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# Mapping the Evolution of Creative Thinking in Education: A Decade-Long Bibliometric Studies

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# Mapping the Evolution of Creative Thinking in Education: A Decade-Long Bibliometric Studies

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## Abstract

This study explores the development of research on creative thinking in education over the past ten years through a bibliometric analysis of 249 Scopus peer-reviewed articles. The findings indicate a significant increase in interest and number of publications. Innovative methods, such as problem-based and collaborative learning, were identified as key strategies to improve students' creative thinking skills. Technology integration, including blended learning and gamification, was also highlighted for creating a more engaging and interactive educational experience. In addition, this research underscores the value of international collaboration in deepening knowledge and applying creative thinking in education. This research offers actionable insights for educators and policymakers to better integrate creative thinking into the curriculum to prepare students for an increasingly complex modern world. Future research is expected to examine how demographic and cultural factors influence the effectiveness of creative thinking in education.

## Introduction

Creativity, innovation, invention, and leadership are key to advancing a nation's civilization. In the 21st century, creative thinking has emerged as an essential skill to overcome various challenges in life (Ayutthaya & Damrongpanit, 2022; Ernawati et al., 2023; Fathonah et al., 2024; Pujawan et al., 2022). These skills play an essential role in designing new methods and solutions to complex problems through innovative perspectives (Ananiadou & Claro, 2009; Hashim et al., 2019; Mishra & Mehta, 2017; Rizal et al., 2022; Sbaih, 2023). These skills include problem-solving, critical thinking, and reflective thinking that encourage originality and uniqueness to obtain meaningful outcomes (Facione, 1990; Gajda, 2016; Hargrove, 2013). Therefore, integrating creative thinking into education is essential to equip students to face future challenges through innovative solutions.

Education research has recognized the importance of fostering creative thinking skills in students (Musdi et al., 2024). Creative thinking integrates lateral and vertical thinking, where lateral thinking generates innovative ideas and vertical thinking systematically evaluates them based on objective criteria (Agustina et al., 2024). This interaction is crucial for academic development and preparing students for future complexities. Researchers have

identified core creative thinking abilities such as originality, fluency, flexibility, elaboration, and sensitivity to problem-solving (Ayasrah et al., 2023). These abilities manifest in new ideas relevant to the context and the ability to elaborate on them in detail (Agustina et al., 2024).

Creative thinking allows individuals to see phenomena in the surrounding environment, which leads to learning and understanding (Ayutthaya & Damrongpanit, 2022). It fosters the imagination needed to generate ideas, propose hypotheses, explore alternatives, and critically assess their ideas and those of others (Kampylis & Berki, 2014). This process is critical to achieving long-term success for individuals, organizations, and countries (Ford & Gioia, 2000). Students must develop problem-solving strategies and adaptability (Behnamnia et al., 2020). Various factors influence the development of creativity and require a favourable environment to support this growth (Glăveanu, 2015; Newton & Newton, 2010).To develop students' creative thinking, creativity must be integrated into every aspect of classroom learning (Ernawati et al., 2023). Creativity can be fostered and enhanced through the application of creative strategies and the transformation of information and experiences into new knowledge and skills (Dweck, 2006; Hsiao et al., 2014; Perry & Karpova, 2017; Sun et al., 2020; Yasin & Yunus, 2014). Research on creative thinking should continue to be conducted across various disciplines to support the development of effective teaching methods and curricula (McLure et al., 2024; Ruiz-del-Pino et al., 2022).

This research examines the evolution of creative thinking in education over the past decade, highlighting critical methodologies and offering insights into effective strategies to foster student creativity. The study identifies dominant trends and their impact on theory and practice in education by analyzing existing literature. It also provides practical recommendations for educators and policymakers in designing curricula that effectively enhance creative thinking skills and highlight gaps to guide future research. This research aims to answer the following questions: (1) What trends are emerging in creative thinking publications among students from 2014 to 2023? (2) What strategies have been used to enhance creative thinking? (3) What future research themes must be explored in this area?

## Methodology

This research uses bibliometric analysis. Bibliometrics is a quantitative analysis method that takes the external characteristics of scientific literature as the object of research (Wang et al., 2020). Bibliometric analysis is used to review publications related to the scope of research to find research trends, concepts, and necessary keywords (Gupta & Bhattacharya, 2004; Van Eck et al., 2010). It is also used to analyze the research status, frontier directions, and development trends of a particular discipline (Koskinen et al., 2008; Wang & Li, 2016). The bibliometric analysis process used in this study will be discussed in this section, which includes data collection, filtering, extraction, and synthesis.

*Literature Search and Data Collection*

This research began with a document search on the Scopus database, using compound keywords combined with the AND operator. Specifically, the search targeted “Article title, Abstract, Keywords” using the terms “creative thinking” and “students.” The initial query, run on May 10, 2024, yielded 3,951 documents. To filter these results,

irrelevant items were excluded based on predefined criteria.

Although the Scopus search was limited, the authors recognized that literature from other sources was needed. If there were compatible standards for combining data across independent databases, Web of Science, PubMed and ERIC could be included. Nonetheless, the bibliometric software package R used in this study does not support this integration. However, Scopus is known for its wide coverage and extensive citation records (Heradio et al., 2016; Shen & Ho, 2020), thus providing sufficient data to describe the scientific landscape, discover research trends, and conduct the analysis presented in this study.

### Extraction, Loading, and Data Processing

Table 1 shows the 249 articles that have been selected based on the inclusion and exclusion criteria after screening. Using the Scopus platform, researchers can export data to various file formats, including RIS, BibTeX, CSV, and Plain Text formats. The data in this study was exported in CSV format, which was then imported into bibliophily, a bibliometric tool (Aria & Cuccurullo, 2017).

