fragmented, and previous reviews often lack a specific focus on national indexing trends. Adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, this study systematically screened articles from the Science and Technology Index (SINTA) database. The selection process used the search string 'creative thinking skills in physics education' and was guided by five inclusion criteria: SINTA 2-4 indexing, a publication timeframe of 2015-2024, a focus on creative thinking as the primary construct, journal article format, and open access availability. From an initial identification of 91 articles, the screening and eligibility stages based on titles, abstracts, and content suitability resulted in a final set of 51 analyzed articles. The findings indicate that the Project-Based Learning (PjBL) model (27%) and Problem-Based Learning (PBL) model (25%) were the most predominant strategies used to foster creative thinking. Quantitative methods with quasi-experimental designs emerged as the most frequently employed research approach (41%), reflecting a strong emphasis on empirical validation. Research peaked in 2023 with 14 publications, with 'Temperature and Heat' being the most investigated topic among Grade 10 students. This study contributes a strategic roadmap for educators to implement innovative models and identifies a need for more qualitative insights into the creative processes in physics education.

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INTRODUCTION

In the contemporary educational landscape, cultivating creative thinking skills is paramount, driven by rapid technological integration and the imperative to equip students with essential 21st-century competencies. According to a report from the World Economic Forum, critical and creative thinking skills are among the most sought-after abilities in the global labor market (Kristiani et al., 2017; Jardim, 2021; Keane & Yeow, 2023). Creative thinking, critical thinking, communication, and collaboration form the essential foundation

across various fields, including education (Yulianci et al., 2021; Habib et al., 2025). In Indonesia, the educational curriculum has begun to integrate approaches that emphasize the development of creative thinking skills in learning, including physics (Setiawati, 2024; Mamluah, 2023; Saadah et al., 2019). Creative thinking skills enable students to develop imagination, think flexibly, and generate original ideas that can be applied to problem-solving in physics (Huda et al., 2023; Viyanti et al., 2022; Ratnasusanti et al., 2018). However, despite efforts to integrate these skills, many students still demonstrate low levels of creative thinking abilities in the context of physics education (Basyir et al., 2020; Djupanda et al., 2015; Batlolona & Diantoro, 2023).

The main issue faced in the development of creative thinking skills in physics classrooms is the lack of effective and relevant teaching methods. Research shows that many teachers still use traditional approaches that do not encourage students to think creatively (Kurniawan & Yanti, 2022; Medriati & Risdianto, 2020; Fayanto et al., 2024). Additionally, the lack of training for teachers in developing and implementing appropriate assessment tools to measure students' creative thinking skills is also a challenge (Kassi et al., 2021; Wang, 2019). Existing literature suggests that while initiatives to foster creative thinking via PjBL and PBL have been implemented, the empirical evidence remains fragmented and inconclusive (Hendri & Sari, 2023; Trianggono, 2017).

The gap in research on creative thinking skills in physics education is also evident in the variation of the studied populations. Many studies focus solely on students at certain educational levels without considering broader contexts (Daeng Naba et al., 2024; Fajri, 2024; Mursidik et al., 2015). Moreover, the methodologies used in previous research are often not comprehensive enough to capture the complexities of creative thinking skills, and the literature review models employed have not been maximized (Nurmahudina et al., 2019; Mulyaningsih & Ratu, 2018). Consequently, further investigation is warranted to examine diverse pedagogical frameworks and contextual variables that effectively facilitate the cultivation of creative thinking skills within the domain of physics education.

This study aims to fill the existing gap by conducting a SLR focusing on the trends in the use of creative thinking skills in physics education from 2015 to 2024. Using the PRISMA model, this research will identify and analyze various relevant studies and evaluate the effectiveness of different approaches that have been applied (Liu et al., 2024; Putri, 2023; Sari et al., 2019; Wang, 2019). It is hoped that this study will provide new insights into best practices for developing creative thinking skills in physics classrooms, as well as offer recommendations for teachers and education policymakers.

The benefits of this research are both theoretical and practical. Theoretically, this study will enrich the existing literature on creative thinking skills within the context of physics education, providing a foundation for further research in this field (Lie, 2024; Priyambodo et al., 2021). Practically, the findings of this research are expected to be used by educators in designing more effective curricula and teaching methods to enhance students' creative thinking skills, preparing them better to face real-world challenges (Makiyah et al., 2020; Puspa et al., 2022). Therefore, this research is expected to make a significant contribution to the development of physics education in Indonesia and improve the quality of classroom learning.

