

RESEARCH ARTICLE | MAY 24 2024

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AIP Conf. Proc. 3116, 070018 (2024)

<https://doi.org/10.1063/5.0210197>



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Unveil Creative Thinking in the Physics Education: Bibliometric Analysis and Literature Review

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Abstract. Physics learning achievements are defined as students having the ability to be responsive to global issues and play an active role in providing problem-solving. However, educational design encounters problems linked to creative thinking skills, such as the ability to consider things in new ways to explain physical phenomena that could otherwise be justified. This study uses bibliometric analysis to provide graphical info about the statistical description of the literature from 45 articles issued in reputable international journals correlated to the theme of creative thinking skills in physics from 1959 to 2023. An in-depth study was conducted on 36 articles to reveal the research results. Document Types are obtained from the Scopus database for creative thinking in physics education in articles, book chapters, books, and conference papers. Visualization with Software R Bliibimetrix with three visualizations: Annual Scientific Production, most cited articles, Country scientific production, and word cloud and Co-occurrence network. The findings of the analysis show that the dominant topic is creative thinking in physics education of research topics trend in 2023 are students, engineering education, and teaching. Less researched topics are cognitive abilities, active learning, and classical mechanics. Creative thinking in the Physics educational design and to investigate the trend of creative thinking and its authors from across the country. There is about. This study can provide a global roadmap for researchers and education on increasing creative thinking in physics education.

INTRODUCTION

Education is essential in developing the proper steps to stimulate creativity. Physics learning achievements are defined as students having the ability to be responsive to global issues [1]. Physics education is a part of learning science; physics is an essential foundation in introducing natural events and has high complexity. The relationship with this science makes the concepts and materials of physics, which are considered to have many formulas and complex scientific laws. Physics is a complex and difficult science, so innovative strategies are needed to increase students' interest in learning physics [2].

Therefore, facilitating it requires a scientific attitude and high Thinking skills. One of the high-order thinking skills that can enable one of them is creative thinking [3]. Creative thinking in individuals with lateral thinking, namely

thinking that jumps flexibly from one aspect to another; in other words, feels by not following the existing path [4]. Two types of Thinking dominate a creative person's way of thinking, namely lateral Thinking, Divergent Thinking, and integrative-convergent Thinking. Lateral thinking remains a person's ability to solve complex problems using creative solutions. Divergent thinking remains an individual's competence to discovery several choice answers to a problem. Integrative convergence is a way of thinking focused on the issue at hand. Analytical is a way of thinking logically and systematically. Creative thinking is very urgent in solving physics problems or generating new ideas that provide answers [5]. This process occurs with the integration of object identification through the eyes and knowledge already owned in mind and then transformed into innovation. Creative thinking can train students to solve problems according to their experience. Creative thinking is a scheme of high cognitive skills that is very urgent for students to instill concepts when they have processed the results of a new idea or solution [6].

A person's creativity starts with the skills to complete original ideas and produce valuable and meaningful impacts [7]. The categories of created practical ideas and outputs remain consistent with scientific processes and products that are specifically likely to have creative portfolios during the concept discovery process. Creative process activities are characterized by specific design products that generate innovative ideas [8]. Creativity relates to the skills of reconstructing problems from phenomena and reinterpreting and directing freedom of thought by using logical and convergent reasoning. A new theory emerges from a combination of new and old knowledge and existing knowledge and ideas in an experiment. Creative thinking abilities mean thinking by applying various mental procedures, namely fluency, flexibility, originality, and expressing opinions to construct great original, new, and valuable [9]. This remains indicated as conceiving a new idea; the brain thinks to have lots of ideas or fluency, varied ideas, different or flexibility, unique ideas or original, with detailed and useful or valuable explanations. Thinking is assumed to be a cognitive process, a mental activity with the knowledge it has. Complex thinking processes are convened into 4, namely: problem-solving, decision-making, critical thinking, and creative thinking. Creativity is combining knowledge to produce the appropriate variety to solve problems [10].

