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Creative Thinking Physics: A Review and Bibliometric Analysis

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ABSTRACT
Creative thinking is one of the tallents required for the Industrial Revolution 4.0. The goal of this research is to conduct a comprehensive evaluation of the bibliometric literature on physics students' creative thinking abilities. Scopus data base articles discovered using publish software or perish (pop). This research analyzes 70 of 102 publications discovered in the Scopus database between 1960 to 2020. Mendeley's Reference Manager software is then used to handle the selected reference. After maintaining the database, this study uses Vosviewer software to classify and visualize it. In general, this study serves as an excellent starting point for future research on "creative thinking in physics." The principal result of this article is that are seven clusters, the authors who contribute the most and wherever the location of this research is carried out from the keyword "Creative Thinking in Physics".

INTRODUCTION

Creative thinking is a set of abilities and talents necessary for resolving difficulties in daily life. Diverse aspects characterize creative thinking [1]. The disparate attributes in question are the capacity for open minded [2]. Creative thinking is a mental habit that may be developed by paying attention to intuition, activating imagination, revealing new possibilities, eliciting an incredible point of view, and eliciting surprising thoughts [3]. Creative thinking is a subset of thinking that results in the development of novel ideas, novel approaches, novel perspectives, or novel ways to comprehend something [4]. According to the description, creative thinking abilities refer to a person's capacity for thinking differently and renewing his imagination in order to generate fresh ideas for resolving an problem.

Physics's concerns are entwined with those of nature and symptoms. Natural symptoms are the subject of physics research because they are the result of the complexity of relationships between events that eventually created a fact, theory, concept, and the laws of physics [5]. Physics difficulties can be solved if someone understands the fundamental concepts of physics [6]. According to Arends, the concept serves as the foundation for the network of concepts that govern one's thoughts [7]. Physics education at the secondary level should equip students to be able to (1) address problems encountered

in everyday life using the physics principles they have learnt, (2) make sound decisions based on scientific notions, and (3) have a scientific mindset when solving difficulties encountered.

The topic of Creative Thanding has been extensively discussed [8] [9] [10]. The topic on Creative Thinking in Education has been discussed in the contexts of nursing education [11], mathematics education [12], economic education [13], psychology education [14], engineering education [15] [16], history education [17], english education [18] [19] [20], and biological education [21], among others. Numerous concepts associated with Creative Thinking Physics have been identified in the existing literature, including creative thinking test instruments in physics [22] [23], learning media for creative thinking in physics [24] [25] [26] [27] [28], learning models for improving creative thinking in physics [29] [30] [31] [32] [33] [34], and analysis of the abilities and skills of thinking creative in physics [35] [36]. According to the exposure of the review that tackles creative thinking in physics, is still extremely limited. Additionally, there has been no bibliometric analysis of the term "Creative Thinking Physics."

Considering the foregoing, this work seeks to close a research gap by conducting a comprehensive bibliometric analysis of the literature on creative thinking in physics. Scopus articles were examined and classified based on distribution and affiliate research. This analysis can determine which research topics receive the most publications and, in the future, the topic of 'Creative Thinking in Physics', which presents prospects for more research. The process for conducting the analysis is bibliometric analysis, which includes the stages involved in implementing Scopus and Publish data-based tools and Publish or Perish (PoP).

METHOD

This bibliometric review of the literature is based on systematic and explicit methodologies [37], or on methods that stress the knowledge gap [38]. This work used a five-stage methodology [38] [39], as seen in Figure 1.

Fig 1. *Five-step method bibliometric analysis*

Determine Livelihood Keywords
In May 2021, a literature search was conducted using the phrase "Creative Thinking Physics." Scopus was chosen since it is now the largest database, and Publish of Perish was chosen because it has been demonstrated to be the most effective method for searching Scopus articles. The first means of subsistence is by using a query language to locate software that has the keyword "Creative Thinking In Physics."

Livelihood of the initial word
This search is limited to 'Journals & Articles Proceedings', the'said title' alone, and the years '0-2020'. The selection of this periode is due to get more accurate result. 102 articles were discovered during the initial search. The findings are assembled in the format of research information systems (RIS), which includes all significant articles such as the title of the paper, the author's name and location of the research, an abstract, keywords, and references.

