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The Evolution of Research on Critical and Creative Thinking Skills in Education (2017-2026) : A Bibliometric Study

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ABSTRACT

This study aims to analyze the evolution of research on critical thinking skills and creative thinking skills in education during the period 2017–2026 using a bibliometric approach. Data were collected from Google Scholar through Publish or Perish and Dimensions.ai and analyzed using VOSviewer to generate network, overlay, and density visualizations. The findings reveal a significant increase in publication output over the last decade, reflecting growing global interest in these competencies. Journal articles emerged as the dominant publication type, while education was identified as the leading research field. The results also indicate strong connections between critical thinking and creative thinking, with creativity, creative thinking, critical thinking skills, relationship, and higher education appearing as the most influential keywords. Visualization analyses demonstrate that these concepts form an interconnected knowledge structure and have increasingly been associated with educational innovation, digital transformation, and 21st-century skills development. Furthermore, the research themes show strong alignment with several Sustainable Development Goals (SDGs), particularly Quality Education. Overall, the findings suggest that critical thinking and creative thinking have evolved into complementary and multidisciplinary competencies that play a strategic role in education and human development. Future research should focus on integrating these competencies with emerging technologies and innovative learning environments.

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Introduction

The rapid advancement of digital technologies, Artificial Intelligence (AI), and the increasing flow of global information has transformed the landscape of 21st-century education (Rahimi & Oh, 2024). Education is no longer solely oriented toward the acquisition of knowledge; rather, it emphasizes the development of higher-order thinking skills that enable learners to adapt to changing environments, solve complex problems, and generate innovative solutions across various real-life contexts (Richland & Simms 2015). In this regard, critical thinking skills and creative thinking

skills have emerged as two essential competencies that are widely recognized as crucial for addressing future challenges (Thornhill-Miller et al, 2023).

The importance of these competencies has been increasingly highlighted in various international reports. The World Economic Forum, through its *Future of Jobs Report 2025*, identified analytical thinking and creative thinking as among the most essential skills required in the future workforce. The report further projects that approximately 39% of current job-related skills will undergo significant transformation by 2030 due to rapid technological advancements and ongoing digital transformation. This trend indicates that critical and creative thinking skills are no longer regarded as merely complementary competencies; rather, they have become fundamental requirements for individuals to adapt and remain competitive in an era characterized by technological disruption (Peters & Maatman, 2017). The Organisation for Economic Co-operation and Development (OECD), through the *Programme for International Student Assessment (PISA) 2022*, incorporated creative thinking as a globally assessed competency for the first time. OECD defines creative thinking as the capacity to generate diverse and original ideas, as well as to evaluate and refine those ideas in order to produce meaningful and valuable solutions. This initiative reflects the growing recognition of creativity as an educational competency that is equally important as other academic skills in preparing young generations to address increasingly complex social, economic, and technological challenges (Isabirye et al, 2025).

From an educational perspective, critical thinking skills and creative thinking skills are considered complementary competencies (Chang et al, 2015). Critical thinking enables learners to analyze information logically, evaluate evidence, identify weaknesses in arguments, and make informed decisions (Hitchcock, 2017). In contrast, creative thinking facilitates the generation of novel ideas, the exploration of alternative solutions, and the development of innovative approaches to addressing problems (Revenko et al, 2024). The integration of these two competencies provides an essential foundation for cultivating learners who are not only capable of understanding problems in depth but also able to develop relevant and innovative solutions to complex challenges (Caena & Redecker, 2019). The growing importance of these competencies has attracted increasing attention from researchers worldwide. Numerous studies have examined the relationship between critical and creative thinking, effective instructional strategies for fostering these skills, their implementation across various disciplines, and their impact on students' learning outcomes (Saroyan, 2022). This growing body of research indicates that critical and creative thinking have become major areas of focus in educational research over the past decade (Padget, 2013). However, the rapid increase in scientific publications has resulted in a vast and fragmented body of knowledge, making it challenging to obtain a comprehensive understanding of research trends, dominant themes, and the conceptual relationships between these two constructs.

Although research on critical thinking and creative thinking has expanded considerably, most existing studies have primarily focused on examining the relationships between these variables within specific educational contexts (Ülger, 2016). Studies that systematically map the global evolution of research on the interconnection between these two competencies remain relatively limited (Reyes & Morales, 2021). Nevertheless, understanding research trends, publication productivity, scientific collaboration networks, and keyword co-occurrence patterns is essential for identifying research gaps and establishing future research directions (Yuan et al, 2022). Such insights can provide a more comprehensive understanding of the development of this field and support the advancement of both theoretical and practical knowledge.

