Mapping the Landscape of Scientific Creativity in Science Education: A Bibliometric Analysis

Putri Sathirah Binti Saaban, Nur Jahan Binti Ahmad*

University Sains Malaysia, Penang, Malaysia

***Corresponding Author**

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ABSTRACT

Scientific creativity is increasingly recognized as a key element in promoting innovation, inquiry and problem-solving in science education. This bibliometric study investigates global research trends in scientific creativity from 2015 to 2025. A total of 380 documents were retrieved from the Scopus database and analyzed using VOSviewer to generate network visualisations. The analysis focuses on six key aspects: (1) publication trends by year, (2) influential authors, (3) subject area distribution, (4) keyword co-occurrence, (5) author co-citation, and (6) co-authorship by country. The findings show a steady rise in publication output, with notable peaks in 2022 and 2024, reflecting growing academic attention to the field. Shell D.F. and Soh L.K. emerged as the most prolific authors. The Social Sciences dominated the subject area distribution (57.2%), followed by Computer Science, Engineering and Psychology, indicating the field's interdisciplinary scope. Keyword analysis revealed that "creative thinking" is the most prominent and interconnected term, often linked with education, STEM and digital learning. Co-citation mapping highlighted influential scholars such as Kaufman, Runco, Hu and Bandura, suggesting strong theoretical foundations. Co-authorship analysis showed active regional collaboration, particularly among Southeast Asian countries like Indonesia and Malaysia, while the United States maintained global connectivity through strategic academic partnerships. This study offers a comprehensive overview of the intellectual structure and collaborative landscape of scientific creativity research in science education. The insights provide a valuable foundation for guiding future research, fostering policy development and strengthening international collaboration in promoting creativity within science education.

Keywords: Scientific Creativity, Science Education, Bibliometric, Network Mapping, Research Trends.

INTRODUCTION

Scientific creativity, often defined as the ability to generate novel and useful ideas within the scientific domain, is recognized as a fundamental component of scientific literacy and innovation in the 21st century. It bridges the gap between scientific knowledge and the creative processes that drive problem-solving and inquiry, especially within STEM education. As global challenges become increasingly complex, nurturing scientific creativity among learners and researchers has become a growing focus in science education, cognitive psychology, and interdisciplinary research (Higuera Martinez et al., 2021).

Scientific creativity is a multidimensional construct involving fluency, originality, and flexibility in generating scientific ideas, processes, or products (Hu & Adey, 2002). It plays a critical role in fostering innovation, advancing inquiry, and solving real-world problems. As nations pursue innovation-driven economies and education systems align with the goals of sustainable development and Industry 4.0, fostering creativity in science education has become a central educational priority (Prahani et al., 2024; Higuera Martinez et al., 2021).

Despite the growing emphasis on creativity in educational policies and pedagogical reforms particularly within STEM education, scientific creativity remains underexplored in comparison to general creativity. Scientific creativity is not only about imaginative thought but also involves rigorous cognitive processes, scientific reasoning, and the application of established knowledge to generate new scientific insights (Wiyanto et al., 2020; Haryandi et al., 2021). This highlights how scientific creativity combines creative thinking with scientific reasoning, enabling learners not only to explore existing concepts but also to formulate hypotheses, conduct experiments, and propose novel interpretations (Hu & Adey, 2002). Within science education, it serves as a catalyst for meaningful engagement, deeper understanding, and innovative problem-solving (Akcanca & Ozsevgec, 2018; Lai et al., 2024).

Given the increasing volume of scholarly publications on scientific creativity in recent years, there is a need for a systematic synthesis of current research trends and intellectual structures. While previous studies have conducted bibliometric analyses on creativity in broader educational contexts (Hernández-Torrano & Ibrayeva, 2020), there is a paucity of bibliometric analyses that focus explicitly on scientific creativity in science education. Limited attention has been given to examining global research trends, influential authors, and thematic developments specific to this domain (Haryandi et al., 2021; Higuera Martinez et al., 2021).

To address this gap, this study employs bibliometric techniques to provide a comprehensive overview of scholarly output between 2015 and 2025 related to scientific creativity in science education. Using the Scopus database and VOSviewer software, this study visualizes the publication trends, influential authors, subject area distributions, and network mappings based on keywords, co-citation, and co-authorship patterns. By examining these dimensions, this study contributes to the consolidation of knowledge in the field and identifies opportunities for future research, curriculum development, and policymaking aimed at enhancing scientific creativity.

Research Question

Considering the focus established in this study, the present study addressed the following research questions:

1. What are the current trends in scientific creativity within the context of science education from 2015 to 2025?
2. Who are the most influential authors contributing to scientific creativity research in science education?
3. What is the distribution of research publications related to scientific creativity according to subject area?
4. What is network mapping based on the popular keywords related to the study?
5. What is network mapping based on co-citation by authors?
6. What is network mapping based on co-authorship countries' collaboration?

LITERATURE REVIEW

In the rapidly evolving landscape of the 21st century, the role of scientific creativity in education has become increasingly significant. As education systems strive to cultivate 21st-century skills, scientific creativity stands out as a vital higher-order thinking skill that intertwined with critical thinking, communication and collaboration (Izhar et al., 2023). Moreover, it fosters curiosity and enables independent exploration of scientific phenomena (Prahani et al., 2024; Wiyanto et al., 2020). Empirical studies suggest that students with higher scientific creativity are better equipped to understand complex concepts, engage in problem-solving, and pursue STEM-related careers (Pont-Niclòs et al., 2024; Haryandi et al., 2021). However, current education systems often prioritize rote memorization and standardized testing, limiting opportunities for creative expression and experimentation in science classrooms (Kakarla, 2024).