### Bibliometric Analysis and Software Packages

R-package, an open-source software that offers tools for conducting bibliometric research, was developed and written in R (Aria & Cuccurullo, 2017). The latest version of the R bibliometrics package (2.0 and above) has key algorithms for performing statistical analysis and scientific mapping. In addition, the Biblioshiny web interface application was added to help users without coding skills perform bibliometric analysis. With the Biblioshiny interface, data can be imported from Scopus or Web of Science databases in Plain Text, BibTex, or CSV formats. In addition, the interface makes it possible to filter the data in the bibliography.

## Results

The bibliometric study conducted from 2014 to 2023 analyzed 249 documents from 106 sources and showed how important creativity is in education as shown in Table 1. With a remarkable annual growth rate of 37.59%, this study shows great progress in this area of research. Per document, an average of 9,896 citations illustrate the relevance and impact of creative thinking in educational literature, and the age of the youngest document is 3.73 years, showing how quickly new ideas enter into practice.

The study generated contributions from 766 authors, including 31 single authors, and involved 11.24% international collaboration. In this study, the collaborative nature-with an average of 3.32 authors per document-is essential for innovation and idea exchange in creative thinking in education worldwide. In addition, the study found 741 “Author Keywords” and 332 “Plus Keywords”, indicating that the study covered a wide range of creative thinking topics and approaches. The focus only on articles shows the researchers' preference for this format, which strengthens the standard and reliability of shared scientific knowledge.

Table 1. Information about the Data

| Description | Results |
|---|---|
| **Main Information About Data** | |
| Timespan | 2014:2023 |
| Sources (Journal, Books, etc.) | 106 |
| Documents | 249 |
| Annual Growth Rate % | 37,59 |
| Document Average Age | 3,73 |
| Average citations per doc | 9,896 |
| References | 11610 |
| **Document Contents** | |
| Keyword Plus (ID) | 332 |
| Author's Keywords (DE) | 741 |
| **Authors** | |
| Authors of single-authored docs | 766 |
| Authors Collaboration | 31 |
| Single-authored docs | 33 |
| Co-Authors per Doc | 3,32 |
| International co-authorships % | 11,24 |
| **Document Types** | |
| Article | 249 |

**What Trends Are Emerging in Creative Thinking Publications Among Students From 2014 to 2023?**

In the past ten years, there has been a clear trend in publications addressing creative thinking in education, as shown by the annual scientific production graph in Figure 1. Starting with less than ten articles in 2014, the number of articles steadily increased to reach 20 in 2017. This indicates a shift in academic focus towards creative thinking due to the global demand for innovative educational skills. The number of articles decreased after reaching its peak in 2017 to 15 articles in 2018. This may be due to topic saturation or because research priorities changed.

This trend quickly returned, and after 2018, publications continued to increase. This shows the importance and significance of creative thinking in education. Publications increased to almost 40 in 2020, most likely due to the COVID-19 pandemic, which demands a creative approach to education. This trend will probably continue and reach more than 50 articles by 2023. This increase shows how important it is to teach students creative thinking skills to face the challenges of modern times.

The scientific production map in Figure 2 shows that some countries are well-known in research on creative thinking education. Dark blue countries show higher levels of scientific production, while light blue countries show lower contributions. The United States and some European countries, such as the United Kingdom and Germany, stand out with the darker intensity of the blue color, indicating that they are leaders in scientific

production on this topic. Well-established academic infrastructure, continuous investment in educational research, and the availability of resources that enable broad and in-depth research are all evidence of these countries' great contribution.

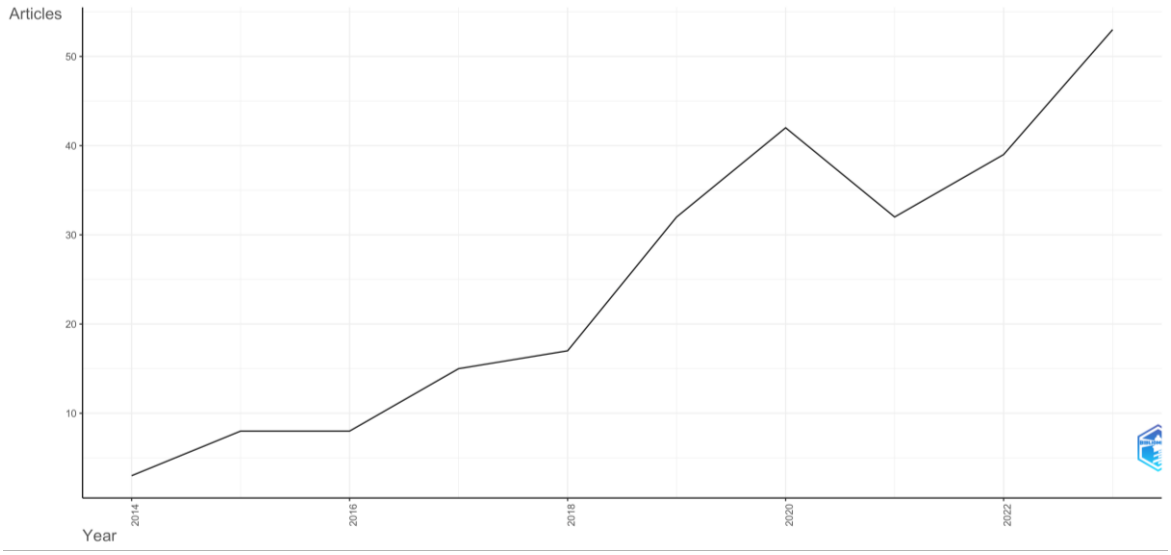


Figure 1. Annual Scientific Production

Asian countries, such as China and India, also show significant research activity, but with different intensities, indicating differences in research capacity and educational priorities in each country. Over the past few decades, China has made massive investments in research and education, which has resulted in a significant increase in scientific production. In addition, Australia and the countries of Oceania made significant contributions, demonstrating their role in educational research worldwide.