This article outlines the results of a literature study on the trends in the use of creative thinking skills in physics education. It is a review of articles from research studies published in national journals indexed by the SINTA. The objective of this study is to thoroughly examine the following research questions:

Q1: How has the scholarly output regarding creative thinking skills evolved between 2015 and 2024, and what patterns characterize this research trajectory?

Q2: What are the predominant methodological approaches employed in investigating creative thinking skills within the field of physics education?

Q3: Which instructional frameworks are predominantly utilized to foster the enhancement of creative thinking skills within the context of physics education?
Q4: What are the primary thematic areas and core topics that have emerged in investigations of creative thinking skills within physics education?

Existing literature suggests that while initiatives to foster creative thinking via PjBL and PBL have been implemented, the empirical evidence remains fragmented and inconclusive. Previous review studies often focus broadly on science education or lack a specific focus on the Indonesian national context within a defined decade. The gap in research is also evident in the limited systematic evaluation of specific trends within SINTA-indexed journals. This study fills this gap by providing an SLR that specifically identifies the trajectory, predominant instructional frameworks, and research gaps in physics creative thinking skills from 2015 to 2024 using the PRISMA model.

METHODS

This study employed a systematic literature review design centered on creative thinking skills. The search was conducted in the SINTA database using the primary keyword 'creative thinking skills in physics education. Articles were systematically screened based on five inclusion criteria: (1) formally indexed in SINTA 2, 3, or 4; (2) published in the 2015-2024 time range; (3) specifically focused on creative thinking skills in physics; (4) published as a journal article (excluding proceedings); and (5) available for open access. The selection process followed the PRISMA framework as shown in Figure 2. In the identification stage, 91 articles were retrieved. During the screening stage, articles were selected based on title and abstract, resulting in 55 articles. In the eligibility stage, 4 articles were excluded because the physics material did not align with the focus, leaving 51 articles for further assessment. Finally, 51 articles were included for analysis, consisting of SINTA 2 (n=26), SINTA 3 (n=22), and SINTA 4 (n=3). After conducting the identification process, 16 relevant journals were found on the topic under investigation. The articles analyzed in this study, published between 2015 and 2024, focus on creative thinking skills in physics education. From these 16 reputable national journals, a total of 91 articles were retrieved, as detailed in Figure 1.

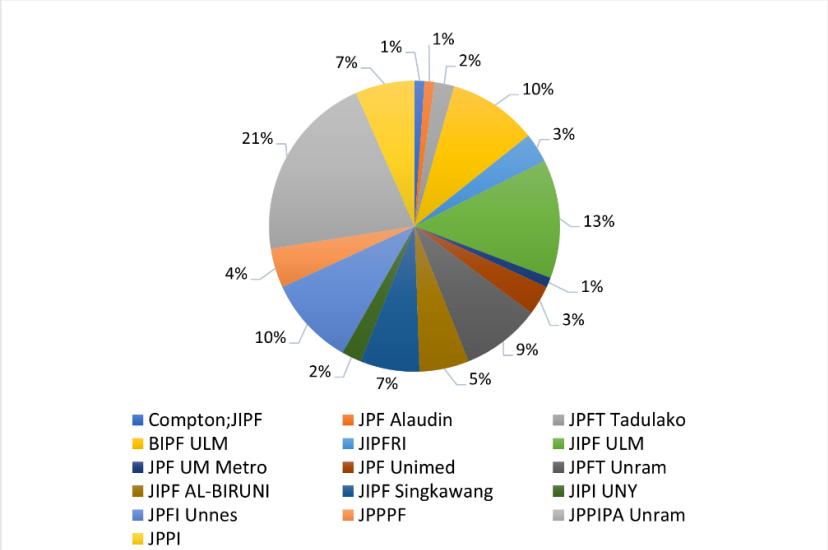

Figure 1 Distribution of article sources

This study adheres to the PRISMA framework, further refined by researcher-defined parameters. Articles were systematically screened for inclusion based on two primary criteria: (1) formal indexing within the SINTA database, and (2) a specific focus on creative thinking skills as the central construct within physics education. 3) The study must be

published as a journal article; 4) The article must not be a conference proceeding; 5) The article must be available for open access. The process of article selection using the PRISMA method is depicted in Figure 2.