This form of creativity is particularly evident in project-based and inquiry-based STEM activities, which allow students to explore open-ended questions and generate unique solutions. In line with this, Akcanca and Ozsevgec (2018) emphasized that students' scientific creativity is positively associated with inquiry-based learning environments and supportive teacher guidance. Moreover, the development of scientific creativity requires opportunities for experimentation, reflection, and the application of prior knowledge to novel situations. However, studies also highlight inconsistencies in how scientific creativity is embedded in STEM instruction.

Multiple systematic and bibliometric reviews have been conducted to explore creativity in science and engineering education (Higuera Martínez et al., 2021; Soomro et al., 2023), yet bibliometric investigations dedicated specifically to scientific creativity in science education remain limited. A bibliometric analysis serves as a valuable tool for mapping the structure, evolution, and trends of scientific fields. It enables the identification of core publications, authors, institutions, and themes, offering a macro-level view of the scholarly landscape (Zupic & Cater, 2015). Building on this, previous reviews such as by Hernández-Torrano and Ibrayeva (2020) mapped general creativity research in educational contexts but did not isolate scientific creativity as a subdomain. Similarly, bibliometric reviews by Haryandi et al. (2021) and Wiyanto et al. (2020) offered foundational insights but covered a limited time frame and dataset scope. For instance, Haryandi et al. (2021) found limited citation impact and international collaboration, thus suggesting that the field is still emerging.

A more recent bibliometric analysis by Prahani et al. (2024) addressed this gap by examining 20 years of literature on scientific creativity, identifying emerging themes such as divergent thinking, creativity assessment, and pedagogical innovation. Their findings highlight the increasing interdisciplinary nature of research in this area and point toward a growing interest in linking scientific creativity with 21st-century competencies. However, there remains a need for updated bibliometric studies that reflect the most recent developments in the field, particularly from 2015 onward, a period marked by rapid educational transformation driven by global disruptions, advancements in digital learning, and renewed emphasis on creative and inquiry-based approaches in science education. The present study addresses this gap by analyzing global trends from 2015 to 2025, offering a comprehensive view of how scientific creativity has evolved within science education over the past decade and how it continues to respond to contemporary educational priorities.

METHODOLOGY

Bibliometric analysis involves the systematic collection, organization, and interpretation of bibliographic data derived from scientific publications (Alves et al., 2021; Assyakur & Rosa, 2022; Verbeek et al., 2002). It utilizes both basic descriptive metrics such as publication sources, years, and author affiliations (Wu & Wu, 2017), and advanced analytical techniques including document co-citation analysis. Conducting a rigorous bibliometric study requires an iterative literature review process, which encompasses the careful selection of relevant keywords, comprehensive literature searches, and in-depth evaluation of the retrieved materials (Fahimnia et al., 2015).

Aligned with these methodological standards, the present study prioritized the inclusion of high-quality publications that offer significant theoretical contributions to the evolution of the research domain. To further enhance the integrity and comprehensiveness of the data, the selection was limited to publications indexed in Elsevier’s Scopus database, a globally recognized and reputable indexing platform known for its extensive and high-quality journal coverage including the sciences, social sciences, arts, and humanities (Aghaei Chadegani et al., 2013; Sudakova et al., 2022). Scopus provides access to a large volume of scholarly journals, making it an ideal source for conducting data-driven evaluations of scientific research (Al-Khoury et al., 2022; Di Stefano et al., 2010; Khiste & Paithankar, 2017).

For this study, publications including journal articles, books and conference proceedings were collected from the Scopus database covering the period between 2015 and 2025. This time frame was selected to capture a broader and more representative span of research, including both foundational developments and the most recent trends in scientific creativity within science education. These methodological decisions enabled a structured and comprehensive analysis of the intellectual landscape, influential scholarly contributions and interdisciplinary developments within the domain of scientific creativity in science education. By leveraging the breadth and depth of Scopus indexed literature, this study was able to ensure the reliability, relevance, and scholarly impact of the data, thereby supporting a robust evaluation of the field’s theoretical foundations and future directions.

Data Search Strategy

Study employed a screening sequence to determine the search terms for article retrieval. Study was initiated by querying Scopus database with online TITLE-ABS-KEY ("scientific creativity" OR "creative thinking" OR "creative in science"), thereby assembling 9737 articles. Afterwards, the query string was revised based on the selection criterion. This adjustment resulted in the compilation of 964 articles, which underwent further refinement to focus students as learners, specifically emphasizing the search terms "scientific creativity" AND "science". Subsequently, the search query was refined, and the results were systematically screened to include only English-language research articles. To enhance the precision of the dataset, additional filters such as publication year range, subject area, and document type were applied to ensure the relevance and quality of the selected literature. The final refinement produced 380 articles which was used for bibliometric analysis. All articles from Scopus database relating to scientific creativity and focusing on science and related to students, were incorporated in the study.