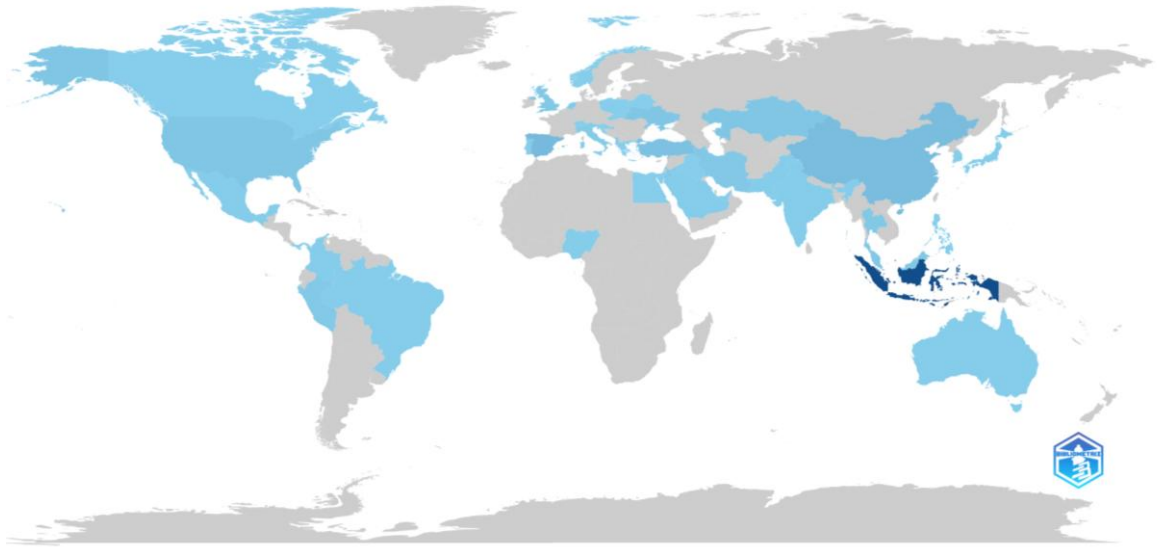

Figure 2. Countries' Scientific Production

Their strong presence on the map may indicate that the national curriculum's strategic focus on developing

educational creativity and innovation is the reason behind their strong presence on the map. A lighter shade of blue may indicate more innovation and research in some countries in Latin America, Africa, and other parts of Asia. Conversely, a darker shade of blue might indicate some structural challenges or research priorities that have an effect on the visibility and influence of creative thinking globally.

With five articles, Ernawati MDW is the most prolific author in this field, as shown in Table 2. Although the "Articles Fractionalized" value of 0.88 indicates that most of the writing was done collaboratively, Ernawati MDW made significant contributions. This demonstrates her important role in creative thinking research in education and shows that she has the ability to lead her research group. With four publications and a fractional value of 0.95, Widiana IW almost entirely contributed to all her articles, showing that she is very independent in research. This indicates a special expertise or a centered and innovative approach that can influence her field of study.

Other authors such as Asrial A., Corebima A., Jumadi J., Rumahlatu D., Waluya SB, Zubaidah S., and Ahmad E. show variations in their number of publications and fractional scores, indicating different levels of collaboration and individual contributions. For example, Asrial A. has three articles and a fractional score of 0.62, indicating a high level of collaboration in the research, which may include interdisciplinary teamwork Although the authors have only two publications, Ahmad E. and Ayutthaya TIN have full and recognized contributions, with fractional scores of 1.00 each. This indicates that they played an important or unique role in the study, marking them as either lead thinkers or sole authors.

Table 2. Most Relevant Authors

| Authors | Articles | Articles Fractionalized |
|---|---|---|
| ERNAWATI MDW | 5 | 0,88 |
| WIDIANA IW | 4 | 0,95 |
| ASRIAL A | 3 | 0,62 |
| COREBIMA AD | 3 | 0,75 |
| JUMADI J | 3 | 0,70 |
| RUMAHLATU D | 3 | 0,75 |
| WALUYA SB | 3 | 0,78 |
| ZUBAIDAH S | 3 | 0,75 |
| AHMADIAN E | 2 | 1,00 |
| AYUTTHAYA TIN | 2 | 1,00 |

Table 3 describes the ranking of "Most Cited Documents Globally" important contributions in educational creative thinking by total citation count. Ulger (2018) article in the Interdisciplinary Journal of Problem-Based Learning tops the list, with 92 citations and an annual citation average of 13.14. The article emphasizes the role of problem-based learning as an important strategy for enhancing creativity. García-Valcárcel-Muñoz-Repiso & Caballero-González (2019) and Yusnaeni et al., (2017), with 86 and 77 citations, respectively, show that communication and instructional strategies are essential for enhancing creative thinking in education. The high citation rates and

wide dissemination are driven by the interdisciplinary research interests and international collaborations in this analysis.

