

Study of creative thinking skills: a bibliometric analysis

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Abstract

This study aims to review creative thinking skills. This research method is a systematic literature review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram using 2,179 scientific articles from the Dimensions database from 2014-2023. A review of the article used in this study is by using the VOSViewer application. This study produced useful findings. The results of this study contribute to developing research related to creative thinking skills. The limitation of this study is that it only uses database dimensions so it cannot describe comprehensively research trends in creative thinking skills around the world. Further research is recommended to use scientific articles sourced from international journals such as Science Direct, Springer, and Scopus.

Keywords: Bibliometric analysis; creative thinking; creative thinking skills

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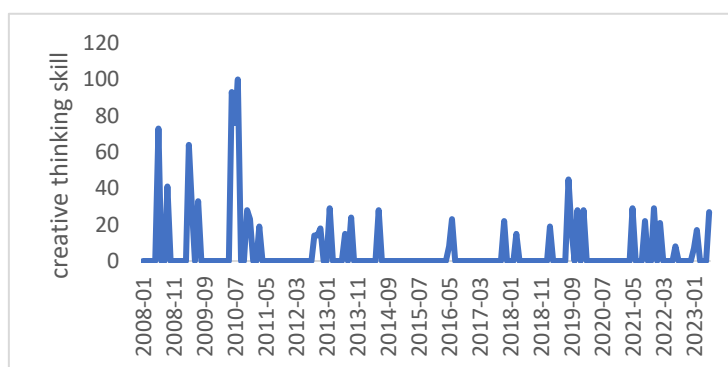
1. Introduction

Creative thinking skills are one of the skills needed in the 21st century (Taar & Palojoki, 2022; Mitani, 2021). The importance of creative thinking is based on students' ability to create innovations to solve a problem (Chrysikou et al., 2020; Le, 2023; Sternberg, 2024). Creative thinking skills are also capable of generating new, complex, and innovative ideas (Goda et al., 2022; Yingprayoon, 2017). Through the process of combining unexpected concepts and looking at problems from different angles (Azaryahu et al., 2023). This ability to think creatively involves associative thinking; Connecting new ideas to create something new and original; Seek to present unprecedented solutions or ideas; To illustrate this idea, students need to solve the problem from different angles. This allows students to adapt to change and find alternative solutions to problems (Smyrnaïou et al., 2020; Stolz et al., 2022; Eshet & Margaliot 2022). Therefore, the ability to think creatively can produce innovative and unlimited thinking. In identifying the problem, critically analyze the factors involved (Dupri et al., 2021; Smyrnaïou et al., 2020). Thus, creative thinking plays an important role in learning and is also a suitable topic of discussion to be researched at this time.

Research related to the topic of creative thinking skills around the world has seen a rise. In line with this statement, creative thinking research has increased from year to year in publications (Jumadi et al., 2020; Palupi et al., 2020). The data obtained from Google Trends by providing the keyword: Creative Thinking Skill from January 2008 to March 2023 can be seen in Figure 1.

Figure 1

Topic interest in creative thinking skills



Source: Google Trends

The data obtained can illustrate the interest in creative thinking skills topics that have been reviewed globally. On the other hand, researchers who want to study the topic of creative thinking skills need more specific information, for example, scientific publications in the form of scientific articles on the topic of creative thinking skills. Thus, data on creative thinking skills require scientific articles as the basic material for conducting this research.

For research on the ability to think creatively in the future, researchers need knowledge about trends and novelty. This is a problem that often arises in research. However, bibliometric analysis related to the ability to think creatively is used to find out trends and novelties that do not yet exist. In detail, this research was conducted to answer the following questions. 1) research trends, 2) productive areas of research, 3) what countries are most productive, 4) what research institutions are most productive, 5) what journals have the most articles, 6) whether there is research that dominates, 7) how to get novelty for future research, and 8) What is the future research direction that recommended.