Table 1: The Search String

Scopus	TITLE-ABS-KEY ("scientific creativity" OR "creative thinking" OR "creative in science" AND "student" AND "science") AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "bk")) AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (LANGUAGE , "English"))

Table 2: The Selection Criterion In Searching

Criterion	**Inclusion**	**Exclusion**
Language	English	Non-English
Timeline	2015 – 2025	< 2015
Literature type	Article, Conference, Book/chapter	Conference review, Erratum, Editorial
Subject Area	Social Science	Other Subjects

Data Analysis

Dataset used in this study, which included publication year, article title, author names, journal source, citation count, and keywords, was exported from the Scopus database in PlainText format, covering the period from 2015 to 2025. The data were analysed using VOSviewer software version 1.6.20, which facilitated the generation of bibliometric visualisations through VOS clustering and mapping techniques. VOSviewer functions as an alternative to the Multidimensional Scaling (MDS) approach (Van Eck & Waltman, 2010), sharing a similar objective that positioning items within a low-dimensional space to reflect the degree of their similarity, where the spatial distance between items represents their relatedness (Appio et al., 2014). Unlike MDS, which is focused on the computation of similarity measures such as Jaccard indexes and cosine, VOS implements a more suitable technique for normalising co-occurrence frequencies (Van Eck & Waltman, 2007), such as, the association strength (AS_{ij}) and it is calculated as:

$$AS_{ij} = \frac{C_{ij}}{W_i wj}$$

which is "proportional to the ratio between, on the one hand, the observed number of co-occurrences of i and j and, on the other hand, the expected number of co-occurrences of i and j under the assumption that co-occurrences of i and j are statistically independent" (Van Eck & Waltman, 2010). This normalization enables VOSviewer to construct maps by minimizing the weighted sum of squared distances between item pairs. In accordance with Appio et al. (2016), the LinLog/modularity normalization method was applied to enhance the clarity of the cluster structures. Using these advanced visualisation techniques, the dataset was examined to uncover mathematical relationships and conduct analyses such as keyword co-occurrence, citation analysis, and co-citation analysis.

Keyword co-occurrence analysis is particularly effective for tracking the evolution of research themes and identifying widely discussed topics in various academic domains (Zhao, 2017; Li et al., 2016). Citation analysis helps uncover influential research areas, key trends, and methodological approaches while also highlighting the historical development of a given field (Allahverdiyev & Yucesoy, 2017). Additionally, document co-citation analysis remains a widely used method in bibliometric studies (Appio et al., 2016; Fahimnia et al., 2015; Liu et al., 2015), with results grounded in network theory to map the structural dynamics and intellectual foundations of a discipline (Liu et al., 2015).

RESULTS AND DISCUSSION

1. **What are the research trends in scientific creativity within science learning according to the year of publication?**

Figure 1 illustrates a longitudinal analysis of 380 scholarly documents published from the year 2015 to 2025. Based on the data visualization, the publication trend shows a generally upward trajectory over the decade, indicating growing scholarly interest and academic engagement in this research topic. In 2015, the field saw a modest beginning with 20 documents, followed by a notable decline in 2016 with only 12 documents, indicating a temporary dip in academic attention. However, this was followed by a sharp increase in 2017, where publication output more than doubled to 31 documents, suggesting a resurgence of interest and possibly the emergence of new theoretical frameworks or policy shifts that revitalized research efforts. The subsequent years, from 2018 to 2021, showed a consistent upward trend with 24 documents in 2018, 30 documents in 2019, 38 documents in 2020 and 42 documents in 2021. This progression indicates the field's expansion and consolidation, with researchers increasingly contributing to its development.

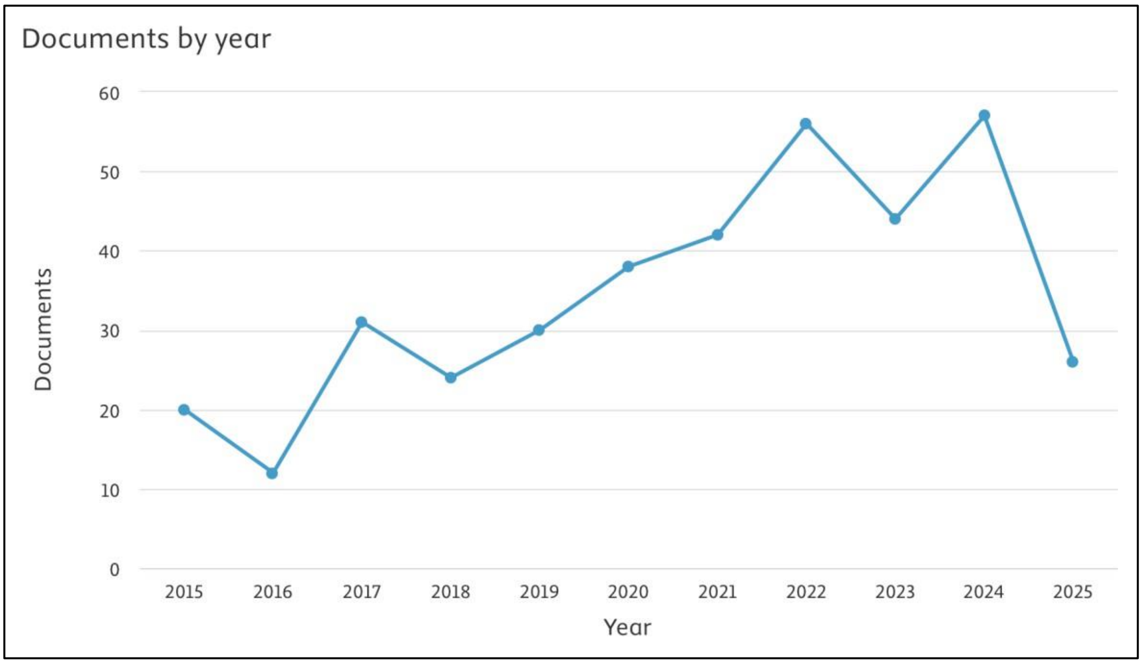

Figure 1: Documents Publication By Years.