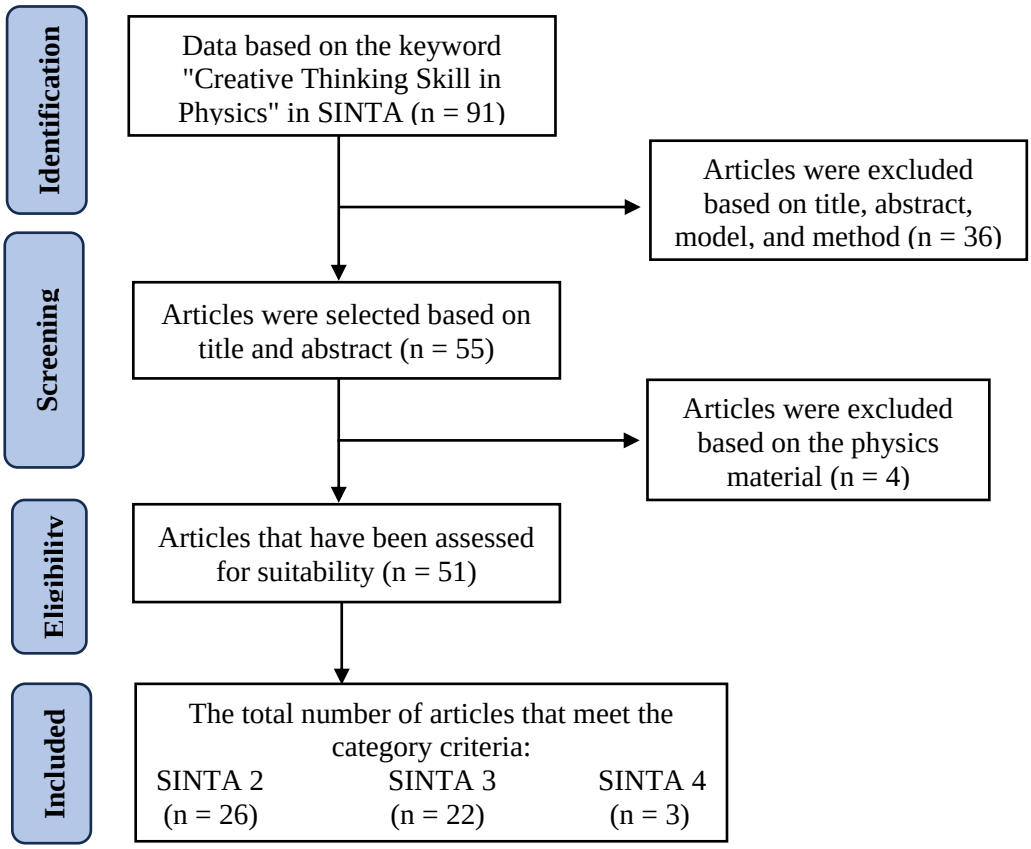

Figure 2 Article selection process using the PRISMA method

The data from each reviewed article were subsequently analyzed using several indicators that align with specific aspects meeting the criteria set by the reviewer. These indicators include the publication year, type of research, subjects, topics, learning models, research methods, and research outcomes. A bibliometric mapping of the correlation between titles and abstracts was performed using VOSviewer software, whereas other research indicators underwent rigorous manual examination. The synthesized data were subsequently organized into tables and visualized through line and bar charts to facilitate interpretation.

RESULTS AND DISCUSSION

The initial search conducted by the researcher resulted in 16 journals and 91 articles related to creative thinking skills. However, after applying the article screening process to meet the criteria required for physics education, 15 journals that met the criteria and 51 articles were selected. The finalized selection of articles is summarized in Table 1.

Table 1 Articles that fulfill the cet criteria

No	Author	Journal
1	Rahmawati et al., (2018)	Compton: JIPF
2	Nailufari et al., (2024)	JPF Alaudin Makassar
3	Rohman et al., (2021)	JPF Tadulako
4	Annisa & Salam (2017)	BIPF ULM
5	Zaky (2019)	BIPF ULM