Given these circumstances, a bibliometric study is needed to provide a comprehensive overview of the development of research on critical thinking skills and creative thinking skills. Bibliometric analysis enables the identification of publication trends, leading publication sources, influential researchers, emerging research categories, and the interrelationships among concepts that shape the knowledge structure of a particular field of study (Kumar, 2025). Therefore, this study aims to analyze the evolution of research on critical thinking skills and creative thinking skills in education during the period 2017–2026 using a bibliometric approach. Specifically, the study seeks to identify publication trends, major publication sources, research categories, the most productive researchers, and keyword relationship patterns that illustrate the connection between critical and creative thinking skills. The findings are expected to provide a comprehensive understanding of the intellectual development of this research area and serve as a valuable reference for researchers and educational practitioners in determining future research directions and advancing educational practices.

Method

This study employed a descriptive bibliometric analysis approach to identify and examine the evolution of research on critical thinking skills and creative thinking skills in education during the period 2017–2026. The analysis focused on exploring the relationship between critical thinking skills and creative thinking skills as the primary research variables. The research data were obtained from the Google Scholar database, which was selected due to its extensive coverage of scholarly publications and its indexing system, which is considered both credible and relevant for bibliometric studies (Halevi et al, 2017). The metadata collection process was conducted

using *Publish or Perish* (PoP) and *Dimensions.ai* software, employing primary keywords related to critical thinking skills and creative thinking skills in educational research.

A total of 1,000 indexed scholarly documents were analyzed using *Dimensions.ai* to map the relationship between critical thinking skills and creative thinking skills, while a larger dataset was also examined through *Dimensions.ai* to broaden the scope of the analysis. The retrieved data were subsequently processed using *VOSviewer* to generate network, overlay, and density visualizations, enabling the systematic identification of keyword relationships and thematic development patterns within the research field. The analysis was conducted through two main approaches. First, a quantitative analysis was performed using bibliometric visualization techniques in *VOSviewer* to map keyword co-occurrence, citation relationships among publications, and dominant research themes. Second, a qualitative analysis was carried out through an in-depth review of selected key publications to gain a deeper understanding of how critical thinking skills and creative thinking skills have been conceptualized and implemented, as well as to identify the challenges and opportunities associated with their development in the digital era. This approach is consistent with previous bibliometric studies that have emphasized the importance of bibliometric analysis in examining the dynamics and evolution of research within educational technology and related fields over the past decade (Huang et al, 2020).

Result and Discussion

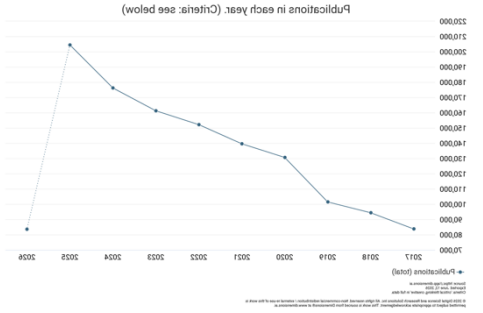

Figure 1. Research Trends in The Evolution of Research on Critical and Creative Thinking Skills in Education

Overall, the publication trend exhibited a substantial increase over time. The number of publications rose from approximately 85,000 documents in 2017 to more than 200,000 documents in 2025, indicating growing scholarly interest in these two competencies across various research fields. This consistent growth suggests that critical thinking skills and creative thinking skills have become major areas of focus in global research aimed at addressing the demands of the 21st century. The notable increase in publications observed during the 2020–2025 period may be attributed to the growing adoption of 21st-century learning paradigms that emphasize the development of higher-order thinking skills (HOTS) (Venkatraman et al, 2022). During this period, educational systems worldwide increasingly integrated critical and creative thinking skills into curricula, instructional models, and assessment frameworks (González-Pérez & Ramírez-Montoya, 2022). Furthermore, the acceleration of digital transformation in education following the COVID-19 pandemic stimulated a growing body of research investigating strategies for fostering these competencies through digital technologies, online learning environments, and innovative pedagogical approaches (Deroncele-Acosta et al, 2023).