Bibliometric analysis is a research method that uses bibliographic data to measure, analyze, and evaluate the quantity, quality, and impact of scientific publications (Ellegaard & Wallin, 2015; Kokol et al., 2021; Kumar et al., 2023). This method utilizes bibliographic information such as article title, author name, publisher's journal, year of publication, and citation to evaluate trends, patterns, and contributions of scientific papers. Bibliometric analysis is often used in the fields of information science, bibliometrics, and science and technology (Prieto-Gutiérrez & Segado-Boj, 2019; Sahu & Parabhoi, 2020; Siddique et al., 2021). The main purpose of this analysis is to provide insight into research performance, author productivity, publication impact, as well as interaction and collaboration between authors,

journals, or institutions. Commonly used bibliometric methods such as: Analyzing citations received by an article to evaluate its impact in the scientific literature and identify the most influential works. Identify frequently cited works together to reveal the relationships and linkages between scientific publications. Analyze collaborative networks between authors, institutions, or countries to understand patterns of scientific cooperation and identify the most influential entities in the network. Count the number of publications and citations received by authors to evaluate the productivity and impact of their work. Identify research trends by looking at patterns of publications, citations, or keywords to understand developments in a field of study.

1.1. Purpose of study

In practice, bibliometric analysis often uses tools and techniques such as text indexing, natural language processing, network analysis, and statistics. Thus, the results of bibliometric analysis can be used by researchers, publishers, and research institutions for trends and strategies in the field of research that will be carried out in the future. The purpose of this study is to identify trends in the number of research that has been published on the topic of creative thinking skills, research fields, researchers' countries of origin, institutions, journals where to publish, keyword networks, and future research directions with a period of 2014 to 2023 through bibliometric analysis.

1.2. Literature review

Table 1 is the result of a literature review, and its purpose is to present guidelines and frameworks for international research. This research is associated with project-based learning to acquire creative thinking skills. The interrelation of each conceptual variable in this field of research is known as a definition. The aim is to provide a conceptual framework that guides research for the interpretation of results. Table 1 presents the main research articles dealing with the theoretical and conceptual structure of the research topic. So that a thorough and concrete analysis can be carried out. This analysis aims to define questions, and objectives and acquire keywords such as Project-Based Learning to acquire creative thinking skills. So that it can be applied in research methodology which is explained in detail in the methodology sub-chapter. In Table 1 it is explained that for each item shows the following information. Year of publication, author, title, journal in which it was published, identified areas of research.

Table 1
Literature review

Year	Author	Title	Journal	Areas of research
2022	(Suherman & Vidákovich)	Assessment of mathematical creative thinking: A systematic review	ELSEVIER	Education
2023	(Saimon et al.,)	Enhancing the 4Cs among college students of a communication skills course in Tanzania through a project-based learning model	Education and Information Technologies	Education
2023	(Ye & Xu,)	A case study of interdisciplinary thematic learning curriculum to cultivate "4C skills"	Frontiers in Psychology	Education
2023	(Le)	The development of student's creative thinking skills in digital art	Education and Information Technologies	Education
2022	(An, Heejung; Sung, Woonher; Yoon, So Yoon)	Hands-on, Minds-on, Hearts-on, Social-on: A Collaborative Maker Project Integrating Arts in a Synchronous Online Environment for Teachers	Tech Trends	Education
2023	(Harris, Dan Coleman, Kathryn Cook, Peter J.)	implementing the critical and creative thinking general capability through an ecological approach	The Australian Educational Researcher	Education
2023	(Thornhill-Miller)	Creativity, Critical Thinking, Communication, and Collaboration: Assessment, Certification, and Promotion of 21st Century Skills for the Future of Work and Education	Journal of Intelligence	Education

2023	(Avci & Durak)	Innovative thinking skills and creative thinking dispositions in learning environments: Antecedents and consequences	Association for Educational Communications and Technology	Education
2022	(Wannapiroon & Pimdee,)	Thai undergraduate science, technology, engineering, arts, and math (STEAM) creative thinking and innovation skill development	Education and Information Technologies	Education
2022	(Wannapiroon & Pimdee,)	Interactive Association of Negative Creative Thinking and Malevolent Creative Thinking	Frontiers in Psychology	Education

The literature in Table 1 offers definitions of basic concepts of project-based learning for building creative thinking skills. In the use of literature may or may not be used. Because the system of literary use is used, it needs to be adapted to the intended context. So that the literature that has been studied will be used but still on the basic concept of fit to context.