As a concept designer, he can find solutions based on his thought processes, which include interpreting problems, recalling memories, and adopting appropriate knowledge [11]. A designer has a method of recognizing that is different from other scientific or academic methods. Creative design can occur with innovative thinking, a powerful way to develop ideas according to understanding the concept to complete the procedure [12]. However, many researchers and educators are interested in approaches to train students' creative thinking skills and highlight the nature of science. The process of creative thinking by generating original ideas defines complex reasoning patterns and highlights the primary ways of reasoning to solve problems [13]. Enhancing creativity is incredibly significant in the field of physics education. It assists students in analyzing their visions, gaining essential skills and knowledge, and applying an idea of the nature of science. Students, personally and in groups, intensively use their creative talents by studying during communication and discussion during lectures. Creative thinking is a pathway to focus on creativity and innovation, practice creative problem-solving, and deepen creative self-confidence [14].

However, one of the problems with learning physics is the content of the subject matter, teaching materials, classroom environment, and teacher factors. Students revealed that they found topics such as mechanics, optics, electromagnetism, and thermodynamics challenging to understand. Physics education, in general, has been conveyed to students through the lecture teaching method. Thus, physics education should have a learning model that is more interesting from the academic aspect to increase creativity. This aspect of the invention is a valuable issue, and an interdisciplinary combination must also be applied. With these conditions, many studies need to be improved through creativity in learning physics. To increase students' creativity in physics education and academic approaches to design learning. Building an educational platform to facilitate possibility thinking to the afterward level in the recent educational idea was deemed necessary to construct creative experiences. Grounded on the analyzed research, we aim to extract future research trends that could be central in physics learning by detecting keywords told to creative thinking. Therefore, researchers conducted a study to understand creativity in learning physics: (1) creative thinking and (2) physics education.

METHOD

The research method in this study uses Scopus Base data. It is processed using Bibliometric software R. This statistical software for bibliometric analysis and co-citation is used to achieve research activities. Software R is software that functions to be shared in an open-source environment for users. Quantitative methods can solve a

substantial amount of information but differ in application. In particular, the meta-analysis summarizes the empirical evidence by analyzing the direction, intensity, and relationship between effects. Software R is a complement of integrated software abilities exploited aimed at data study, statistical modeling, reproduction, and visuals. R is an easy and compelling language that involves conditionals, circles, user-defined recursive works, and input and output capabilities. This research aims to solve open research problems using conclusive data rather than informed in a single main analysis [15]. Therefore, this investigation uses a bibliometric method brief quantitative procedure on bibliometric data to enable a method to the scientific database at Scopus base to get significant quantities of bibliometric data with the keywords Creative thinking skills and physics education. A number of articles is 36 articles selected in reputable international journals correlated to the theme of creative thinking skills in physics from 1959 to 2023.

Scopus is one of the largest bibliometric database providers in the world for preparing data on creative thinking and physics education. R Software software visualizes bibliometric networks using data imported from Scopus data sources. This study uses bibliometric analysis to provide graphical info about the statistical description of the literature from 45 articles published in reputable international journals related to creative thinking skills in physics from 1959 to 2023. An in-depth study was conducted on 36 articles to reveal the research results. Figure 1 shows the process of the bibliometric analysis of the data extracted from Scopus using BibliometricX (Software R).