Table 3. Most Globally Cited Documents

| Paper | DOI | Total Citations | TC per Year | Normalized TC |
|---|---|---|---|---|
| Kani Ulger, 2018, Interdisciplinary Journal of Problem Based Learning | 10.7771/1541-5015.1649 | 92 | 13,14 | 5,73 |
| García-Valcárcel-Muñoz-Repiso & Caballero-González, 2019, Comunicar | 10.3916/C59-2019-06 | 86 | 14,33 | 4,82 |
| Yusnaeni et al., 2017, International Journal of Instruction | 10.12973/iji.2017.10216a | 77 | 9,63 | 3,36 |
| Sıburıan et al., 2019, Erusian Journal of Educational Research | 10.14689/ejer.2019.81.6 | 59 | 9,83 | 3,31 |
| Sumarni & Kadarwati, 2020, Jurnal Pendidikan IPA Indonesia | 10.15294/jpii.v9i1.21754 | 51 | 10,20 | 4,31 |
| Hu R et al., 2016 Eurasia Journal of Mathematics, Science and Technology Eduacation | 10.12973/eurasia.2016.1226a | 51 | 5,67 | 2,27 |
| Sosa Neira et al., 2017, International Journal Of Emerging Technologies in Learning | 10.3991/ijet.v12i05.6939 | 50 | 6,25 | 2,18 |
| Yustina et al., 2020, Jurnal Pendidikan IPA Indonesia | 10.15294/jpii.v9i3.24706 | 48 | 9,60 | 4,06 |
| Rahardjanto & Fauzi, 2019, International Journal of Instruction | 10.29333/iji.2019.12212a | 44 | 7,33 | 2,47 |
| Sun et al., 2020, Thinking Skills and Creativity | 10.1016/j.tsc.2020.100682 | 43 | 8,60 | 3,63 |

Studies from Indonesia by Sumarni & Kadarwati (2020) and Yustina et al., (2020) show increasing international recognition of developing countries' contributions by focusing on science and technology education in learning.

Overall, this table identifies the most significant works and signals the direction of future research on creative thinking education. The table also emphasizes the importance of new methods such as problem-based learning, technology integration and interdisciplinary approaches to improve students' ability to think creatively.

**What Strategies Have Been Used to Enhance Creative Thinking?**

In this Figure 3 graphic, "creative thinking" is an important focus in educational research, with various interlinked nodes indicating subthemes and methodologies related to the concept. Key nodes such as "problem-based learning" and "project-based learning" are strongly linked to "creative thinking", which emphasizes the application of creativity in the real world through integrated problem-solving and projects. In addition, the "emotional intelligence" and "flexibility" networks indicate that emotional management and adaptability are important parts of the creative process. The "artificial intelligence education" and "computational thinking" nodes underscore the growing role of technology in creative thinking education; this suggests new research directions that use advanced technology to improve learning outcomes.

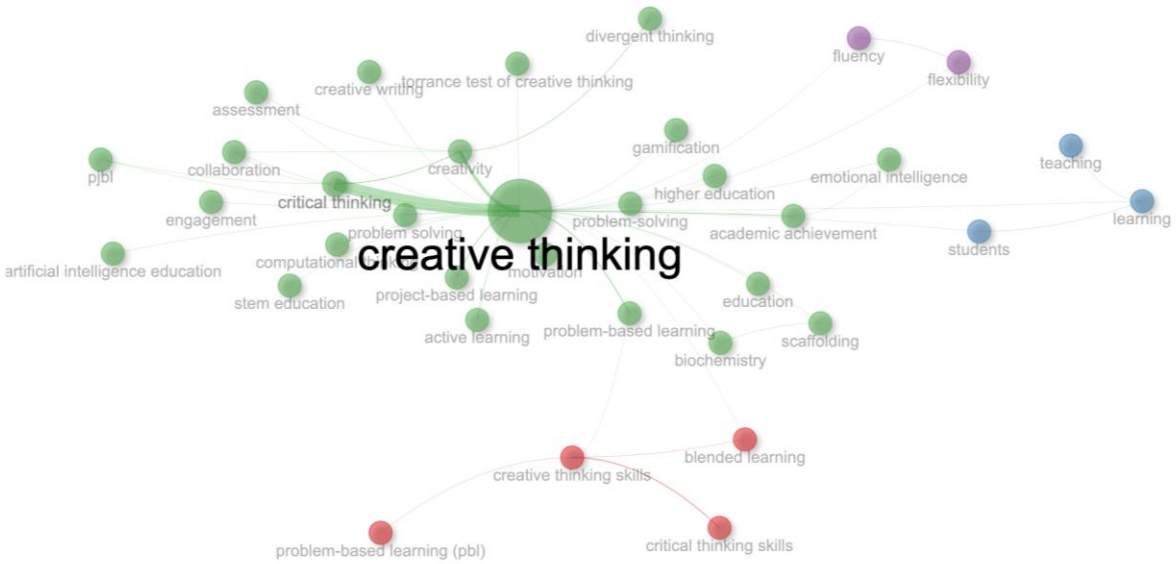


Figure 3. Co-occurrence Network

Figure 4 thematic map categorizes the research themes into four quadrants as follows:

1. Motoric Themes: Themes such as "problem-based learning", "creative thinking", "collaborative learning", and "critical thinking" are particularly important and relevant, demonstrating their significant and established role in the field. Research on creative thinking centers on these topics, and then becomes the basis for educational innovation and practice.
2. Specialized Themes: Specialized areas, such as "instructional management models" and "meta-analysis," have high popularity but little importance. These specialized areas offer opportunities for new educational innovations and applications, despite their lack of popularity.
3. Emerging or Declining Themes: Themes such as "21st century skills" and "middle school students" are less relevant and central, suggesting that new areas of growing interest or less importance are emerging.