The ability to think creatively is a cognitive component of students that will support success (Suherman & Vidákovich, 2022; Zhan et al., 2022; Adams et al., 2021). In essence, creative thinking is related to the discovery of something (Van Hooijdonk, 2022). To produce something new by using and developing something that already exists. Creative thinking is a thought where students try to create findings (Le, 2023; Wadtan et al., 2024). Creative thinking is a series of processes, including understanding problems, making hypotheses related to a problem, finding solutions, proposing solutions, to reporting the results (Avci & Durak, 2023; Thornhill-Miller et al., 2023). Creative thinking is the ability that is grown to process data or information (Torrance, 2018). So that it can provide a product or new ideas for understanding new things. Creative thinking can be developed through a process of stimulus, exploration, planning, activity, and review.

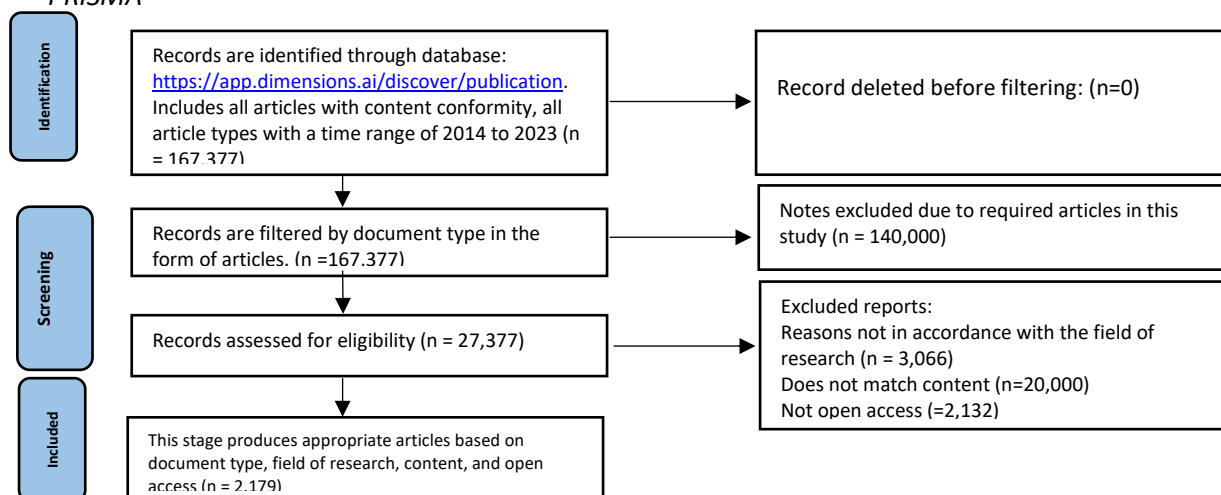
2. Methods and Materials

2.1. Research method

Bibliometric Analysis is a research method using bibliographic databases that consider the quantity, quality, and scale relating to the relevant content analyzed (Gan et al., 2022; Kokol et al., 2021). The method uses bibliographic information from articles, authors, writing strategies, journal articles on writing, trend citations, patterns, and summaries of research conducted by previous researchers (Alramadan, 2023; Yu et al., 2023). So bibliometric analysis is very important to provide a recommendation through the analysis that has been done.

The data obtained in this study was extracted from Dimensions (n.d.) web pages. The method used is a systematic literature review (SLR) whose steps follow the flowchart of PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) (Page et al., 2018) can be seen in Figure 2.