The increasing publication trend also reflects a growing global recognition of the interrelationship between critical thinking and creative thinking in developing individuals who are adaptive, innovative, and capable of addressing complex problems (Thornhill-Miller et al, 2023). In contemporary educational research, these competencies are no longer viewed as independent constructs; rather, they are increasingly recognized as complementary skills that jointly contribute to problem-solving and decision-making processes (Greiff et al, 2013). Consequently, researchers have shown increasing interest in exploring both the conceptual and empirical relationships between these two competencies.

Meanwhile, the decline in publication output observed in 2026 should not be interpreted as a decrease in research interest in this field. Rather, this decline is more likely attributable to limitations in data coverage, as the indexing process for publications released in 2026 was still ongoing at the time of data collection. Similar patterns are commonly reported in bibliometric studies that utilize data from the current publication year, since a proportion of recently published articles may not yet have been fully indexed in the selected databases (Akhavan et al, 2016).

Table 1. Research Trends in The Evolution of Research on Critical and Creative Thinking Skills in Education Based On Publication

Publication Type	Publication
Article	1,227,131
Chapter	472,771
Edited Book	169,297
Monograph	167,568
Preprint	53,669
Proceeding	40,121

The results indicate that journal articles represent the most dominant publication type, accounting for 1,227,131 documents, far exceeding all other publication categories. The predominance of journal articles suggests that research on critical thinking skills and creative thinking skills has evolved into a well-established field characterized by high levels of scholarly productivity (Saroyan, 2022). Journal articles serve as the primary medium for

disseminating empirical findings, largely due to their rigorous peer-review process, which ensures the quality, reliability, and credibility of published research (Kharasch et al, 2020).

A substantial number of publications were also identified in the book chapter category, with a total of 472,771 documents. This finding indicates that discussions surrounding critical and creative thinking extend beyond empirical investigations to include conceptual analyses, theoretical development, and pedagogical discourse, which are frequently disseminated through academic books and educational reference volumes (Baddane & Ennam, 2024). The large number of book chapters further suggests that these topics have become integral components of global educational discourse, particularly in relation to 21st-century skills, educational innovation, and human capacity development (Reimers & Chung, 2019).

Meanwhile, the relatively high numbers of edited books and monographs reflect systematic efforts to compile, synthesize, and integrate diverse research findings into more comprehensive scholarly works. The presence of these publication types indicates that research on critical and creative thinking has reached a level of maturity that supports the development of more sophisticated theoretical and conceptual frameworks (Ramírez-Montoya et al, 2022). In other words, the field has progressed beyond merely examining relationships among variables and has increasingly moved toward integrating diverse disciplinary perspectives to advance theoretical understanding. In contrast, the lower number of publications in the preprint and conference proceeding categories suggests that most studies in this field continue to be disseminated through formal scholarly channels that undergo academic evaluation and quality assurance processes. Nevertheless, preprints and conference proceedings continue to play an important role in accelerating knowledge dissemination and fostering scholarly discussion, particularly in emerging and rapidly evolving research areas (Wang et al, 2025).

Table 2. Top 20 Sources Title in Trends in The Evolution of Research on Critical and Creative Thinking Skills in Education

Name	Publications	Citations	Citations Mean
SSRN Electronic Journal	19,118	95,338	4.99
Sustainability	16,822	438,044	26.04
Research Square	14,330	8,213	0.57
arXiv	12,093	16,854	1.39
Frontiers in Psychology	12,054	309,861	25.71
Behavioral and Brain Sciences	8,921	201,399	22.58
PLOS ONE	8,752	261,664	29.90
Lecture Notes in Computer Science	7,579	52,405	6.91
Advances in Social Science, Education and Humanities Research	7,335	7,677	1.05
Preprints.org	6,830	10,499	1.54
International Journal of Environmental Research and Public Health	5,701	148,010	25.96
Education Sciences	4,785	68,070	14.23
Journal of Physics Conference Series	4,726	28,976	6.13
Scientific Reports	4,445	75,308	16.94
Religions	3,862	16,927	4.38
Frontiers in Education	3,782	36,851	9.74
HortScience	3,226	2,667	0.83
BMC Medical Education	3,221	61,813	19.19
Lecture Notes in Networks and Systems	3,163	6,667	2.11
Encyclopedia of the UN Sustainable Development Goals	2,967	5,186	1.75