4. Basic Themes: Themes such as “math” and “active learning” are foundational to the research; however, they may be less innovative or in-depth than the existing literature.

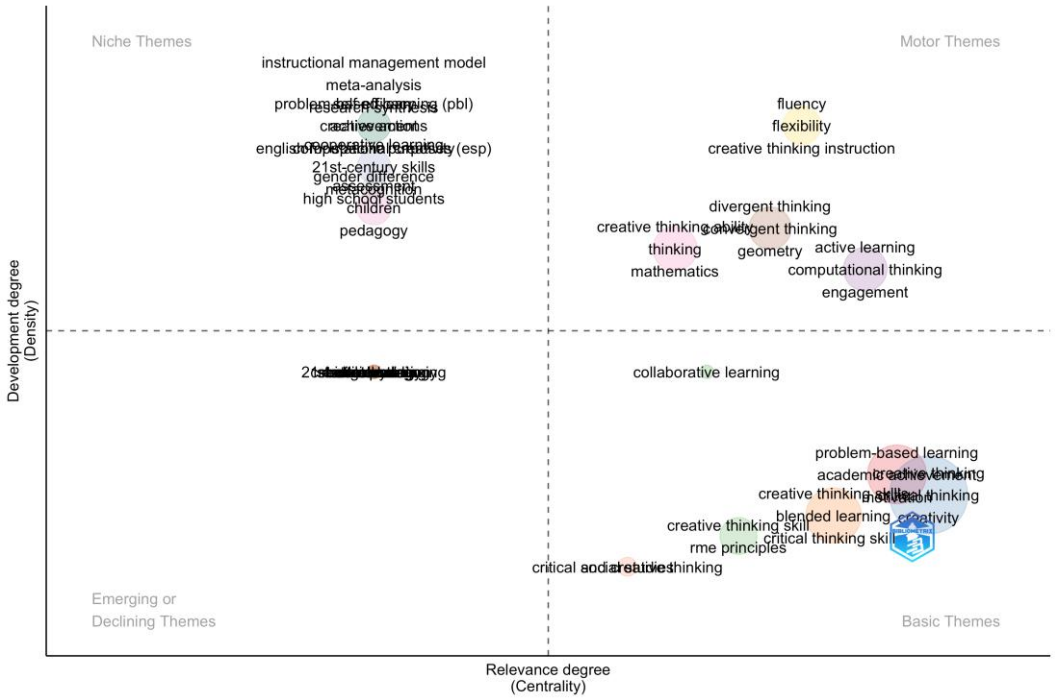


Figure 4. Thematic Map

The graph in Figure 5 shows the main trends in research on creative thinking in education and shows the changes in the prevalence of the subject over ten years.

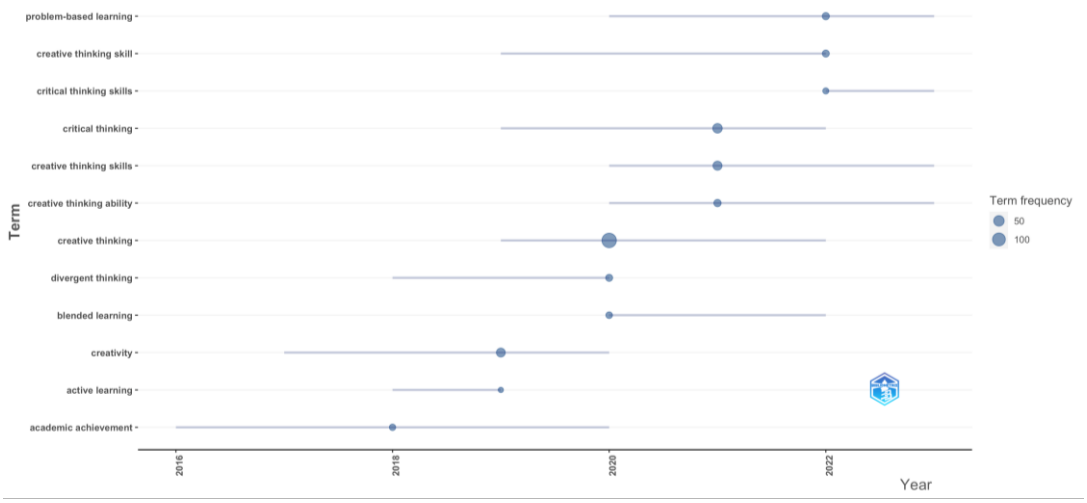


Figure 5. Trending Topics

Key topics such as “problem-based learning” and “creative thinking skills” show a persistent focus in educational research and underline how important these techniques are for improving students' creative abilities. The emergence of the terms “critical thinking” and “critical thinking skills” shows how important critical analysis is

in the creative thinking process in education. Occasionally, topics such as "creative thinking" and "divergent thinking" appear, indicating a growing research interest in response to the growing needs and demands of education. In addition, the peaks of "blended learning" and "creativity", especially those that emerged in the middle of this decade, indicate new interests or developments. Meanwhile, the separate emergence of "active learning" and "academic achievement" indicates a shift in research focus or a reaction to broader educational trends.

Figure 6 shows "creative thinking" appears in this word cloud, showing how important it is in the educational research reviewed. The prominence of the terms "critical thinking" and "creative thinking skills" indicates that the focus of the research is on the abstraction of creative abilities and the development of skills that can be taught. Both "problem-based learning" and "blended learning" emphasize primarily student-centered methods to enhance their creative thinking.