Figure 2
PRISMA



Source: Page et al., 2018

2.2. Data collection

By searching, identifying, organizing, and analyzing through the app.dimensions.ai database. The first phase of identification detected 167,377 publications including articles, books, and proceedings published between 2014 and 2023. The second stage (screening), classifying based on the type of document in the form of articles and the field of research carried out by researchers resulted in 143,066 articles being excluded. In the third stage (including), at this stage, 24,311 articles were selected for analysis based on the selected content. Then 22,132 articles were excluded because they did not match the content and were not open Access. So, at this final stage found a final sample of 2,179 suitable articles. In conducting the analysis, researchers used VOSViewer as an application to map bibliometrics (Azan & Li, 2022). In this study, the analysis conducted was reviewed based on co-occurrence and co-authorship.

2.3. Procedure

The mechanism of co-occurrence analysis is as follows: 1) the type of data that has been obtained is then extracted so that data in the form of dimensions is produced. 2) then open VOSViewer after opening select Create a Map on bibliographic data. 3) Then select Read Data Form Bibliographic Data, this selection is made based on the files owned by the researcher. 4) Then, select files based on the data owned, namely dimensions, and search for data to be analyzed. 5) Then, select Title and Abstract and select the calculation method with the Full Counting option. 6) Then, a threshold selection is made to determine how many words will appear, which is 10. Of the 76,269 terms, 288 have met the threshold. Based on 288 terms then selected to produce 180 terms.

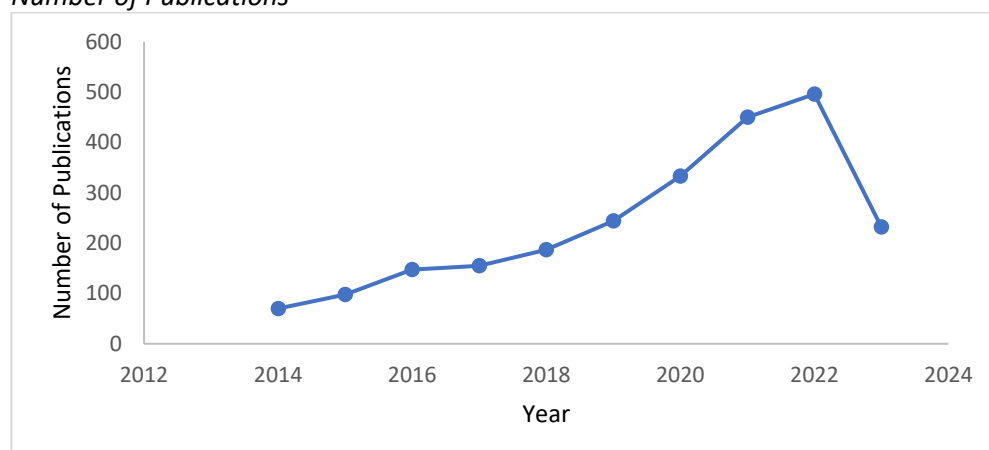
The mechanism of co-authorship analysis is as follows: 1) the type of data that has been obtained is then extracted so that data in the form of dimensions is produced. 2) then open VOSViewer after opening select Create a Map on bibliographic data. 3) Then select Read Data Form Bibliographic Data, this selection is made based on the files owned by the researcher. 4) Then, select files based on the data owned, namely dimensions, and search for data to be analyzed. 5) Types of analysis and counting type methods on co-authorships in author, organizations, and countries analysis units with a maximum review of each document reaching 25. 6) from the previous step 9,851 terms with the chosen one being 28.

3. Results

In the results section, researchers start by displaying something from general to something specific. Starting from research trends conducted in 2014 to 2023 to the most specific, namely article bibliography followed using keywords.