Improvement of Research Results
The article is acceptable and has been indexed in a scopus database that has been screened. This data

does not include newspapers, books, book reviews, or book chapters. Only peer-reviewed journal articles and proceedings are considered. The information is then saved as a RIS file to allow for future enhancements. Mendeley's bibliographic software imports RIS data. The resultant RIS file is then utilized to do additional data analysis.

Prepare statistics for initial data
The gathered data is saved in RIS format. During the initial phases, we verify all journal article components (published years, volume, number, and page) and supplement missing data. Data analysis is used to classify articles and proceedings by year, publishing source, and publisher.

Data Analysis
Bibliometric analysis of this study's bibliometric analysis utilizing pop software [40] [41]. However, Vosviewer software should be used to study and display the bibliometric network [42] [43]. Vosviewer is utilized because it is capable of efficiently processing big data sets and generating a range of visualizations, analyses, and visually appealing studies [44]. Additionally, Vosviewer may generate publication maps, author maps, or journal maps based on co-citation networks, or keyword maps based on shared networks.

RESULTS AND DISCUSSIONS

Publications and Quotes Structure
Output analyzed based on PoP software through VOSviewer software to determine the keywords that appear most often. But the number of keywords that most often appear tailored to the data collection and analysis needs. VOSviewer is used to visualize the bibliometric map. This software displays bibliometric mapping in three different visualization, namely, network visualization, overlay visualization, and visualization of density.

Before perfecting the search results 102 articles obtained through the Scopus database. After repair, 70 articles are grouped from Scopus databases. This data has been well verified in the Scopus database from 1960-2020 with the keyword 'physics creative thinking'. About 102 articles were obtained at the initial results by 271 citations (4.44 citation / year). Improvement results obtained 70 articles; Quote data also changed, with 41 quotes and 0.67 quotes / year. Complete results of the comparison of metrics data from initial search and enhanced searches can be seen in Table 1.

Table 1. Matrix Comparison

Matrix Data	Initial Livelihood	Livelihood of Improvement
Source	creative thinking in Physics	creative thinking in physics
Publication year	0-2020	1960-2020
Papers	102	70
Citations	271	41
Cite/paper	2.66	0.59
Author/paper	1	3.34
h_indeks	9	3
hI_norm	9	2
hI_annual	0.15	0,03

Researchers tried to present the most relevant contributions in this study. The steps taken are to take 70 articles with the keyword "Creative Thinking Physics" which has the highest citasi value (10 top articles quoted) [23] [24] [45] [46] [47] [48] [49] [50] [51] [52]. Results are obtained as in Table 2.

Table 2. 10 Top Articles Quoted

Year	Author	Title	Journal / Proceedings	Quote Amount	Publisher
2018	Setiawan, A Malik, A Suhandi, A Permanasari, A	Effect of Higher Order Thinking Laboratory on the Improvement of Critical and Creative Thinking Skills	IOP Conference Series: Materials Science and Engineering	25	IOP Publishing Ltd.
2018	Shabrina Kuswanto, Heru	Android-assisted mobile physics learning through indonesian batik culture: Improving students' creative thinking and problem solving	International Journal of Instruction	17	Faculty of Education, Eskisehir Osmangazi University
2017	Nurulsari, Novinta Abdurrahman Suyatna, Agus	Development of soft scaffolding strategy to improve student's creative thinking ability in physics	Journal of Physics: Conference Series	16	IOP Publishing Ltd.
2017	Malik, Adam Setiawan, Agus Suhandi, Andi Permanasari, Anna	Enhancing pre-service physics teachers' creative thinking skills through HOT lab design	AIP Conference Proceedings	14	American Institute of Physics
2019	Adawiyah, R. Harjono, A. Gunawan, G. Hermansyah, H.	Interactive e-book of physics to increase students' creative thinking skills on rotational dynamics concept	Journal of Physics: Conference Series	13	IOP Publishing Ltd.
2018	Romli, S. Abdurrahman, A. Riyadi, B.	Designing students' worksheet based on open-ended approach to foster students' creative thinking skills	Journal of Physics: Conference Series	13	IOP Publishing Ltd.
2019	Satriawan, M. Liliasari, S. Setiawan, W.	Wave energy concept mastery relate on creative thinking skills of the pre-service physics teachers in environmental physics lectures	Journal of Physics: Conference Series	10	IOP Publishing Ltd.
2019	Putranta, H Supahar	Development of physics-tier tests (PysTT) to measure students' conceptual understanding and creative thinking skills: A qualitative synthesis	Journal for the Education of Gifted Young Scientists	9	Journal for the Education of Gifted Young Scientists
2019	Ma'Ruf, M. Marisda, D. H. Handayani, Y.	The basic physical program based on education model online assisted by alfa media to increase creative thinking skills	Journal of Physics: Conference Series	9	IOP Publishing Ltd.
2018	Wahyudi, W	Development of Inquiry-Creative-Process Learning Model to Promote Critical Thinking Ability of Physics Prospective Teachers	Journal of Physics: Conference Series	8	IOP Publishing Ltd.