Figure 6. WordCloud

In addition, the terms "creativity" and "divergent thinking" indicate a broader acceptance of developing different types of thinking as an important component of the learning process, emphasizing the complexity of creativity more than simple problem solving. Finally, the incorporation of "active learning" and "collaborative learning" emphasizes how important it is for students to engage and work together. Both are examples of an educational style that values collaboration and interaction, which helps students achieve better learning outcomes and enhance their creative abilities.

**What Future Research Themes Must Be Explored in This Area?**

The analysis identifies several promising directions for future research in creative thinking education. Based on the co-occurrence network in Figure 3, themes such as the intersection of emotional intelligence and creative thinking suggest the need for interdisciplinary studies to explore how emotional regulation influences creativity in educational settings. Additionally, emerging nodes like artificial intelligence and virtual reality highlight opportunities to investigate the effective integration of advanced technologies into learning environments to foster creativity.

Meanwhile, insights from the thematic map in Figure 4 indicate areas such as 21st-century skills and middle school students categorized as emerging or declining themes. These areas require deeper examination to understand their specific roles in enhancing creativity. The thematic map also emphasizes foundational topics like active learning, which may serve as a basis for expanding innovative educational strategies.To advance this field,

future studies should consider longitudinal designs that examine the long-term impacts of creative thinking education, including its influence on career trajectories, societal contributions, and the development of problem-solving capabilities. Such research would provide a more comprehensive understanding of how creative thinking skills shape individuals and their broader environments.

Publications on creative thinking in education show a significant annual growth rate of 37.59%. This indicates a growing interest and evolving demands and needs in modern education. Problem-based learning and collaborative learning methodologies effectively enhance creative thinking through solution-oriented activities and student interaction. Integrating technology in creative thinking in education, such as blended learning and gamification, is essential to foster student creativity by providing engaging and dynamic learning platforms.

The study also highlights the importance of global collaboration, with more than 10% of publications involving cross-country collaboration. This enriches the academic discourse with diverse perspectives. Practical recommendations include integrating PBL and collaborative learning into the curriculum and investing in teacher training to use educational technology effectively. Further research is needed to examine how demographic and contextual factors influence the effectiveness of creative thinking education, including its long-term impact on academic performance and career success. This research deepens our understanding of effective teaching methodologies and advocates for broader application of these practices in education.

The role of technology in fostering creative thinking has become increasingly significant, with tools such as Artificial Intelligence (AI), gamification, and virtual reality (VR) emerging as key innovations. AI-powered platforms enable personalized learning experiences that cater to individual student needs, fostering creativity through adaptive problem-solving exercises. Gamification introduces interactive, reward-based learning systems that boost engagement and motivation, while VR provides immersive environments that inspire imaginative and critical thinking. These tools have demonstrated their potential to transform educational practices by making learning more engaging and interactive. However, to fully harness their benefits, educators must integrate these technologies effectively into curricula and align them with specific learning objectives.

Creative thinking education has profound implications that extend beyond immediate academic outcomes. Over the long term, students equipped with creative thinking skills are better positioned to excel in their careers, as these skills enhance their ability to adapt to complex and dynamic work environments. Creative problem-solving capabilities, a core component of creative thinking, enable individuals to address real-world challenges with innovative solutions, contributing to organizational success and societal advancement. Moreover, fostering creative thinking in education cultivates a mindset of lifelong learning and curiosity, which is essential for continuous personal and professional growth.

## Conclusion

Bibliometric analysis has highlighted a significant growth in publications examining creative thinking in education, with an annual growth rate of 37.59% in the past decade. These findings emphasize the growing interest

in understanding and integrating creative thinking in educational environments, which is supported by adopting innovative methodologies such as problem-based and collaborative learning. Technology integration has markedly enriched students' learning experiences and facilitated the adoption of more interactive and engaging teaching approaches such as blended learning and gamification. Strong international collaboration between researchers from different countries has also contributed to expanding knowledge and exchanging best practices. It is highly recommended for educators and policymakers to adopt and integrate methodologies that support the development of creative thinking into curriculum standards. In addition, they should also focus on training for educators to optimize the use of technology and innovative methodologies in teaching. This study also identified the need for further research exploring the influence of demographic and cultural contexts on the effectiveness of creative thinking education and its effect on students' academic performance and future career success.

## Limitations and Recommendations

This study provides valuable insights into the trends in creative thinking in education through a quantitative bibliometric approach. However, certain limitations should be acknowledged. Firstly, the exclusive reliance on quantitative analysis may overlook the deeper qualitative insights that could enrich the understanding of creative thinking trends and their pedagogical implications. Integrating qualitative methods, such as content analysis of highly cited papers or expert interviews, could provide a more nuanced interpretation of the findings.

Secondly, the study relied solely on the Scopus database, which, while comprehensive, may exclude relevant literature from other sources such as Web of Science or PubMed. Expanding the data sources in future research could provide a broader and more representative overview of the field. Lastly, the focus on publications in English may limit the diversity of perspectives, particularly from non-English-speaking regions, where innovative approaches to creative thinking in education may exist. Addressing these limitations in future research would allow for a more holistic and multidimensional understanding of creative thinking in education, thereby enhancing both theoretical and practical contributions.