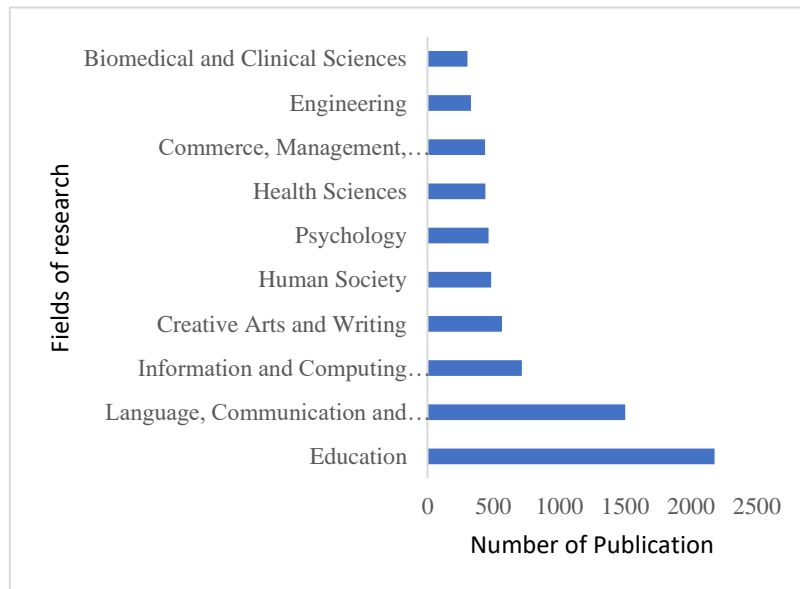
In the section of the scientific article, publications carried out from 2014 to 2023 resulted in a significant increase. Figure 3 shows the number of publications from 2014 to 2023 published globally on the theme of students' creative abilities.

Figure 3
Number of Publications



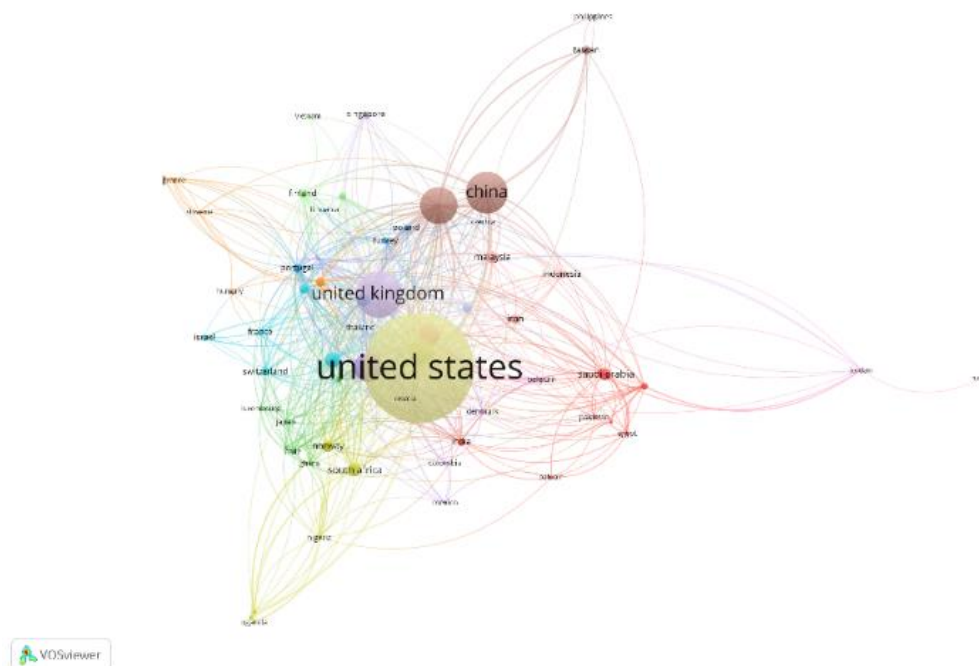
The number of research areas collected is then categorized into the top 10 research areas where each item contains creative thinking skills from 2014 to 2023 in Figure 4.

Figure 4
Fields of research



In addition, the number of publications can be reviewed from the author's country of origin. Visualization of state networks based on co-authorship methods that contribute to students' creative thinking research can be seen in Figure 5.

Figure 5
State network visualization based on the co-authorship method.