The most relevant contribution in this study is the number of citations. Based on table 2, the highest

quote indexed by Scopus is an article from Setiawan, A , Malik, A., Suhandi,A., in 2018. This article discusses the influence of laboratories thinking higher order to improve critical and creative thinking skills [45]. This article was quoted 25 research articles. Meanwhile, there is one publisher with the highest citation frequency based on data, namely IOP Publishing Ltd.

Display Network Visualization Data on scopus data related to the enhanced 'Creative Thinking Physics' keyword in the search can be seen in Figure 2, overlay visualization can be seen in Figure 3, and visualization of density in Figure 4.

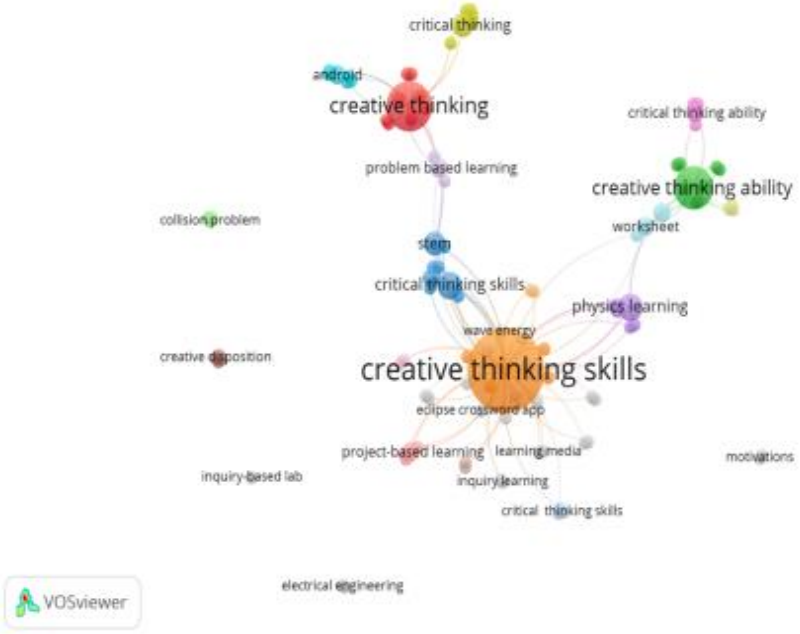

Fig 2. *Network Visualization*

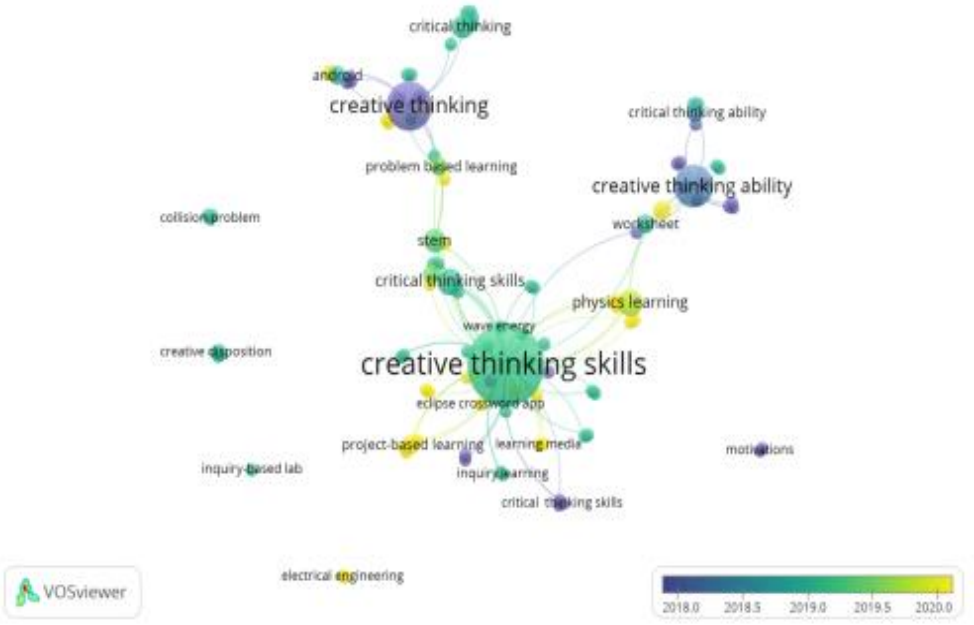

Fig 3. *Overlay Visualization*

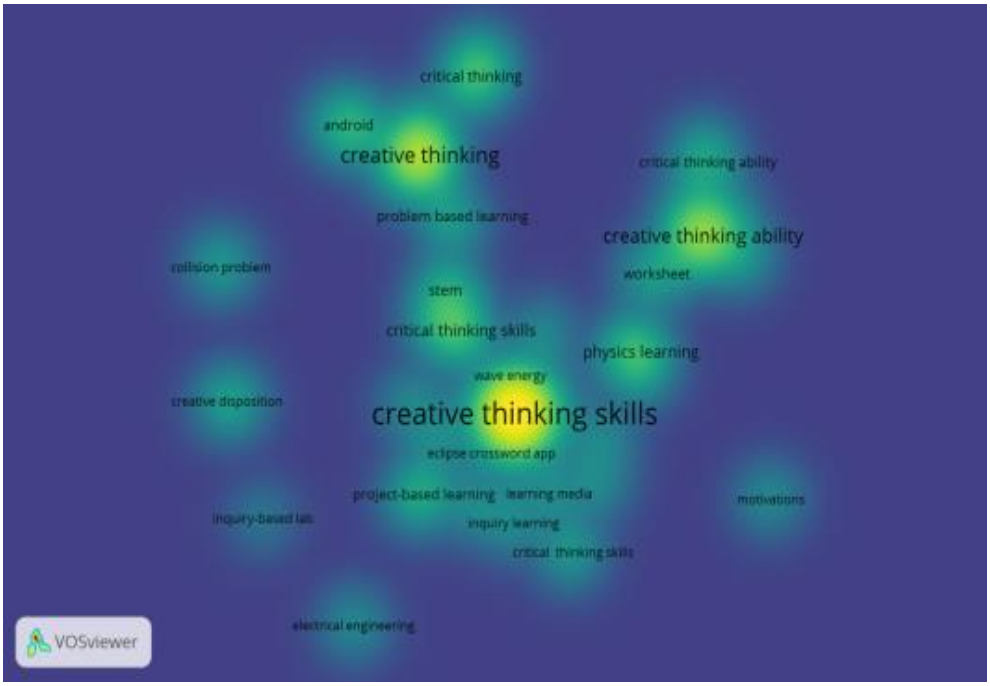

Fig 4. *Density Visualization*

The overlay visualization analysis and density visualization are used to discover significant themes within each research or body of knowledge. These findings were obtained by calculating the co-occurrence of keyword pairs [53] [54]. Vosviewer software was used to do the analysis. As can be observed, each cluster is associated with other terms. This indicates that the advancement of study on this subject is connected. Additionally, network analysis enables the identification of the Authority Author [55].