No	Author	Journal
6	Julfitri et al., (2020)	BIPF ULM
7	Dewi et al., (2021)	BIPF ULM
8	Dewi et al., (2024)	BIPF ULM
9	Nazhifah et al., (2023)	JIPFRI
10	Sarah (2018)	JIPFRI
11	Meiarti (2021)	JIPFRI
12	Mubarok et al., (2022)	JIPF ULM
13	Azyyati & Sulisworo. (2022)	JIPF ULM
14	Hartiani et al., (2022)	JIPF ULM
15	Shaf et al., (2023)	JIPF ULM
16	Rosha et al., (2023)	JIPF ULM
17	Sutriyono et al., (2022)	JIPF ULM
18	Wati et al., (2024)	JPF UM Metro
19	Puji & Ridwan (2015)	JPF UNIMED
20	Utami et al., (2019)	JPF UNIMED
21	Mahmudah et al., (2022)	JPFT UNRAM
22	Gunada et al., (2019)	JPFT UNRAM
23	Kosim et al., (2023)	JPFT UNRAM
24	Fitriani & Gunawan (2017)	JPFT UNRAM
25	Sahidu & Ayub (2018)	JPFT UNRAM
26	Malik et al., (2019)	JIPF Al-Biruni
27	Khoiri et al., (2019)	JIPF Al-Biruni
28	Pratiwi et al., (2019)	JIPF Al-Biruni
29	Andi et al., (2021)	JIPF Singkawang
30	Wibowo & Ahmad., (2023)	JIPF Singkawang
31	Sumo et al., (2024)	JIPF Singkawang
32	Santofani & Rosana (2016)	JIPI UNY
33	Yarid & Ariswan (2016)	JIPI UNY
34	Marnita & Ernawati (2017)	JPFI UNNES
35	Hakim et al., (2017)	JPFI UNNES
36	Wartono et al., (2018)	JPFI UNNES
37	Amelia et al., (2021)	JPFI UNNES
38	Lestari et al., (2023)	JPPPF
39	Bakri et al., (2018)	JPPPF
40	Made & Mujayanah (2020)	JPPPF
41	Trisna & Rahmi (2016)	JPPPF
42	Nafiah et al., (2023)	JPPIPA
43	Ningrum & Jumadi (2024)	JPPIPA
44	Rabbani et al., (2023)	JPPIPA
45	Nilyani & Ratnawulan (2023)	JPPIPA
46	Saputri et al., (2023)	JPPIPA
47	Yanti et al., (2023)	JPPIPA
48	Iftitah et al., (2023)	JPPIPA
49	Feranie et al., (2023)	JPPIPA
50	Yulianci et al., (2021)	JPPIPA
51	Rosidin et al., (2023)	JPPIPA

The connections between the articles were established by examining their titles and abstracts. The analysis took into account a broad set of references, improving the efficiency of the cluster distribution. VOSviewer software was employed to visualize words that formed a network of interconnected nodes, which subsequently generated several clusters. Therefore, articles that shared similar terms with other articles were categorized into the same cluster, as shown in Figure 3.

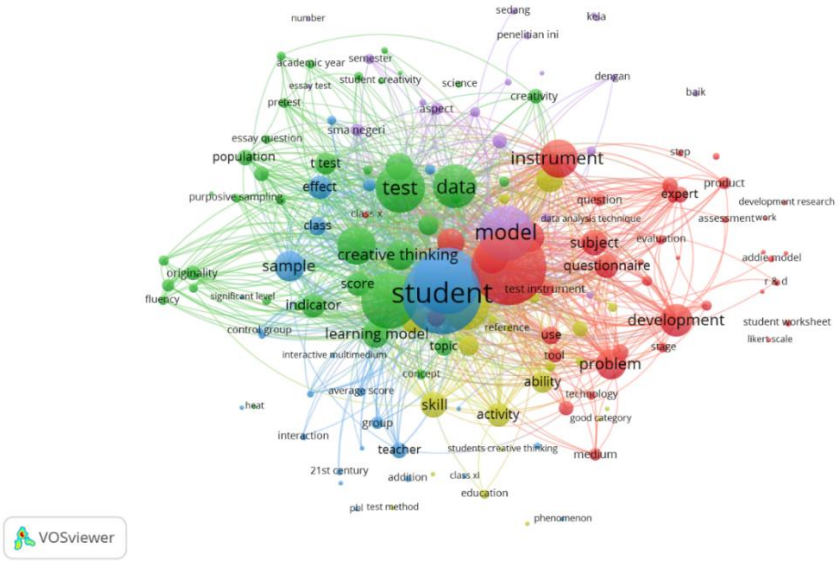

Figure 3 VOSviewer screenshot showing word interconnections

Based on the analysis results, 150 items/words were identified. Keywords representing the research were then selected and grouped into five color clusters: red, green, blue, yellow, and purple. Based on the thematic mapping illustrated in Figure 3, the specific keywords associated with each identified cluster are systematically detailed in Table 2.