Despite the promise of technology-enhanced learning, certain limitations warrant consideration. Accessibility remains a critical challenge, particularly in under-resourced regions where technological infrastructure is limited. Furthermore, teacher readiness and professional development are essential for effective implementation. Without adequate training, educators may struggle to utilize tools such as AI, gamification, or VR to their fullest potential. Future research should address these issues by exploring strategies to overcome technological disparities and examining the long-term impacts of these tools on diverse student populations. Pilot studies and case examples can provide valuable insights into the practical application of technology in enhancing creative thinking, paving the way for more inclusive and effective educational practices.

While this study provides detailed thematic maps and co-occurrence networks, the potential for synthesizing cross-sectoral themes, such as the interaction between emotional intelligence and creative thinking, remains underexplored. Emotional intelligence, which involves the ability to manage emotions and interpersonal relationships effectively, has a strong theoretical link to fostering creativity through enhanced collaboration and

adaptability. Investigating how these dimensions intersect could provide deeper insights into optimizing educational strategies for creative thinking.Future research should explore these cross-sectoral interactions, potentially through interdisciplinary approaches that combine psychology, education, and technology. By understanding these connections, educators and policymakers can develop more comprehensive frameworks to enhance both emotional and creative competencies in students. This represents a promising area for advancing knowledge and improving educational outcomes.

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## References

Agustina, L., Zaenuri, Isnarto, & Dwijanto. (2024). Students' creative thinking ability on problems of mathematics literacy. *Journal of Higher Education Theory and Practice*, *24*(1), 46–57.

Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD Countries. In *OECD Education Working Papers 41* (OECD Education Working Papers, Vol. 41). https://doi.org/10.1787/218525261154

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An r-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Ayasrah, S., Obeidat, M., Katatbeh, Q., Aljarrah, A., & Al-Akhras, M. A. (2023). Practicing creative thinking and its relation to academic achievement. *Creativity Studies*, *16*(1), 178–192.

Ayutthaya, T. I. N., & Damrongpanit, S. (2022). A meta-analysis of instructional management model for students' creative thinking development: An application of propensity score matching. *European Journal of Educational Research*, *11*(4), 2429–2444. https://doi.org/10.12973/eu-jer.11.4.2429

Behnamnia, N., Kamsin, A., & Ismail, M. A. B. (2020). The landscape of research on the use of digital game-based learning apps to nurture creativity among young children: A review. *Thinking Skills and Creativity*, *37*. https://doi.org/10.1016/j.tsc.2020.100666

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House.

Ernawati, M. D. W., Yusnidar, Haryanto, Rini, E. F. S., Aldila, F. T., Haryati, T., & Perdana, R. (2023). Do creative thinking skills in problem-based learning benefit from scaffolding? *Journal of Turkish Science Education*, *20*(3), 399–417. https://doi.org/10.36681/tused.2023.023

Facione, P. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction*. www.insightassessment.com

Fathonah, S., Cahyono, E., Haryani, S., Sarwi, S., & Lestari, N. H. (2024). Application of multirepresentation-based creative problem-solving learning models to Improve critical and creative thinking skills for students. *International Journal of Cognitive Research in Science, Engineering and Education*, *12*(1), 185–200. https://doi.org/10.23947/2334-8496-2024-12-1-185-200

Ford, C. M., & Gioia, D. A. (2000). Factors influencing creativity in the domain of managerial decision making. *Journal of Management*, *26*(4), 705–732. https://doi.org/10.1177/014920630002600406

Gajda, A. (2016). The relationship and moderators of school achievement and creativity at different educational stages. *Thinking Skills and Creativity*, *19*, 246–259. https://doi.org/10.1016/j.tsc.2015.12.004

Muñoz-Repiso, G.-V. A., & Caballero-González, Y.-A. (2019). Robotics to develop computational thinking in early childhood education. *Comunicar*, *27*(59), 63–72. https://doi.org/10.3916/C59-2019-06

Glăveanu, V. P. (2015). Creativity as a sociocultural act. *Journal of Creative Behavior*, *49*(3), 165–180. https://doi.org/10.1002/jocb.94

Gupta, B. M., & Bhattacharya, S. (2004). Bibliometric approach towards mapping the dynamics of science and technology. *DESIDOC Bulletin of Information Technology*, *24*(1), 3–8.

Hargrove, R. A. (2013). Assessing the long-term Impact of a metacognitive approach to creative skill development. *International Journal of Technology and Design Education*, *23*(3), 489–517. https://doi.org/10.1007/s10798-011-9200-6

Hashim, M. A., Syed Aris, S. R., & Chan, Y. F. (2019). Promoting empathy using design thinking in project-based learning and as a classroom culture. *Asian Journal of University Education*, *15*(3), 14. https://doi.org/10.24191/ajue.v15i3.7817

Heradio, R., De La Torre, L., Galan, D., Cabrerizo, F. J., Herrera-Viedma, E., & Dormido, S. (2016). Virtual and remote labs in education: A bibliometric analysis. *Computers and Education*, *98*, 14–38. https://doi.org/10.1016/j.compedu.2016.03.010

Hsiao, H. S., Chang, C. S., Lin, C. Y., & Hu, P. M. (2014). Development of children's creativity and manual skills within digital game-based learning environment. *Journal of Computer Assisted Learning*, *30*(4), 377–395. https://doi.org/10.1111/jcal.12057

Hu, R., Wu, Y. Y., & Shieh, C. J. (2016). Effects of virtual reality integrated creative thinking instruction on students' creative thinking abilities. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(3), 477–486. https://doi.org/10.12973/eurasia.2016.1226a

Kampylis, P., & Berki, E. (2014). Nurturing creative thinking. In *https://unesdoc.unesco.org/ark:/48223/pf0000227680*.