Table 3. Keywords that represent each cluster

No.	Cluster	Element
1.	Cluster 1 (red)	bachelor-designers training(1), contextual teaching and learning (1), creative thinking(13), Inquiry based learning(1), learning science(1), Module development(1), physics textbooks(1), Problem-based learning(1), understanding concept(1)
2.	Cluster 2 (Green)	Creative thinking ability(10), education instructional(1), personal desk laboratory(1), problem based learning(2), self-eficacy(1), soft scaffolding strategy(1), static fluid(1), students scientific attitude(1)
3.	Cluster 3 (Blue)	7e learning cicle (1), cbl model (1), computational physics courses (1), critical thinking skills (4), discovery learning model (1), fluid static (1), stem (3), temperature and heat (2)
4.	Cluster 4 (dark green)	Construct open ended question (1), critical thinking (13), hidrostatic preasure (1), learning achievement (1), scientific creative (2), scientific creativity skill (1)
5.	Cluster 5 (Purple)	Contextual problem (1), Critical thinking skill (4), fluid topic (1), hots student worksheet (1), physics learning (1), scientific creativity skill (1)
6.	Cluster 6 (light blue)	Android (2), hopscotch (1), local culture (batik)(1), local wisdom (1), physics mobile learning (1), problem solving ability (1)
7.	Cluster 7 (Orange)	Cooperative integrated reading (1), creative thinking skills (37), hot lab design (1), phet simulation (1), project-based-learning (2).

These results are derived using the title, keywords, and abstracts, with the minimum number of events set at two. There are up to 93 things that fulfill the 105-item requirement. This item is devoid of generic terms. Each item indicates a term that has been added, as indicated by the knot size. In other

words, the knot size indicates the frequency with which shared phrases appear. This study found 35 clusters, however the dominating seven clusters and subsequent seven groups were discovered. Table 3 shows the terms that appear in each cluster reflecting the study of physics creative thinking.