The analysis revealed that *SSRN Electronic Journal* ranked first in terms of publication output, with a total of 19,118 documents. The high number of publications in SSRN suggests that research on critical and creative thinking has developed rapidly and has been widely disseminated through platforms that facilitate the open sharing of research findings prior to formal publication. This finding reflects strong academic interest in these topics and highlights the increasing demand for rapid knowledge dissemination within the scholarly community (Zamiri & Esmaeili, 2024). Although SSRN recorded the highest publication output, its scientific impact was relatively lower than that of several other journals when assessed based on average citations per publication. In contrast,

journals such as *PLOS ONE*, *Frontiers in Psychology*, *International Journal of Environmental Research and Public Health*, and *Sustainability*demonstrated remarkably high citation counts. This finding indicates that research on critical and creative thinking extends beyond the field of education and has attracted substantial attention in psychology, public health, environmental studies, and broader social science disciplines (Shiraev & Levy, 2024). Consequently, these concepts have evolved into multidisciplinary research themes with relevance across diverse academic contexts.

Sustainability emerged as one of the most influential publication sources, with more than 16,000 publications and over 438,000 citations. The prominence of this journal suggests that critical and creative thinking are increasingly examined in relation to sustainable development, educational innovation, and competency development that support the achievement of the Sustainable Development Goals (SDGs). This trend highlights the growing recognition of these skills as essential capacities for preparing individuals to address complex global challenges (Tushar & Sooraksa, 2023). The inclusion of *Frontiers in Psychology* and *Behavioral and Brain Sciences* among the leading publication sources further demonstrates the strong psychological foundation underpinning research on critical and creative thinking. These competencies are not merely regarded as educational outcomes but are also viewed as fundamental cognitive processes involving reasoning, problem-solving, decision-making, and the generation of novel ideas. As a result, a substantial body of research on these variables has been developed from the perspectives of cognitive psychology and behavioral sciences (Lin & Guo, 2024).

In addition, the presence of educational journals such as *Education Sciences* and *Frontiers in Education* indicates that the development of critical and creative thinking skills remains a central focus of educational innovation. Studies published in these journals frequently investigate the effectiveness of instructional models, digital learning tools, project-based approaches, and other pedagogical strategies aimed at enhancing students' higher-order thinking skills. Interestingly, publication sources from the fields of technology and computer science, such as *Lecture Notes in Computer Science* and *Lecture Notes in Networks and Systems*, also demonstrated considerable productivity. This finding suggests a growing integration of critical and creative thinking research with digital technologies, artificial intelligence, computational approaches, and technology-enhanced learning environments. Such a trend aligns with the increasing demand for complex thinking skills required to navigate digital transformation in the era of Industry 4.0 and Society 5.0 (Mourtzis et al, 2022).

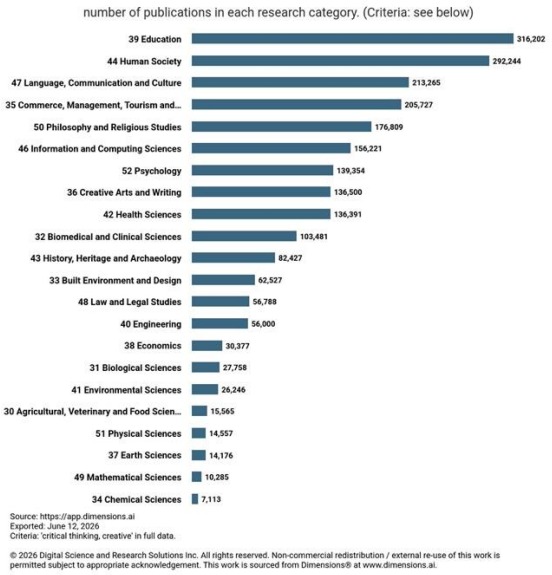

Figure 2. Research categories based on the classification of Fields of Research (ANZSRC 2020)

The visualization results indicate that *Education* represents the most dominant research category compared to other fields of study. This finding suggests that critical thinking and creative thinking continue to be regarded as core competencies and remain central to the development of modern educational systems (Ellerton & Kelly, 2022). The dominance of the education category reflects the strong scholarly interest in fostering higher-order thinking skills through various instructional models, pedagogical strategies, learning media, and curriculum innovations designed to meet the demands of the 21st century. The strong prominence of the education field further indicates that critical and creative thinking are not merely considered learning outcomes but are increasingly viewed as fundamental objectives of the educational process (Saroyan, 2022). Research within this domain has sought to identify the most effective approaches for cultivating these competencies across different educational levels, ranging from primary education to higher education (Canavesi & Ravarini, 2024). This trend demonstrates that the development of critical and creative thinking skills has become an integral component of global educational reform efforts aimed at strengthening learners' competencies for future challenges (Abdulganeey et al, 2025).