Table 2 Thematic Categorization of Creative Thinking Research in Physics

Cluster Colors	Keywords in Clusters
Red	Research, value, instrument, analysis, question, subject, questionnaire, physics teacher, development, creative thinking ability, problem, high school student, value, use, tool, validity, test instrument, medium, assessment, R&D, product, validation sheet, learning process, expert validation, work, development research, valid criterion, feasibility, ADDIE model, likert scale, student worksheet, stage, electronic module, high category, learning, technology, step, class X,
Green	Creative thinking skill, test, data, pretest, posttest, population, concept, creativity, type, learning model, medium category, creative thinking, score, indicator, inquiry, significant differences, t-test, group pretest posttest design, purposive sampling, significance, sampling technique, elaboration, originality, flexibility, fluency, improvement, essay question, academic year, 21century skill, data collection, n-gain, student creativity, topic, heat.
Blue	Student, study, sample, class, effect, control group, difference, average score, group, teacher, 21 st century, control class, experimental class, research instrument, significant level, experimental group, interactive multimedium, interaction, hypothesis testing, discovery, PBL, addition, student creative thinking ability, research method, class XI.
Yellow	Physics, implementation, skill, activity, ability, observation, effectiveness, student creative thinking, form, increase, reference, project, influence, physics learning, science learning, good category, education, alternative, PJBL, test method, Sman.
Purple	Model, level, aspect, students, with, moderate, public senior high school, level, average, essay, semester, senior high school student, class, number, data analysis, this study, good, information, observation sheet, this study aims to.

The visualization in Figure 4 identifies five key concepts with a strong correlation: students, model, research, creative thinking skills, and tests. Further analysis shows that the concepts of students, models, and research have significant relationships with creative thinking skills. The concept of "students" refers to the subjects of the research, "model" denotes the approach employed in the study, and "tests" serve as the tools for assessing

creative thinking skills.

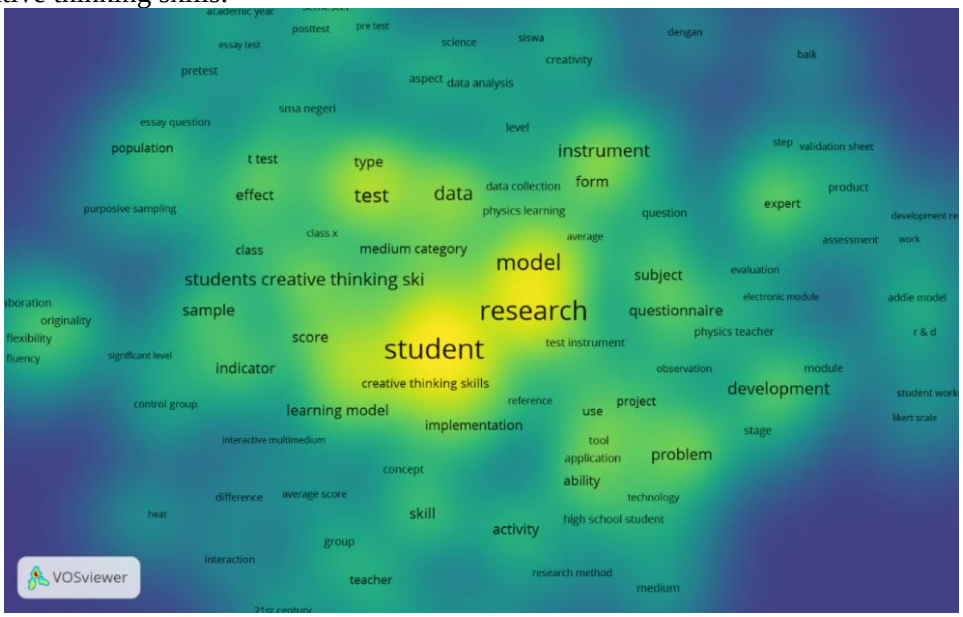

Figure 4 Vosviewer displaying density visualization

The mapping outcomes derived from title and abstract data in VOSviewer, as seen in Figure 4, were further validated through a systematic re-examination of the selected articles. This refined analysis offers a more comprehensive synthesis based on key variables, such as publication year, research methodology, participant demographics, instructional models, and core themes in physics education. The detailed evaluation of creative thinking skills is structured as follows.