In 2022, the output surged to 56 documents, marking one of the highest publication counts in the dataset. Although there was a slight decrease in 2023 with 44 documents, the field rebounded in 2024 with the highest annual output recorded at 57 documents. In 2025, a significant decline is observed with only 26 documents published. This reduction, however, is likely due to the partial year of data collection, as bibliometric analyses conducted mid-year often reflect incomplete indexing. Overall, the data illustrates a clear upward trend in scholarly output, especially from 2018 onwards, signifying a maturing research field. The peak outputs in 2022 and 2024 may also correlate with global shifts in academic focus, funding priorities, or the introduction of new theoretical or methodological frameworks within the discipline. The slight fluctuations year-on-year are expected in bibliometric data and do not detract from the overall positive growth pattern.

2. Who are the most influential authors in the field?

Figure 2 illustrates an analysis of the top contributing authors in the selected dataset of 380 documents published between 2015 and 2025. Based on the visualization, the ten most prolific authors have each contributed significantly to the development of the research area under investigation. Shell, D.F. and Soh, L.K. emerge as the most influential authors, each with five publications. Their consistent scholarly output suggests a sustained engagement and possibly leadership in shaping discourse within the field. Following closely are Aschauer, W., Haim, K., Hwang, G.J., and Sajidan, each contributing four documents. These authors represent a cohort of active researchers who have made repeated and meaningful contributions to the literature, likely through collaborative networks and sustained thematic exploration.

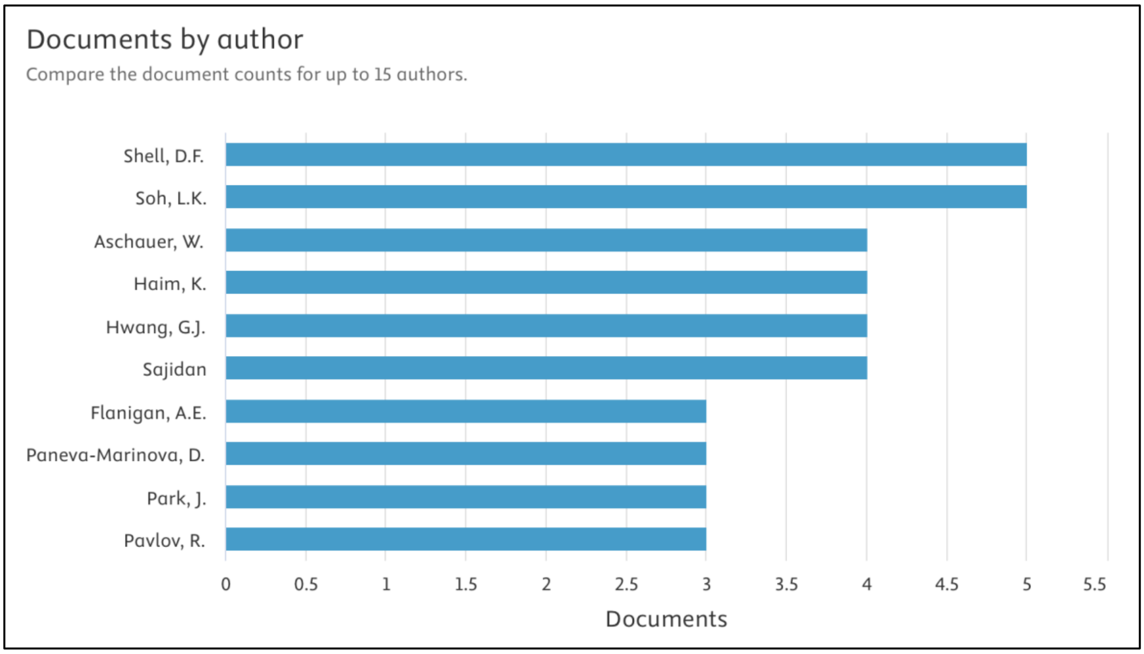

Figure 2: Most Influential Authors in The Field.

Authors such as Flanigan, A.E., Paneva-Marinova, D., Park, J., and Pavlov, R., each with three publications, also hold notable positions within the scholarly landscape. While their output is slightly lower in quantity, their inclusion in the top ten suggests that their work is still central to ongoing discussions and may reflect either high-impact publications or involvement in emerging subtopics. This author-level analysis reveals a moderately distributed pattern of authorship, with no single dominant figure, which may indicate a collaborative and interdisciplinary nature of the research field. Furthermore, the diversity of names suggests a global academic interest, likely reflecting international contributions to the evolving body of literature. Such findings are essential for identifying potential collaborators, influential thought leaders and intellectual trends shaping the research trajectory in the studied domain.

3. What is the distribution of research publications according to subject area?

Figure 3 displays the distribution of research publications by subject area, offering insight into the disciplinary focus of scholarly output within the dataset. The data reveals a strong concentration of research in the Social Sciences, which accounts for 57.2% of the total publications (n = 380). This dominance suggests that the core discourse and theoretical underpinnings of the research topic are heavily grounded in social science paradigms, including education, sociology and human development studies. Computer Science emerges as the second most represented domain, comprising 10.1% of the documents. This reflects a growing intersection between technological tools and social applications, likely indicating the integration of digital learning, artificial intelligence or educational technologies within social science research. Engineering ranks third with 7.7%, underscoring the relevance of applied scientific knowledge and design processes, potentially tied to STEM education, problem-solving or interdisciplinary innovation. The Psychology field contributes 6.0% of the

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publications, suggesting an interest in cognitive, behavioral or motivational aspects relevant to the social sciences.