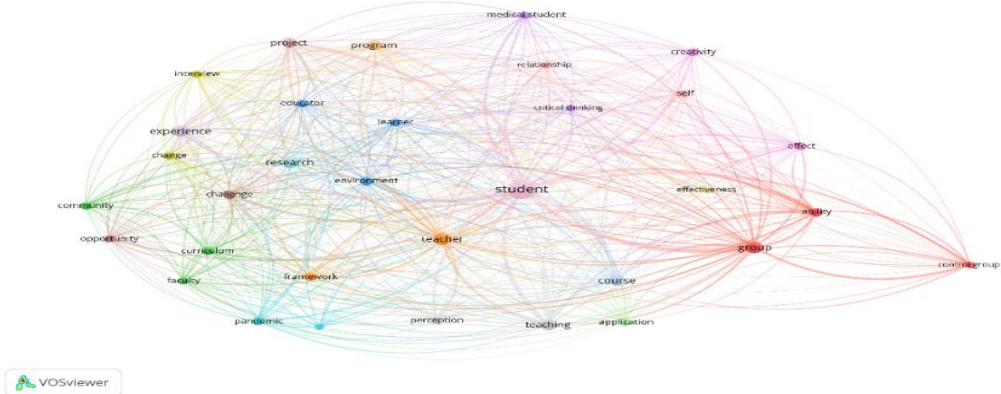
Of the 2,179 articles that have been analyzed based on the topic, there have been 249 different international research institutions. Figure 6 shows that research institutes are productive in conducting creative thinking research on students. Related research was conducted between 2014 and 2023.

Table 3
Top 10 top authors

Author	Number of Publications	Number of Citations
Zsolt Lavicza	18	55
Franz Xaver Bogner	16	161
Sara E Brownell	15	720
Michael Adrian Peters	15	309
Athanasios S Drigas	15	286
Dwi Agus Kurniawan	13	47
Joke M Voogt	13	799
Paul Arthur Kirschner	13	1.296
Wilfried F Admiraal	13	160
Mary Elizabeth Ryan	13	309

In keyword searches, researchers do not determine the classification so that all articles that have been found are then analyzed. Figure 8 is a visualization of keywords from each variable in the form of creative thinking skills.

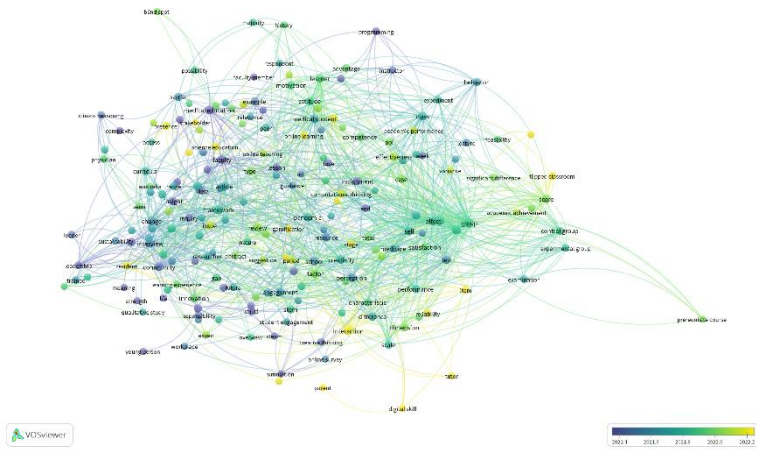
Figure 8
Network Visualization



Source: Vosviewer and Dimensions (n.d.)

Researchers found that a lot of creative thinking research was done in 2021, this is shown in each color in Figure 9.

Figure 4
Overlay visualizations



Source: VOSViewer and Dimensions (n.d.)