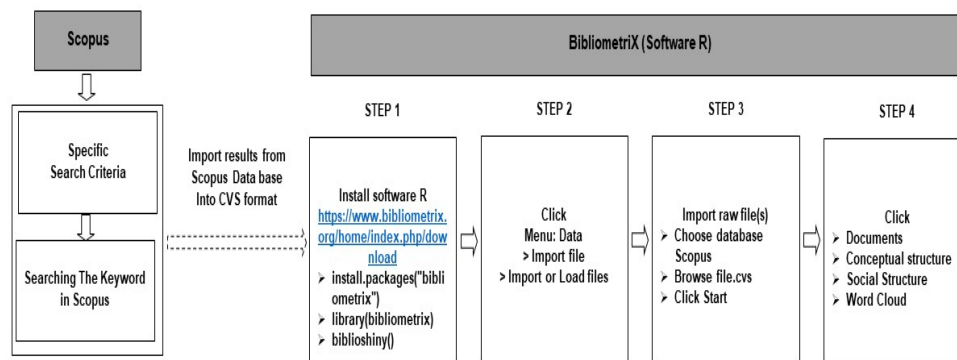


FIGURE 1. Design of Bibliometric Study with R Software

The design of the bibliometric analysis process Figure 1 was initiated in two stages, namely the stage of data collection from the Scopus database and data processing using BibliometricX Software R. The first stage of data collection from the Scopus database was carried out by returning the database from Scopus by entering the Specific Search Criteria on scopus.com. The next step is Searching for the Keyword in Scopus. The last step is to Import results from Scopus Database Into CVS format. The second stage is with BibliometricX Software R, starting with Step 1. Install R software on the page <https://www.bibliometrix.org/home/index.php/download> install.packages("bibliometrix") then type library(bibliometrix) then type biblioshiny() in the software. Step 2 Click Menu: Data, then Import file, then Import or Load files. Step 3 Import raw file(s) with Choose Scopus database, then browse file.cvs and Click Start. The last step is Step 4 Click Documents, then Conceptual Structure, then Social Structure and Word Cloud, then the visualization of the image formation process.

RESULT AND DISCUSSION

Bibliometric study is a general and thorough technique for exploring or investigating significant amounts of scientific data to determine trend looks and investigate the academic structure of published literature. The analysis works by condensing the productivity components of research results in the form of the sum of publications and citations per year, and investigation of publications by journal, research quarter, author, affiliation, and country. The results of the collection of 36 articles issued in reputable international journals correlated to the theme of creative thinking skills in physics from 1959 to 2023. Figure 2 shows the Annual Scientific Production, which has experienced an increase in research on creative thinking skills in physics education.

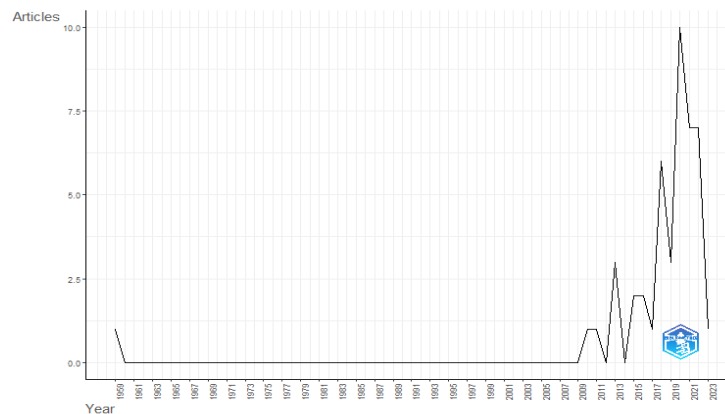


FIGURE 2. Annual Scientific Production Creative Thinking Skills in Physics Education

Figure 2 identified displays of publication action based on data integrated into the Scopus Base data. The x-axis displays the year, and the y-axis shows the total of cumulative articles for 1959–2023. The number of articles on creative thinking in physics education in 2019 and from 1961–2009 found no articles discussing this. Table 1 displays the top 15 most cited articles in the Scopus database exploration results from 1959 to 2023 regarding thinking skills in physics education. This investigation aimed to relate the primary findings of ideas and affect which papers have taken the greatest significant impact on influencing the subject and field of physics education investigation.