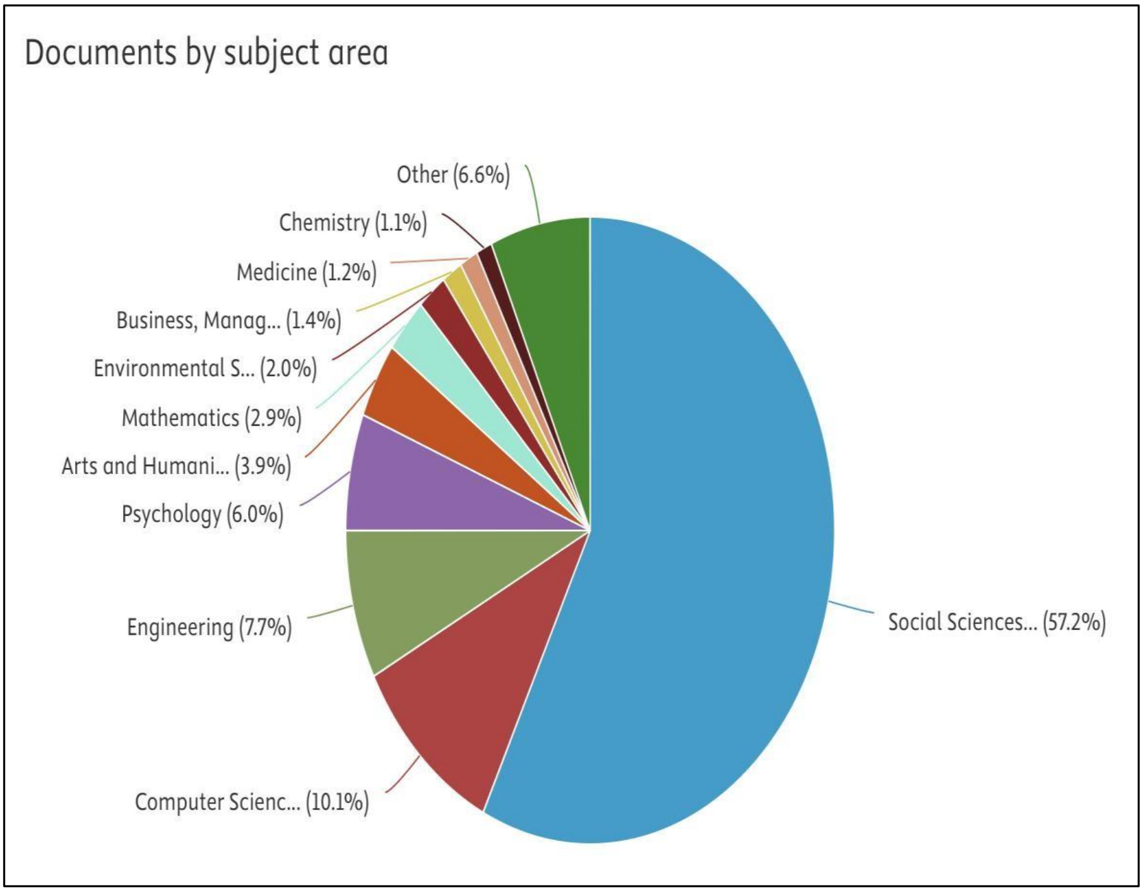

Figure 3: Distribution of Research Publications By Subject Area.

Smaller yet notable contributions come from Arts and Humanities (3.9%), Mathematics (2.9%), and Environmental Science (2.0%), illustrating the multidisciplinary nature of the research landscape. Fields such as Business, Management and Accounting (1.4%), Medicine (1.2%), and Chemistry (1.1%) are minimally represented, reflecting more peripheral engagement. Finally, the 'Other' category (6.6%) captures a diverse array of publications that fall outside traditional classifications, potentially encompassing interdisciplinary or emerging fields. Overall, this subject area analysis highlights the research's strong social orientation while also demonstrating an increasing convergence with technological, psychological, and engineering domains. This reflects the interdisciplinary evolution of the field and underscores the broad applicability of the research theme.

4. What is network mapping according to popular keywords related to the study?

Figure 4 illustrates a keyword co-occurrence network generated using VOSviewer, based on 55 documents from the selected bibliographic dataset. The map visualizes how frequently terms appear together in the literature, with node size indicating keyword frequency and line thickness representing the strength of co-occurrence links. At the core of the map, the keyword "creative thinking" emerges as the most dominant and interconnected term. Its prominent position and large node size highlight its role as a central construct, closely associated with other key terms such as "students," "education," "critical thinking," "scientific creativity," "creativity," and "STEM". This centrality indicates that creative thinking serves as a pivotal theme through which various cognitive, pedagogical, and disciplinary perspectives are explored. The red cluster, featuring terms like "students," "engineering education," "curricula," "learning systems," and "e-learning," reflects a focus on instructional design and educational technologies that support the development of creative thinking. It suggests a strong emphasis on how structured pedagogical practices and digital tools can cultivate creativity among learners.