Number of Publications

The volume of scholarly publications serves as a proxy for research intensity within a specific field. As illustrated in Figure 5, investigations into creative thinking skills within the Indonesian physics education context have been consistently documented since 2015. A significant upward trend is observed in 2023, with the number of publications reaching its peak at fourteen articles. This phenomenon indicates an increased interest among researchers in exploring creative thinking skills within the context of physics education. However, a decline in the number of publications is noted in the following year.

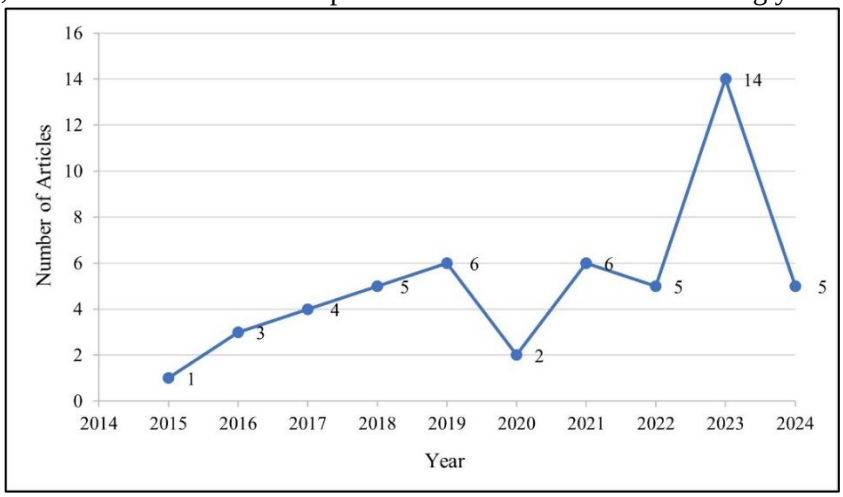

Figure 5 Distribution of publication years

The results of research are generally rooted in the researchers' sensitivity to common issues that frequently arise in their surroundings (Maharani, 2023). The motivation behind most studies is a response to contemporary issues that hold social relevance (Fajri, 2024). One significant challenge currently is the low level of creative thinking skills among Indonesian students (Prasetyo et al., 2021). Therefore, scientific research is considered an effective tool to address this challenge. Through research, academics can identify the most efficient pedagogical strategies and learning media to significantly enhance students' creative thinking skills (Pramesti, 2023). Thus, the increasing number of scientific publications focusing on creative thinking skills is expected to make a substantial contribution to the transformation of education in Indonesia (Fajri, 2024). This perspective aligns with the primary goal of research, which is to provide information and improvements to existing educational practices (Maharani, 2023).

Research Type

The research orientation is fundamentally shaped by the chosen methodological design. As delineated in Table 3, quantitative approaches emerge as the predominant methodology for investigating creative thinking skills, with 30 publications utilizing this framework. This trend aligns with extant literature, suggesting a prevailing preference for quantitative designs within educational inquiries, particularly in the domain of physics education (Setiawan & Musaffak, 2021; Nabilah & Jumadi, 2022). Thus, the growing preference for quantitative research in educational studies, especially in physics education, is evident and relevant.

Table 3 Distribution of articles on creative thinking skills in physics based on research method

Research Method	Total (n)
Quantitative	30
Qualitative	5
R & D	15
Mixed Method	1

Quantitative approaches emerge as the predominant methodology with 30 publications. This trend indicates that researchers prioritize empirical validation through quasi-experimental designs to compare the effectiveness of learning interventions. The implication for physics education is that while these results provide strong statistical evidence of improvement, there is a significant opportunity for future research to utilize qualitative or mixed-method designs to capture the deeper complexities of how students' creative thinking processes evolve.

Beyond identifying broad research categories, this study delineates the distribution of specific research designs, as systematically presented in Table 4, based on the methodological frameworks adopted in the reviewed literature. Table 4 reveals that quasi-experimental research designs are more prevalent than other designs, with a total of 21 published articles. In quasi-experimental studies, researchers aim to compare which intervention is most effective in improving creative thinking skills (Azizah, 2023). Previous studies also indicate that the quasi-experimental design is frequently used in educational contexts to evaluate the effectiveness of various learning interventions (Abraham & Supriyati, 2022). This highlights that this approach provides valuable insights into the impact of treatments on student learning outcomes.