4. Discussion

This bibliometric study summarizes the most relevant evidence about students' creative thinking abilities. Evidence can quickly accumulate with the number of publications from 2014 to 2023 can be seen in Figure 3. Publications related to creative thinking experienced a significant increase from 2014 to 2022. However, in 2022 towards 2023, it decreased compared to previous years. The decline in 2023 is due to other studies that refer to other skills that can more easily be analyzed. Such as problem-solving skills and does not lead to students' creative thinking abilities. In essence, problem-solving skills are problem-solving efforts based on previous learning (Mizyed & Eccles, 2023). Creative thinking skills are abilities where students are required to solve problems from various sides and in some cases celebratedly (Soubra et al., 2022; Thornhill-Miller et al., 2023; Le, 2023). In addition, creative thinking will also stimulate students to be more innovative in solving complex problems (Suherman & Vidákovich, 2022). By thinking creatively students will get new innovative ideas to solve problems (Kampylis & Berki, 2014; Mcfadzean, 1998; Segundo-marcos et al., 2023; Rezaei, 2023). The importance of creative thinking skills is to encourage students to innovate in academic and non-academic learning activities (Berg & Lepp, 2023; Starko, 2018). Because, creative thinking skills involve the ability to look at problems from different angles to come up with innovative solutions (Ola & Gafour, 2020; Suherman & Vidákovich, 2022; Birgili, 2015). Thus, creative thinking skills need to be redeveloped to achieve 21st-century skills.

Figure 4 shows the number of publications in each field: Education 2,179 publications (29%), followed by the fields of language Communication and culture 1,501 publications (20%), information and computer science 717 publications (10%), creative arts and writing 565 publications. Human Society 484 publications (7%), Psychology 463 publications (6%), Health Sciences 439 publications (6%), Trade, Tourism Management 438 (6%), Engineering 330 publications (4%) and biomedical and clinical sciences 304 publications (4%). The topic of creative thinking skills is a multidisciplinary research topic. The multidimensional analysis that occurred in Figure 4 shows that creative thinking skills can be applied in all domains (Israel-Fishelson & Hershkovitz, 2022; Wang et al., 2022; Moghadam et al., 2023). because creative thinking can expand and trigger new ideas that are complex and can be implemented systematically (Arici & Uysal, 2022). Therefore, research needs to be expanded in fields other than education.

In Figure 5, 14 country visualization groups play a role in researching students' creative thinking spread across 111 countries. Each class demonstrates productivity in conducting research related to creative thinking skills. Figure 5 explains that Group 1 is occupied by Bahrain, Egypt, India, Pakistan, Qatar, Saudi Arabia, and the United Arab Emirates. Cluster 2 is occupied by Brazil, Chile, Ghana, Japan, Luxembourg, and Romania. Group 3 is occupied by the Czech Republic, Lithuania, Poland, Portugal, Sweden, and Turkey. Group 4 is occupied by Kenya, Nigeria, Norway, Rwanda, South Africa, and Uganda. Cluster 5 is occupied by Austria, Colombia, Croatia, Denmark, Mexico, and Spain. Cluster 6 is occupied by France, Germany, Ireland, Israel, and Switzerland. Cluster 7 is occupied by Cyprus, Greece, Hungary, Italy, and Slovenia. Group 8 is occupied by Australia, China, the Philippines, and Thailand. Cluster 9 is occupied by Belgium, Jordan, Kazakhstan, and Russia. Cluster 10 is occupied by Indonesia, Iran, Malaysia, and the Netherlands. Cluster 11 is occupied by Finland, New Zealand, and Vietnam. Cluster 12 is occupied by South Korea and Thailand. Group 13 is occupied by Canada and the United States. Cluster 14 is occupied by Singapore and the United Kingdom. Research on creative thinking skills has been widely conducted in the United States followed by China, Taiwan, Croatia, New Zealand, Indonesia, Taiwan, Norway, Australia, and Germany. The United States is particularly prominent in this study because students desperately need to think creatively in education (Aktoprak & Hursen, 2022; Hughes et al., 2022; Sawyer, 2015). The importance of creative thinking is so that students can solve problems, innovate, and adapt quickly, to improve cognitive abilities when analyzing, evaluating, and solving problems that have been given. By thinking creatively, students will have the ability to analyze, and collect ideas (Alabbasi et al., 2022; Zulyusri et al., 2023), to be able to solve learning and learning problems concretely. Therefore, countries that focus on research on creative thinking skills are to have the widest circle area, for example, the United States and China.