The broad distribution of research categories suggests that critical and creative thinking are no longer confined to the educational domain alone; rather, they have evolved into multidisciplinary research themes with significant relevance across diverse fields of knowledge. This pattern reflects a growing academic recognition that the complex challenges of the 21st century require individuals who are capable of both analytical and creative thinking in order to navigate dynamic and increasingly complex environments (Srivastava, 2023).

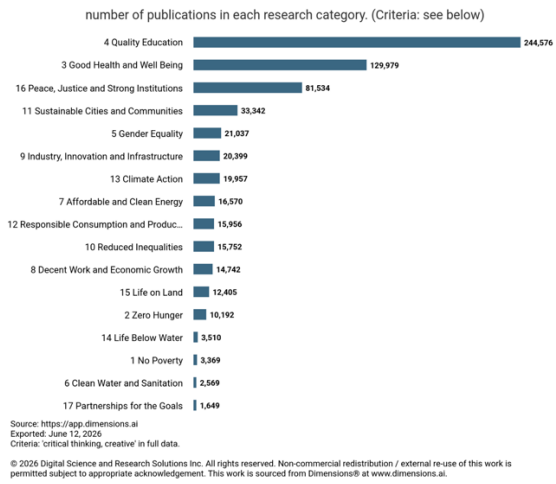

Figure 3. Research categories based on the classification of Sustainable Development Goals (SDGs)

The strongest association is observed with SDG 4 (Quality Education). The prominence of this category indicates that critical and creative thinking skills constitute key components of efforts to improve educational quality across different countries. These competencies are widely recognized as essential indicators of 21st-century skills, emphasizing learners' abilities to think analytically, solve problems, collaborate effectively, and generate innovative solutions (González-Pérez & Ramírez-Montoya, 2022). Consequently, a substantial body of research has focused on developing instructional models, pedagogical strategies, and educational technologies aimed at enhancing these competencies. In addition to SDG 4, a considerable contribution is also evident in SDG 3 (Good Health and Well-being). This finding highlights the importance of critical and creative thinking in the healthcare sector, particularly in decision-making processes, clinical problem-solving, and healthcare innovation. Within health education, critical thinking enables healthcare professionals to analyze information and make informed decisions, while creativity facilitates the development of novel solutions to emerging healthcare challenges (Hudson & Michael, 2025). These findings underscore the relevance of both competencies in supporting the effectiveness and sustainability of healthcare systems.

The broad distribution of research across multiple SDG categories suggests that critical and creative thinking have evolved into universal competencies with far-reaching implications for human development (Binagwaho et al, 2022). This finding reinforces the view that fostering these competencies should not be considered solely the responsibility of the education sector; rather, it should be regarded as a key component of global strategies aimed at addressing increasingly complex social, economic, technological, and environmental challenges.

Table 3. Top 10 Trends of Researchers Researching The Evolution of Research on Critical and Creative Thinking Skills in Education

Name Organization, Country	**Publications**	**Citations**	**Citations Mean**
Roger J R Levesque Indiana University Bloomington, United States	678	782	1.15
North-West University	510	1,052	2.06
Patrick S Madigan Saint Louis University, United States	399	339	0.85
Robert Jeffrey Sternberg Cornell University, United States	380	25,905	68.17
Saul I Gass University of Maryland, College Park, United States	336	2,575	7.66
Iztok Podbregar University of Maribor, Slovenia	219	101	0.46
Michael Adrian Peters Tsinghua University, China	211	5,512	26.12
Michael D Mumford University of Oklahoma, United States	200	17,453	87.27
Polona Šprajc University of Maribor, Slovenia	188	157	0.84
Gwo-Jen	185	9,169	49.56

Name Organization, Country	**Publications**	**Citations**	**Citations Mean**
Hwang National Taiwan University of Science and Technology, Taiwan			

The analysis revealed that Roger J. R. Levesque from *Indiana University Bloomington, United States*, was the most prolific researcher in this field in terms of publication output. The high level of scholarly productivity suggests that research on critical and creative thinking has attracted substantial attention from academics and continues to evolve as a significant theme within educational and social science research. Although publication output is an important indicator in bibliometric studies, a researcher's scientific influence should also be assessed through citation counts and average citations per publication. In this regard, Robert J. Sternberg from *Cornell University* demonstrated a particularly strong academic impact, with citation counts substantially exceeding those of most other researchers in the dataset. This finding suggests that Sternberg's contributions occupy a central position in the development of theories and research related to creativity, intelligence, and higher-order thinking processes. His considerable influence indicates that research on critical and creative thinking has not only expanded quantitatively but has also been supported by a robust theoretical foundation (Runco, 2014).