Koskinen, J., Isohanni, M., Paajala, H., Jääskeläinen, E., Nieminen, P., Koponen, H., Tienari, P., & Miettunen, J. (2008). How to use bibliometric methods in evaluation of scientific research? An example from Finnish schizophrenia research. *Nordic Journal of Psychiatry*, *62*(2), 136–143.

McLure, F., Won, M., & Treagust, D. F. (2024). Science teachers' understanding of creative thinking and how to foster it as mandated by the Australian curriculum. *Journal of Science Teacher Education*, *35*(5), 524–543. https://doi.org/10.1080/1046560X.2024.2313882

Mishra, P., & Mehta, R. (2017). What we educators get wrong about 21st-century learning: Results of a survey. *Journal of Digital Learning in Teacher Education*, *33*(1), 6–19. https://doi.org/10.1080/21532974.2016.1242392

Musdi, E., As'ari, A. R., Harisman, Y., Syaputra, H., & Hevardani, K. A. (2024). Student's creative thinking based on study level, learning style, gender, and combination of the three. *International Journal of Evaluation and Research in Education* , *13*(3), 1591–1601. https://doi.org/10.11591/ijere.v13i3.27936

Newton, L., & Newton, D. (2010). Creative thinking and teaching for creativity in elementary school science. *Gifted and Talented International*, *25*(2), 111–124. https://doi.org/10.1080/15332276.2010.11673575

Perry, A., & Karpova, E. (2017). Efficacy of teaching creative thinking skills: A comparison of multiple creativity assessments. *Thinking Skills and Creativity*, *24*, 118–126. https://doi.org/10.1016/j.tsc.2017.02.017

Pujawan, I. G. N., Rediani, N. N., Antara, I. G. W. S., Putri, N. N. C. A., & Bayu, G. W. (2022). Revised bloom taxonomy-oriented learning activities to develop scientific literacy and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 47–60. https://doi.org/10.15294/jpii.v11i1.34628

Rahardjanto, A., Husamah, H., & Fauzi, A. (2019). Hybrid-PjBL: Learning outcomes, creative thinking skills, and learning motivation of preservice teacher. *International Journal of Instruction*, *12*(2), 179–192. https://doi.org/10.29333/iji.2019.12212a

Rizal, S., Putra, A. K., Suharto, Y., & Wirahayu, Y. A. (2022). Creative thinking and process science skill: Self-organized learning environment on watershed conservation material. *Jurnal Pendidikan IPA Indonesia*, *11*(4), 578–587. https://doi.org/10.15294/jpii.v11i4.39571

Ruiz-del-Pino, B., Fernández-Martín, F. D., & Arco-Tirado, J. L. (2022). Creativity training programs in primary education: A systematic review and meta-analysis. *Thinking Skills and Creativity*, *46*, 101172. https://doi.org/10.1016/j.tsc.2022.101172

Sbaih, A. D. (2023). Creative thinking in students of mathematics in universities and its relationship with some variables. *Perspectives of Science and Education*, *64*(4), 108–124. https://doi.org/10.32744/pse.2023.4.7

Shen, C. wen, & Ho, J. tsung. (2020). Technology-enhanced learning in higher education: A bibliometric analysis with latent semantic approach. *Computers in Human Behavior*, *104*. https://doi.org/10.1016/j.chb.2019.106177

Siburian, J., Corebıma, A. D., & Saptasarı, M. (2019). The correlation between critical and creative thinking skills on cognitive learning results. *Eurasian Journal of Educational Research*, *19*(81), 1–16. https://doi.org/10.14689/ejer.2019.81.6

Sosa, O. E., Salinas, J., & De Benito, B. (2017). Emerging technologies (ETs) in education: A systematic review of the literature published between 2006 and 2016. *International Journal of Emerging Technologies in Learning (IJET)*, *12*(05), 128. https://doi.org/10.3991/ijet.v12i05.6939

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

Sun, M., Wang, M., & Wegerif, R. (2020). Effects of divergent thinking training on students' scientific creativity: The impact of individual creative potential and domain knowledge. *Thinking Skills and Creativity*, *37*.

Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, *12*(1). https://doi.org/10.7771/1541-5015.1649

Van Eck, N. J., Waltman, L., Dekker, R., & Van Den Berg, J. (2010). A comparison of two techniques for bibliometric mapping: Multidimensional scaling and VOS. *Journal of the American Society for Information Science and Technology*, *61*(12), 2405–2416. https://doi.org/10.1002/asi.21421

Wang, Q., & Li, R. (2016). Natural gas from shale formation: A research profile. *Renewable and Sustainable Energy Reviews, 57*, 1–6. https://doi.org/10.1016/j.rser.2015.12.093

Wang, Q., Su, M., & Li, R. (2020). Is China the world's blockchain leader? Evidence, evolution and outlook of China's blockchain research. *Journal of Cleaner Production*, *264*, 121742.

Yasin, R. M., & Yunus, N. S. (2014). A meta-analysis study on the effectiveness of creativity approaches in technology and engineering education. *Asian Social Science*, *10*(3), 242–252.

Yusnaeni, Y., Corebima, A. D., Susilo, H., & Zubaidah, S. (2017). Creative thinking of low academic student undergoing search solve create and share learning integrated with metacognitive strategy. *International Journal of Instruction*, *10*(2), 245–262. https://doi.org/10.12973/iji.2017.10216a

Yustina, Syafii, W., & Vebrianto, R. (2020). The effects of blended learning and project-based learning on pre-service biology teachers' creative thinking skills through online learning in the covid-19 pandemic. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 408–420. https://doi.org/10.15294/jpii.v9i3.24706

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