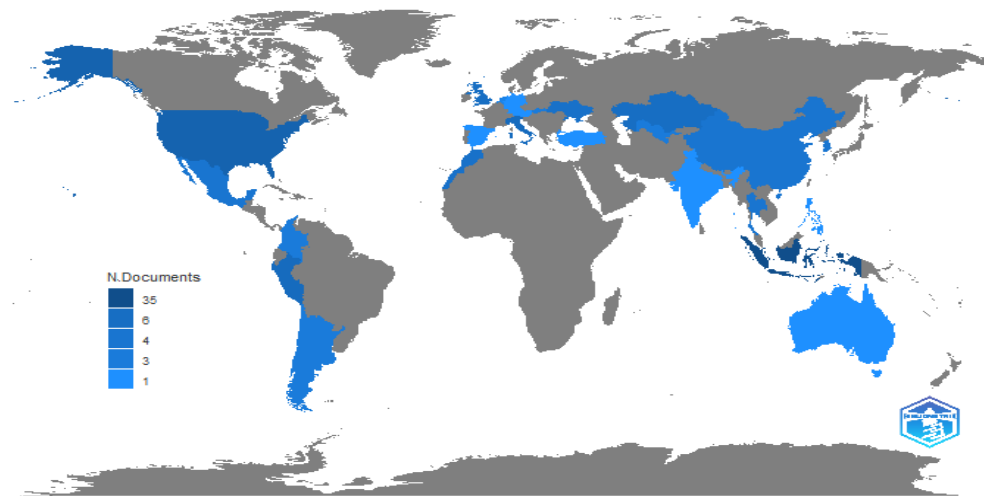
TABLE 1. The Top 15 Most Cited Articles into Scopus Explore Results

No.	Author's name, Year, Journal	Result	Total Citations
1	Hockicko P, 2015, Eur J Eng Educ [16]	Improving students' conceptual thinking with video analysis & interactive simulations	39
2	Jou M, 2010, Turk Onl J Edu Tech [17]	Web-Based Environments with Scaffold to increasing Creative Reasoning for Physics concept	19
3	Teodorescu R E, 2013, Phys Rev Spec Top Phys Educ Res [18]	Analyzing physics problems for Taxonomy of Introductory Physics with Problems & Creative	17
4	Pulgar J, 2020, Phys Rev Phys Educ Res [14]	Increasing Undergraduate cooperation problem elaboration and problem solving and creative	15
5	Verawati N, 2018, J Phys Conf Ser [19]	Inquiry-Creative- Learning Model for improving Critical Thinking Ability for Physics concept	14
6	Ramankulov S, 2016, Int J Environ Sci Educ [8]	Improving Creativity of Students for Context of the Education	14
7	Habibi H, 2020, Int J Emerg Technol Learn [10]	Phet simulation for increasing the creative thinking skills of physics	9
8	Penprase BE, 2020, STEM Educ [20]	STEM for Education of the 21st Century skills	8
9	Bhatnagar T, 2017, Smart Innov Syst Technol [21]	Development creative problem solving of undergraduate engineering	7
10	Permata Sari F, 2020, Rev Mex Fis E [13]	Implementation Hopscotch or Engklek with game android to increasing creative thinking	6
11	Athifah, 2020, JPCS [22]	Physics student's worksheet with inquiry to improve students creative thinking	5
12	Rahayu et al., 2022 JPPII [23]	Effectiveness of Flipped Classroom for Enhancing Students' Creative Thinking	6
13	Jumadi, et al., 2020, IJERE [24]	Implementation Project Effects on Creative Thinking Skills for Pre-Service Physics Teachers	23

TABLE 1. Continued

No.	Author's name, Year, Journal	Result	Total Citations
14	Rizal, et al., 2020, JPCS [25]	Application Creative thinking skills for physics teacher	26
15	Batlolona, et al., 2019 [26]	Application Creative thinking skills students' physics for solid material elasticity concept	61

Country scientific production for creative thinking in physics education for the most productive writers by the most significant recurrent contributions to creative thinking in physics education sourced from the Scopus database is Indonesia with 35 articles, followed by the USA with 11 articles, Italy, and Peru with 7, Kazakhstan, UK, with six articles, Morocco, and Ukraine as many as five articles. While China, Mexico, South Korea, and Thailand have as many as four articles. In the entire Country, scientific production for creative thinking in physics education is shown in Figure 3.