A similar pattern can be observed in the case of Michael D. Mumford from the *University of Oklahoma*, who recorded the highest average citation rate among the listed researchers. The high citation average indicates that his publications possess substantial scholarly relevance and are frequently referenced by other researchers. This finding suggests that Mumford's work on creativity and problem-solving has made a significant contribution to the advancement of the international literature on higher-order thinking skills. Furthermore, the presence of Gwo-Jen Hwang from the *National Taiwan University of Science and Technology*highlights the increasingly important role of educational technology in fostering critical and creative thinking skills. Hwang's research has primarily focused on the application of digital technologies, mobile learning, artificial intelligence, and innovative instructional approaches designed to enhance learners' thinking skills. The prominence of a researcher from the field of educational technology demonstrates that research on critical and creative thinking is becoming increasingly integrated with digital transformation in education (Moustaghfir & Brigui, 2024).

Interestingly, the most productive researchers represent a diverse range of institutions and countries, including the United States, China, Taiwan, and Slovenia. This geographical distribution indicates that research on critical and creative thinking has evolved into a global research agenda involving diverse international academic communities. Moreover, this pattern suggests the existence of cross-disciplinary and cross-national collaborations aimed at developing a more comprehensive understanding of these competencies (Cleary et al, 2019).

Table 4. Keywords on Research The Evolution of Research on Critical and Creative Thinking Skills in Education

Terms	**Occurences**	**Links**
Creativity	160	157
Creative thinking	73	150
Critical Thinking skill	35	119
Higher education	33	256
Relationship	105	149

Keyword analysis constitutes a crucial component of bibliometric studies, as it provides insights into research focus, conceptual relationships, and the developmental trajectory of a particular field of inquiry. The results indicate that the keyword Creativity recorded the highest frequency, with 160 occurrences and 157 links. This finding suggests that creativity represents the most central concept in the literature and maintains strong connections with a wide range of related research themes. The prominence of the keyword Creativity indicates that scholarly attention extends beyond the mere generation of novel ideas to encompass the role of creativity in innovation, problem-solving, learning development, and individuals' preparedness for global change. The high number of links further demonstrates that creativity serves as a bridging concept connecting diverse research domains, including education, psychology, technology, and human development (Hernández-Torrano & Ibrayeva, 2020).

The keyword Relationship ranked second in terms of frequency of occurrence. This finding suggests that a substantial proportion of studies have not examined critical thinking and creative thinking as isolated constructs; rather, they have sought to explore the relationships, interactions, and mutual influences between these competencies and other relevant factors. The prominence of this keyword indicates that research over the past decade has increasingly focused on understanding how critical and creative thinking jointly contribute to learning outcomes, problem-solving abilities, academic achievement, and the development of 21st-century competencies (Almulla, 2023). The keyword Creative Thinking, which recorded 73 occurrences and 150 links, indicates a growing emphasis on more specific investigations of creative

thinking processes as a component of higher-order thinking skills. The high level of interconnectedness suggests that creative thinking does not operate independently but interacts with other concepts such as creativity, innovation, problem-solving, and active learning. This finding reflects a shift in research focus from the broader concept of creativity toward the systematic assessment and development of creative thinking skills (Thornhill-Miller et al, 2023).

Meanwhile, the keyword Critical Thinking Skill exhibited a lower frequency of occurrence than creativity-related keywords but maintained a strong level of interconnectedness within the research network. This pattern suggests that critical thinking remains a major research theme, particularly in relation to information analysis, argument evaluation, decision making, and problem-solving. The high number of links further indicates that critical thinking is frequently examined alongside creative thinking as a complementary component of higher-order thinking skills (Chang et al, 2015). The presence of the keyword Higher Education suggests that higher education institutions constitute one of the most prominent research contexts for the development of critical and creative thinking skills. Universities are widely regarded as strategic environments for fostering higher-order thinking skills, as students are expected to engage in in-depth analysis, address complex problems, and generate innovative solutions relevant to societal and workforce demands (Gamage et al, 2022). The strong interconnectedness of this keyword indicates that higher education has served as a primary setting for investigating and developing these competencies.