In addition, Figure 6 shows the regularity of research conducted by research institutes. Each research institution found a diversity in the number of publications that have been carried out by authors from the highest 18 publications to 13 publications. It states that there is a diversity of authors in the study

related to students' creative thinking skills. Thus, articles associated with students' creative thinking indirectly contribute to advancing the educational potential of the 21st century. Also, strengthen and manage education to develop students' creative thinking optimally. Therefore, research related to students' creative thinking becomes an international-level subject and needs to be reviewed to stimulate students' creative thinking.

Table 3 explains that the institution that is most actively conducting research is Arizona State University in the United States, followed by Peking Normal University, Taiwan University of Science and Technology, University of Zagreb, the University of Auckland, Jambi University, National University of Taiwan. Normal University, Metropolitan University of Oslo, Monash University, and TU Dortmund University. These 10 institutions received publications from 2014 to 2023 which show that interest in conducting creative thinking research has reached an international level. These 10 institutions are most productive in producing articles related to creative thinking skills using learning-based projects. Arizona State University and Beijing Normal University have the most publications related to students' creative thinking research. So, in developing creative thinking, research students can then use the study of the top 10 studies.

In figure 7 the BMC medical education journal has the largest diameter of the others. This means that the journal has the highest number of articles among other journals. The journal BMC Medical Education has 40 articles with 350 citations. Judging from the color, there are 4 clusters with different colors. The largest clusters are shown in green. Thus, the journal can be used as a source of review literature as well as a place to publish in future research and the need for re-expansion related to the selection of journal publications.

In Table 4, the top 10 studies that have been published in reputable journals are found. It is known that there are 18 top publications and researchers found 13 publications at the bottom. So that the 10 articles can be used as a source of review literature in conducting further research.

Figure 8 is a visualization used to review the relationship between variables used in the study. This is important because by visualizing these keywords, researchers know how the relationship between the variables is used. The use of this visualization can be presented by how far apart the keywords are. The farther the distance between variables in the visualization, the less often it is done, and the shorter the distance between variables, the more often the research is carried out. However, what is often done is to examine students' creative thinking and self-defecation. This is a gap where in general, the student-centered learning model is very suitable for developing students' creative thinking skills (Capone, 2022; Chistyakov et al., 2023; Sutrisno & Nasucha, 2022; Birgili, 2015). In line with (Le, 2023) which shows that the level of student creativity can be increased through student-centered learning methods. In addition, student-centered learning can stimulate students' creative thinking skills through student-centered syntax (Khoury, 2022; Lu et al., 2022; Tabieh & Hamzeh, 2022). This is a novelty for other researchers to be able to use the student-centered learning model to improve students' creative thinking skills. So, researchers can then directly relate each item in Figure 8 with students' creative thinking.

In Figure 9 there are only yellow, green, and blue colors, each color means that each article has been published every year. Yellow indicates publications from 2022 to 2023, green indicates 2018 to 2022 and blue indicates 2014 to 2016. Therefore, the current trend of creative thinking skills research focuses on yellow, for example, digital skills and tutor interaction flipped classroom.

5. Conclusion

The purpose of this study was to examine trends in creative thinking skills around the world from 2014 to 2023 through Dimensions. This study shows the following results: Based on the data that has been obtained, the trend of students' creative thinking research has increased. The topic of creative thinking skills has the most publications in the field of education, and the country that has the most contributions is the United States. The research institution that has the most publications on the topic of creative thinking skills is Arizona State University, the journal that has the most publications is the journal BMC Medical Education, and the most research in this study is Zsolt Lavaca With a total of 55 publications, on the keyword network, it was found that there was still little research directly related to

students' creative thinking, and more research directed to examine the use of developments in the 21st century.

This research helps generate knowledge that serves to provide novelty for future research in the period 2014 to 2023 through Dimensions. The limitation of this study is that it uses only Dimensions databases, which will continue to have up-to-date publications. Thus, bibliometric analysis of creative thinking skills can be reviewed in future research for broader creative thinking skills that can be spoken in depth.

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