Table 4 Distribution of articles on creative thinking skills in physics based on research design method

Research Method			Total (n)
Quantitative	Experimental	Quasi-Experimental	21
		Pre-Experimental	5
	Non-Experimental	Descriptive Quantitative	4

Research Method		Total (n)
Qualitative	Descriptive Qualitative	5
R & D	R&D Dick and Carey	3
	R&D ADDIE	2
	R&D Plomp's	2
	R&D 4D	4
	R&D Borg & Gall	3
	R&D Rowntree	1
Mixed Method	Embedded Design	1

Research Subjects

To empirically validate research hypotheses, the selection of appropriate participants is essential. As illustrated in Figure 6, tenth-grade high school students emerge as the most frequently targeted demographic in the analyzed studies. High school students are the predominant subject group in educational research (Damaskinidis, 2017). Figure 6 also highlights that university students are the least selected as research subjects. The word "students" is the third most frequently searched keyword in educational research (Sarpel et al., 2013). Previous studies also indicate that selecting students as research subjects is often prioritized due to their relevance to the educational context being studied (Damaskinidis, 2017).

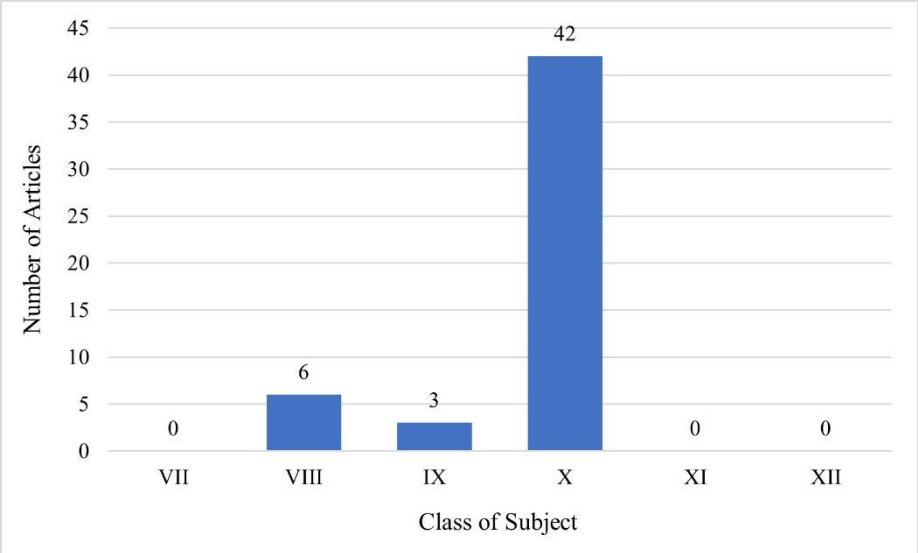

Figure 6 Distribution of articles on creative thinking skills in physics based on research subjects

Figure 6 not only presents a comparison of the distribution of research subjects across middle and high school levels but also reveals an interesting trend. There is a noticeable decline in the frequency of selecting higher-grade levels as research subjects, particularly in high school. This phenomenon suggests potential accessibility challenges for certain grade levels. Restrictive school policies, especially as final exams approach, often limit the selection of research subjects, particularly for grades XI and XII (Karlina et al., 2023).

Learning Models

The use of learning models implemented to enhance creative thinking skills is shown in Table 5. As evidenced in Table 5, Project-Based Learning (PjBL) emerges as the most prominent instructional framework for fostering creative thinking skills, accounting for 27% of the total, followed closely by Problem-Based Learning (PBL) at 25%. Creative thinking skills in the context of physics education refer to problem-based steps that utilize

project content, which is highly beneficial in achieving learning objectives. In technology-based learning, project-based models are often linked with the implementation of technology-based practical work. This model has the potential to enhance students' creativity, deepen their understanding, and increase their engagement in the learning process, as the learning activities are student-centered and allow them to connect practical work to real-life situations (Apriwanda & Hanri, 2022; Sari et al., 2017). Therefore, this model can foster the development of students' creative thinking skills.