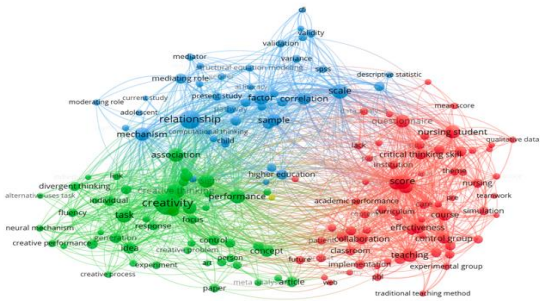

Figure 4. Network Visualization on The Evolution of Research on Critical and Creative Thinking Skills in Education

The visualization results indicate that the keyword Creativity occupies a highly central position within the research network. Its large node size and extensive connections with other keywords suggest that creativity represents a core concept that has received considerable scholarly attention across a wide range of studies. This central position indicates that creativity is not only examined as an individual capability but is also associated with various dimensions, including learning, innovation, problem-solving, the development of 21st-century skills, and the enhancement of educational quality. In addition to Creativity, the keywords Creative Thinking and Critical Thinking Skills exhibit strong connections within the research network. The close proximity of these keywords suggests that they are frequently investigated together in the literature. This finding reflects a growing tendency among researchers to view critical thinking and creative thinking as complementary competencies rather than independent constructs. Critical thinking contributes to the rational evaluation and analysis of information, whereas creative thinking facilitates the generation of innovative alternative solutions (McCuen, 2023). The integration of these competencies forms a fundamental basis for the development of higher-order thinking skills.

The presence of the keyword Relationship within the core network indicates that a substantial proportion of studies have focused on examining relationships among variables. This finding suggests that researchers are not solely concerned with developing each competency independently but are also interested in understanding how critical and creative thinking interact and contribute to various educational outcomes and aspects of individual development. Consequently, the investigation of interrelationships among variables has emerged as one of the dominant themes in the evolution of this research field over the past decade. The keyword Higher Education also occupies a prominent position within the network. This finding suggests that higher education institutions represent one of the most frequently examined contexts for investigating critical and creative thinking skills. Higher education environments provide students with extensive opportunities to engage in analysis, evaluation, idea exploration, and complex problem-solving, making them particularly suitable settings for the development and study of these competencies (Sousa & Costa, 2022).

The overall network structure further demonstrates that research on critical and creative thinking has not developed in isolation but rather forms an interconnected conceptual ecosystem. The strong interconnections among keywords indicate that the field is moving toward a more holistic perspective, in which critical and creative thinking are understood as complementary competencies required to address the challenges of the 21st century in both educational and professional contexts.

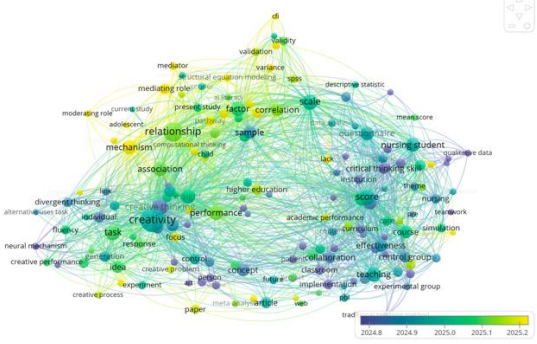

Figure 5. Overlay Visualization on The Evolution of Research on Critical and Creative Thinking Skills in Education

The visualization results indicate that research during the early period was primarily focused on fundamental concepts related to creativity, creative thinking, and critical thinking as core cognitive skills. At this stage, studies were largely directed toward understanding the characteristics of these competencies, developing measurement instruments, and examining their relationships with learning outcomes and academic achievement. The predominantly conceptual nature of this research suggests that scholars were primarily concerned with establishing a strong theoretical foundation regarding the importance of these skills in educational contexts (Aulls & Shore, 2023).