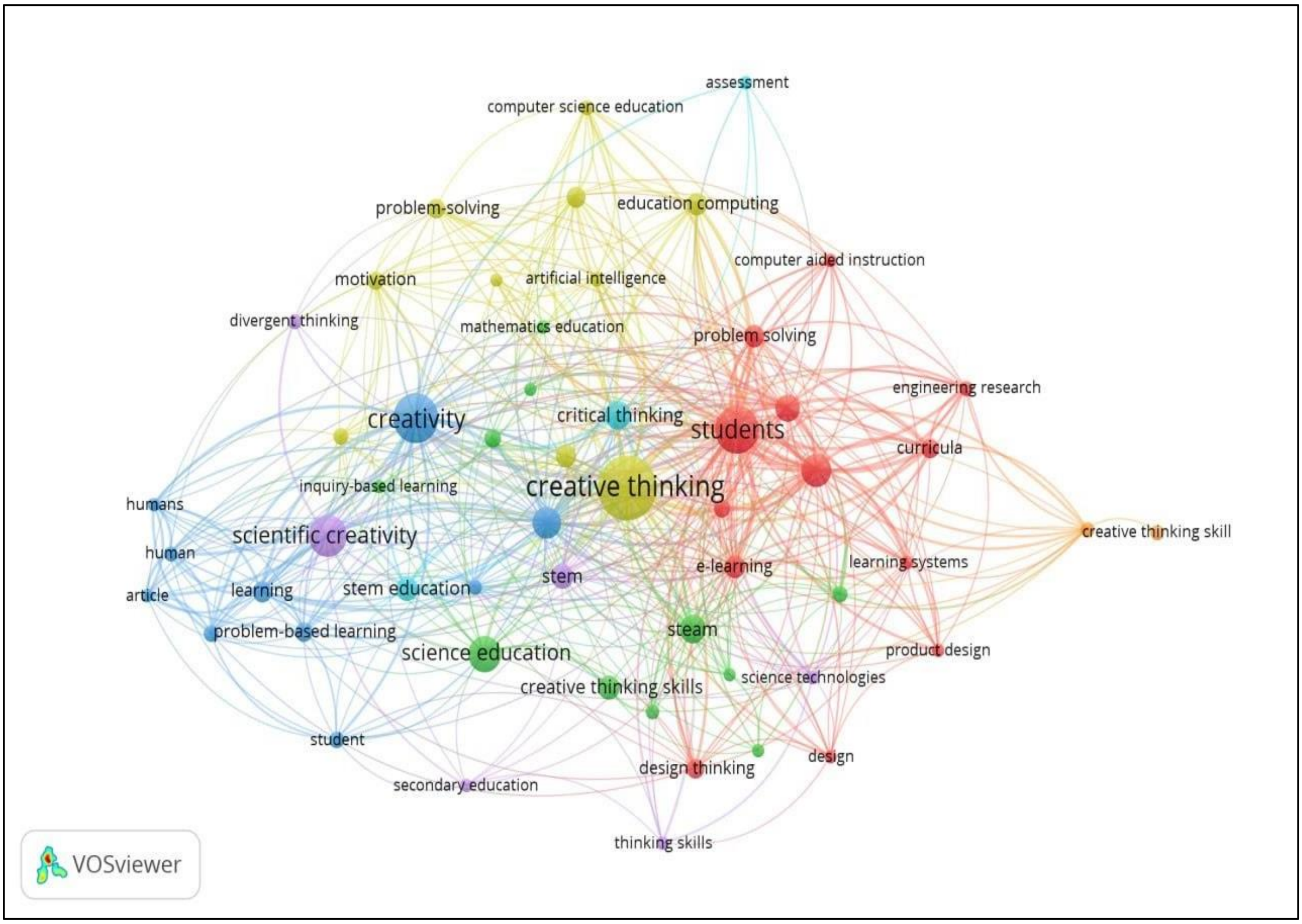

Figure 4: **Network Visualizations Map of Keywords' Co-Occurrence**

The blue and purple clusters, which include "creativity," "scientific creativity," "STEM education," "problem-based learning," and "inquiry-based learning," represent educational approaches that aim to foster creative capacities through inquiry, research-based activities, and science instruction. These clusters underscore the interdisciplinary integration of creativity within science and STEM education. Meanwhile, the yellow and green clusters contain terms such as "critical thinking," "motivation," "self-efficacy," "mathematics education," and "augmented reality." These clusters highlight the psychological and technological factors that support creative learning, pointing to the importance of learner attitudes and digital innovations in promoting higher order thinking skills. Additionally, peripheral but meaningful nodes such as "design thinking," "product design," and "science technologies" indicate an emerging emphasis on innovation and engineering-based problem-solving, particularly within STEM and STEAM contexts.

In conclusion, the visualisation reveals that creative thinking functions as an integrative theme linking a wide array of educational, cognitive, and technological domains. The map illustrates the field's interdisciplinary development and reinforces the notion that cultivating creativity is a complex, multifaceted process that benefits from diverse pedagogical strategies and cross-disciplinary collaboration.

5. What is network mapping according to Co-citation between authors?

Figure 5 presents an author co-citation network map generated through VOSviewer, consisting of 59 authors grouped into six clusters. Each node represents an author, with the node size indicating the frequency of co-citation, and the connecting lines showing the strength of relationships between them. This co-citation analysis reveals prominent scholars and their interconnectedness, helping to identify thematic cores, influential figures, and disciplinary bridges.