Table 5 Distribution of articles on creative thinking skills in physics based on research design method

No	Learning Model	Total (n)	Percentage
1	Project-Based Learning (PJBL)	14	27%
2	Problem-Based Learning (PBL)	13	25%
3	Inquiry Learning	10	20%
4	Ethnoscience Learning	2	4%
5	Interactive Multimedia	2	4%
6	POGIL	1	2%
7	SFAE Model	1	2%
8	Cooperative Learning	1	2%
9	Causalistic Model	3	6%
10	Blended Learning	1	2%
11	C3PDR Model	1	2%
12	Discovery Learning	1	2%
13	Conceptual Understanding Procedures (CUPs)	1	2%

Physics Topics Selected for the Study

Physics is known as a challenging subject that many students find difficult and unappealing. The challenges students encounter in grasping physics concepts have been a major focus in educational research (Darmaji et al., 2021). As shown in Table 6, the researchers selected several topics for their studies. Regarding thematic distribution, temperature and heat emerged as the most investigated subject, being the primary focus of five scholarly publications. Analysis of Table 6 indicates that temperature and heat became a primary focus of research, likely due to a gap between students' mastery levels and curriculum expectations. The low levels of students' creative thinking skills on these topics (Fitriyani, 2022; Sudiarta, 2019). This gap has led physics education researchers to focus on temperature and heat as their research topic. Additionally, global warming and static fluids also emerged as popular topics among researchers, with four articles published on each topic related to creative thinking skills. This reflects efforts to develop more effective learning approaches to address the challenges students face.

Table 6 Thematic distribution of scholarly publications on creative thinking skills across physics subject domains

Topics	Total (n)	Class
Newton's Laws	2	Grade X
Renewable Energy	3	Grade X
Rotational Dynamics	1	Grade X
Light Waves	2	Grade X
Laboratory	1	Grade VIII
Sound Waves	2	Grade X
Static Electricity	2	Grade X
Statics Fluids	4	Grade X
Temperature and Heat	5	Grade X
Pressure	2	Grade VIII
Work & Energy	3	Grade IX
Linear Motion	1	Grade VIII
Elasticity	3	Grade X
Global Warming	4	Grade X

Topics	Total (n)	Class
Dynamic Fluids	2	Grade X
Simple Machines	2	Grade VIII
Vectors	1	Grade X
Harmonic Vibrations	1	Grade X
Kinematics of Motion	2	Grade X
Thermodynamics	4	Grade X
Projectile Motion	1	Grade X
Momentum and Impulse	3	Grade X

CONCLUSION

The analysis of research publications on creative thinking skills in the field of physics in Indonesia from 2015 to 2024 reveals a significant increase in research interest in this area. The peak of research activity occurred in 2023, with 14 articles published. The majority of the studies adopted a quantitative approach, with quasi-experimental designs being the most commonly chosen. The most frequently researched physics topic was the concept of temperature and heat, with Grade 10 high school students being the predominant research subjects. In efforts to enhance students' creative thinking skills, PJBL and PBL models were the most frequently applied approaches. While providing a clear overview of current trends, this study is constrained by the predominance of quantitative methodologies and a concentration on specific topics, which limits a profound exploration of students' creative processes across diverse educational levels. Nonetheless, these findings offer vital implications, serving as a strategic roadmap for researchers to investigate more complex physics concepts and providing a robust empirical foundation for educators to implement innovative learning models aimed at strengthening creative literacy in the classroom. The findings of this systematic literature review, which involved 51 articles, can serve as a reference for further research, particularly in the context of developing creative thinking skills in physics education in Indonesia.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The authors' contributions to this study span several critical stages: Sul Daeng Naba was responsible for conceptualizing the study, developing the methodology, performing formal analysis, and drafting the original manuscript. Heru Kuswanto provided technical supervision and validation concerning instructional media and educational technology, while Aris Kurniawan contributed to learning assessment aspects and data analysis. Nanang Adrianto provided scientific perspectives and assisted in the final manuscript refinement, ensuring that the reported work represents a substantial collaborative effort by the entire team.

AI DISCLOSURE STATEMENT

The authors utilized the Gemini Pro application for language translation and lexical refinement during the preparation of this manuscript. Following the AI-assisted translation, the authors thoroughly reviewed, edited, and refined the content to ensure its technical accuracy and academic integrity. The authors maintain full responsibility for the final version of the article and its originality.

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