Over time, however, a noticeable shift in research focus can be observed toward broader implementation contexts. Critical and creative thinking began to be examined across diverse educational settings, particularly in higher education, project-based learning, collaborative learning environments, and problem-oriented instructional approaches. This transition indicates that research has moved beyond merely explaining theoretical concepts and has increasingly sought to identify effective strategies for fostering these competencies in educational practice (Bhardwaj et al, 2025).

The visualization further reveals that themes emerging in more recent years are strongly associated with educational innovation and digital transformation. Advances in information technology, online learning, artificial intelligence, and various digital learning platforms have stimulated the emergence of studies that integrate the development of critical and creative thinking skills with educational technology. This finding suggests that current research trends are increasingly oriented toward leveraging technology as a means of cultivating the higher-order thinking skills required in the 21st century.

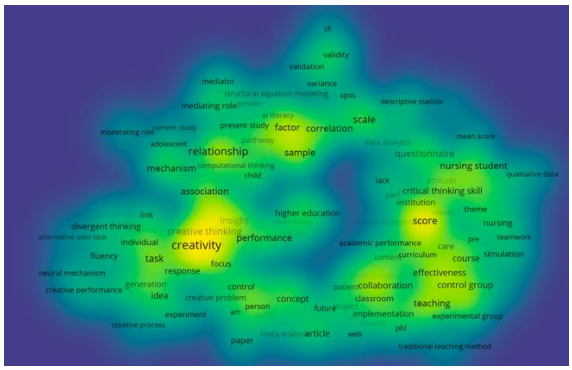

Figure 6. Density Visualization on The Evolution of Research on Critical and Creative Thinking Skills in Education

The density visualization indicates that the highest concentration of research activity is centered around the keyword Creativity. This finding suggests that creativity has been the most dominant theme and has served as the core focus of research development over the past decade. The high density observed in this area demonstrates that creativity is not only a primary research topic but also a convergence point for various studies related to learning, innovation, competency development, problem-solving, and 21st-century skills. This prominent position confirms that creativity functions as a central concept shaping the knowledge structure of this research field.

High-density areas are also evident around the keywords Creative Thinking and Critical Thinking Skills. This finding indicates that both competencies have consistently remained at the forefront of scholarly attention and maintain strong connections with a wide range of related research themes. The substantial density associated with these keywords suggests that the global research community increasingly recognizes the importance of integrating critical and creative thinking in supporting learning processes, decision-making, and complex problem-solving. Consequently, these competencies can be regarded as fundamental components in the development of higher-order thinking skills.

The presence of the keyword Relationship within a high-density area further reinforces earlier findings that research on critical and creative thinking has largely focused on examining relationships among variables. The prominence of this keyword indicates that researchers are not only interested in developing each competency independently but are also concerned with understanding the patterns of interaction, influence, and contribution between these competencies across various educational contexts and aspects of individual development. This pattern helps explain why investigations into the relationship between critical and creative thinking continue to represent one of the most extensively explored themes in the scientific literature.

Furthermore, the high density associated with the keyword Higher Education indicates that higher education represents the most prominent research context for the development of critical and creative thinking skills. Universities are widely viewed as academic environments that provide students with opportunities to develop analytical, evaluative, reflective, and innovative capacities through diverse learning experiences. Consequently, many studies have utilized higher education settings to examine the effectiveness of instructional models and strategies designed to foster higher-order thinking skills.

Conclusion

This bibliometric study provides a comprehensive overview of the evolution of research on critical thinking skills and creative thinking skills in education from 2017 to 2026. The findings reveal a substantial increase in publication output over the past decade, indicating growing global interest in these competencies as essential components of 21st-century education. The dominance of journal articles, the increasing contribution of multidisciplinary research fields, and

the strong association of these topics with several Sustainable Development Goals (SDGs) demonstrate their broad relevance beyond educational contexts.

The analysis further shows that creativity, creative thinking, and critical thinking skills constitute the core themes of the research landscape. Keyword network, overlay, and density visualizations consistently indicate strong conceptual connections among these constructs, suggesting that critical and creative thinking are increasingly viewed as complementary competencies rather than independent abilities. Higher education emerged as one of the most prominent research contexts, while educational innovation, digital transformation, and technology-enhanced learning have become important directions in recent studies.

Overall, the results confirm that critical thinking and creative thinking have developed into interconnected and multidisciplinary research domains with significant implications for education, innovation, and human development. Future research should further explore the integration of these competencies within emerging educational technologies, artificial intelligence, and innovative learning environments to address the evolving demands of the digital era and support sustainable development.

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