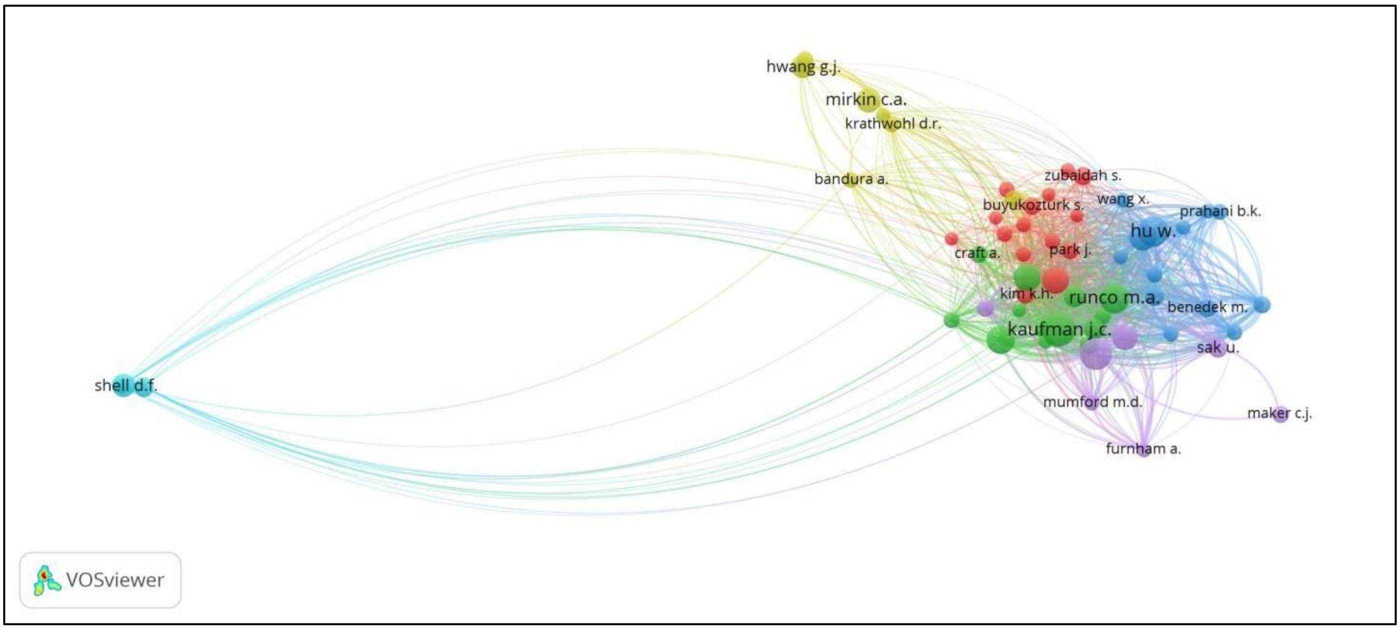

Figure 5: **Network Visualisation Map of Author Co-Citation**

At the centre right of the network lies a densely clustered group of scholars, including Kaufman J.C., Runco M.A., Hu W., Park J., and Mumford M.D., who are frequently co-cited. Their large node sizes and dense interlinkages signify their strong influence and foundational contributions, particularly in the fields of creativity research, psychology and education. The centrality and proximity of these authors indicate a cohesive body of scholarship that serves as the theoretical and methodological backbone of this research area. Surrounding this core are multiple smaller but interconnected clusters, each representing distinct but related subdomains. Authors such as Craft A., Kim K.H., and Buyukozturk S. are closely linked with the core cluster, suggesting contributions to applied educational contexts and regional creativity studies. Meanwhile, Sak U., Benedek M., and Furnham A. appear on the periphery of the central cluster but are still well integrated, indicating specialized yet influential works.

Significantly, Shell D.F. appears isolated on the far left of the map yet maintains numerous connecting lines to the central and surrounding clusters. This placement suggests that while Shell's work is conceptually distinct, possibly focusing on self regulated learning, motivation or educational assessment, it is frequently cited across various contexts and highlights its interdisciplinary relevance. The clear spatial separation, along with robust citation linkages, reinforces Shell's role as a bridge between different thematic domains. Authors such as Bandura A., Krathwohl D.R., Mirkin C.A., and Hwang G.J. occupy a strategic intermediate space in the upper middle region of the network. Their positioning reflects theoretical importance, as seen in Bandura's self efficacy theory, Krathwohl's educational taxonomies, and Hwang's work on technology enhanced learning, which are foundational to many studies but are not as tightly clustered due to their broader conceptual scope.

Overall, this co-citation network illustrates a well organised and interdisciplinary citation landscape, with creativity focused scholars at the centre, supported by various theories and methods. The unique yet connected positions of authors like Shell D.F. and Bandura A. highlight the wide range of ideas shaping the field, showing that current research on creativity and education is strongly influenced by psychology, teaching practices and input from different disciplines.

6. What is network mapping according to Co-authorship between countries?

Figure 6 presents the co-authorship network map between countries, based on bibliometric data involving 19 contributing nations and organised into five distinct clusters. This co-authorship analysis reflects the patterns of international collaboration within the field, highlighting both regional cooperation and the central roles of certain countries in connecting global research networks. The network identifies two major zones. On the left side, countries such as Malaysia, Indonesia, China, India, Taiwan, Australia and the United Kingdom are situated closer together, forming a densely interconnected network. Among them, Indonesia and Malaysia emerge as notable contributors, evidenced by their larger node sizes and multiple collaborative links. These countries form strong regional research ties especially within Asia, and indicate active bilateral or multilateral research collaborations.