**FIGURE 3.** Country Scientific Production

Co-Occurrence with Keywords Plus for creative thinking in physics education consisting of Sources (Journals, Books, etc.) totaling 36 articles. With Keywords Plus (ID), creative thinking, and physics education, as many as 212. The total number of Authors from 1959-2023 was 138, and the Authors of single-authored documents were nine authors. The results of the top ten-word cloud about creative thinking and physics education from the most to the lowest consist of the words students as many as 14, engineering education as many as 7, teaching as many as 4, while e-learning, Likert scale, professional aspects, and computer software as many as 3.

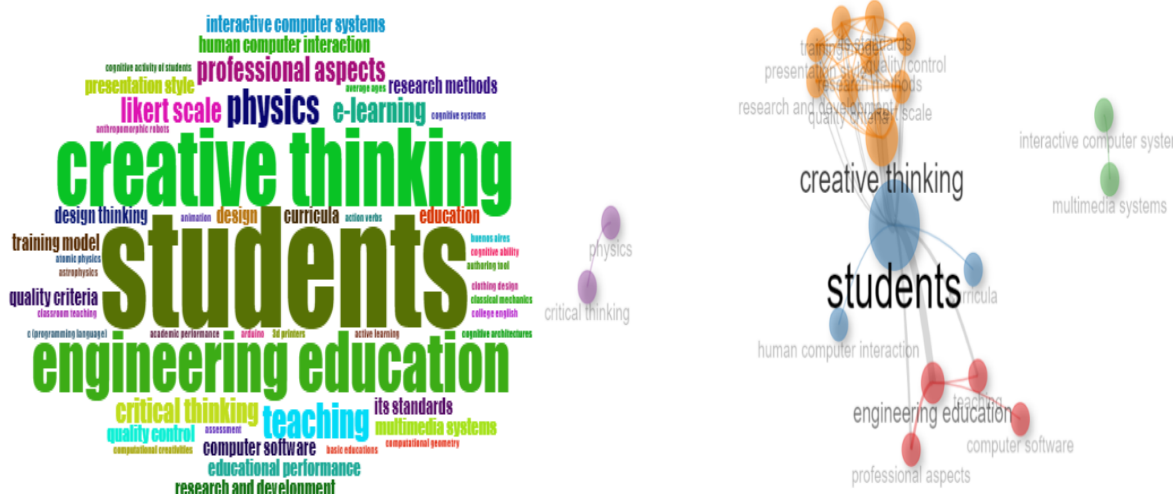


FIGURE 4. Wordcloud & Co-Occurrence Network of Creative Thinking & Physics Education In Scopus

The Document Types are obtained from the Scopus database for creative thinking in physics education through articles, book chapters, books, and conference papers. Visualization with Software R Bliometrix with three visualizations: Annual Scientific Production, most cited articles, Country scientific production, word cloud, and Co-occurrence network. The analysis results show that creative thinking in physics education is the dominant topic. Of research topics in 2023 are students, engineering education, and teaching. Less researched topics are cognitive abilities, active learning, and classical mechanics. Creative thinking in the Physics educational design and to investigate the trend of creative thinking and its authors from across the country. There is about. This study can provide a global roadmap for researchers and education on increasing creative thinking in physics instruction.

CONCLUSION

The results of study have explored mapping and grouping of research topics about creative thinking in physics education from the metadata of 36 articles from the Scopus database. Use of BibliometriX Software R to process statistical data and visualize processing results that focus on five Annual Scientific Production studies, most cited articles, Country scientific production, word cloud, and Co-occurrence network. The analysis results show that the dominant topic is creative thinking in physics education, and research topics in 2023 are students, engineering education, and teaching.

ACKNOWLEDGMENT

The study was supported funded by LPPM Universitas Negeri Jakarta, Number: 18/KI/LPPM/III/2023.

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