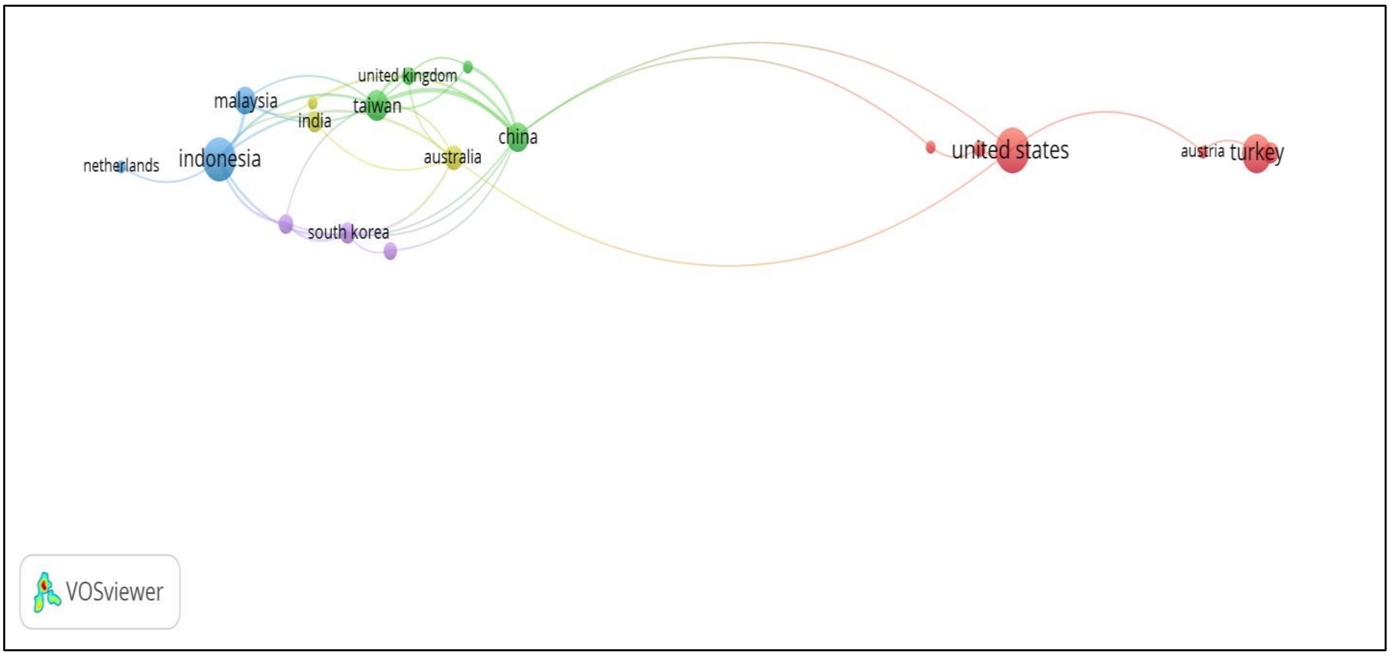

Figure 6: The Co-Authorship Countries' Collaboration

In particular, Indonesia appears as one of the most prominent nodes in this cluster, with co-authorship links extending to Malaysia, China, the Netherlands and South Korea. Similarly, Malaysia is closely linked with Indonesia, Taiwan and the United Kingdom, suggesting that Southeast Asian countries are actively engaged in cross-border academic partnerships. China and India also serve as important bridging countries within this region, connected to both regional and global collaborators such as Australia and the United Kingdom. On the right side of the network, the United States stands out as a highly influential contributor with a large node size and clear co-authorship ties to other countries, including Finland, Austria and Turkey. This group, while slightly less connected to the denser Asian-European cluster, demonstrates strong internal collaboration. The position of the United States in this region of the map reflects its role as a global leader in academic research, maintaining independent but impactful collaborations with countries beyond the central Asian cluster.

In summary, the co-authorship map reveals a regionally concentrated and moderately globalised research landscape, with Southeast Asian countries like Indonesia and Malaysia playing a central role in collaboration. At the same time, countries such as the United States and Turkey function as powerful research hubs with distinct partnership patterns. This distribution reflects both regional academic integration and global participation, suggesting that while global collaboration is present, much of the research effort remains geographically concentrated and regionally driven.

CONCLUSION

This bibliometric analysis, offers a comprehensive overview of scientific creativity research within the context of science education, based on Scopus-indexed publications from 2015 to 2025. The findings reveal an overall positive trend in publication output, particularly since 2018, suggesting that scholarly interest in this field is growing steadily. Peaks in publication activity in 2022 and 2024 indicate responsive shifts likely influenced by global educational priorities and evolving methodological approaches. Although a slight drop is observed in 2025, it is likely due to the ongoing nature of the year's data collection rather than a true decline.

The investigation into influential authors highlights a moderately distributed pattern of authorship, with key contributors such as Shell D.F. and Soh L.K. consistently shaping the field. The diversity among top authors also reflects the collaborative and interdisciplinary nature of the research domain. The distribution of publications across subject areas further confirms the field's interdisciplinary breadth. While Social Sciences dominate, the presence of contributions from Computer Science, Engineering, Psychology and other domains underscores the field's integration of both humanistic and technological dimensions. Keyword co-occurrence analysis reveals that "creative thinking" stands as the central theme, closely connected to core concepts such as education, critical thinking and STEM. This finding highlights the role of creativity as a foundational construct that bridges various pedagogical and cognitive domains. The network also demonstrates the integration of digital technologies, learner motivation, and inquiry-based methods as central to current research efforts.

The author co-citation analysis uncovers a cohesive intellectual foundation, with figures such as Kaufman J.C., Runco M.A., and Hu W. emerging as pivotal. These scholars anchor the field's core, supported by others such as Shell D.F. and Bandura A., whose work connects multiple disciplinary perspectives. The map reinforces the idea that creativity in science education is deeply informed by psychological theory, learning sciences and educational innovation. Finally, the co-authorship network reveals both regional and global collaboration patterns. Southeast Asian countries, particularly Indonesia and Malaysia, are shown to be central within regional partnerships, while countries such as the United States act as independent but significant global contributors. These patterns reflect a research landscape that is regionally concentrated but gradually expanding toward broader international cooperation.

In conclusion, this study affirms that scientific creativity in science education is a vibrant and expanding field, characterized by interdisciplinary collaboration, conceptual diversity and increasing global engagement. The insights generated from this analysis can serve as a valuable foundation for future research directions, policymaking, and cross-border academic initiatives aimed at strengthening creativity in science education worldwide.

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