Authors and Joint Author Relations

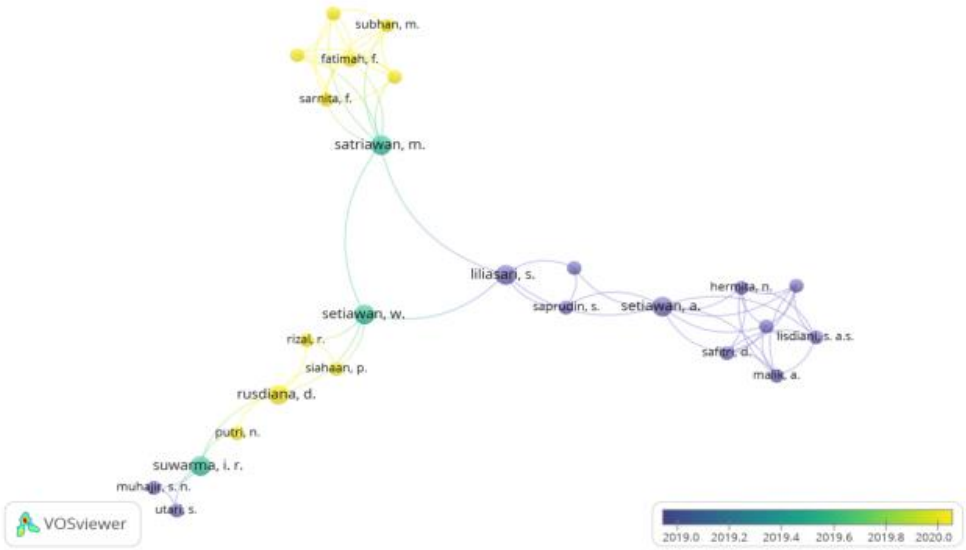

Fig 5. *Analysis of the authors' connection*

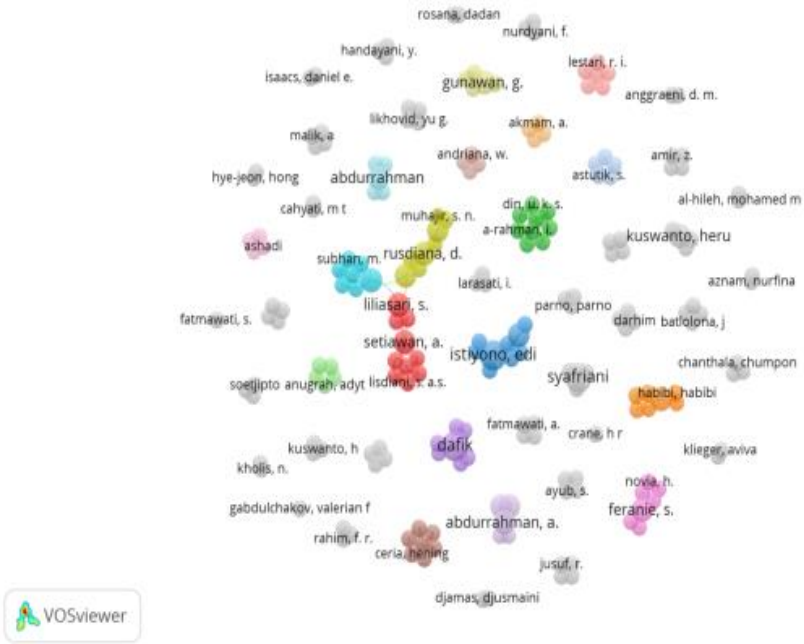

Fig 6. *Analysis of the author is seen from the number of documents*

Figure 5 depicts an analysis of common authors and networks relating to patterns of collaboration between people. Each node in this network symbolizes the author in relation to his writing. This analysis can incorporate a large number of distinct dimensions in order to display groupings and correlations between dimensions or changes over time. Figure 5 depicts a network analysis of the author from the author's birth year to the present. In this scenario, the author's connection might be classed as an annual one. It has been established that Lilia Sari, A., is the author with the most

relationships. Meanwhile, as mentioned by Subhan, Fatimah, Sarnita, Rizal, Rusdiana, and Hiddy, the most recent research are highlighted in yellow.

Additionally to analyzing shared authors, it is possible to examine all article authors and procedures connected to Creative Thinking in Physics, as seen in Figure 5. The author's examination of the number of documents is depicted in Figure 6.

Research Statistics
The location of the study was taken from Excel files. The city is extracted from each journal and proceedings to analyze this. After obtaining data in Excel, it is marked to Google Earth then this analysis is extracted using city coordination with the open source online platform gpsvisualizer.com [56] [57]. Figure 7 presents the research location on the article "Creative Thinking Physics".

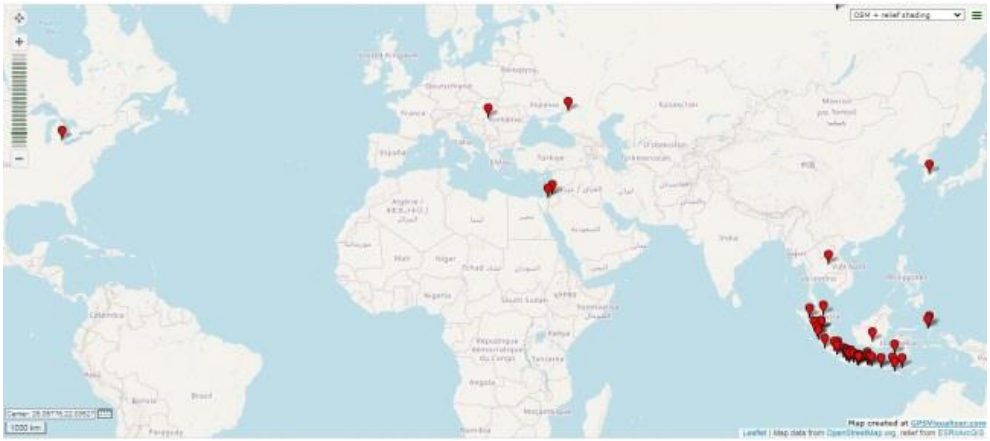

Fig 7. *Analysis Research Location*

Indonesia has a high density of research locations in publications about Creative Thinking Physics. According to this study's geographical distribution, research on Creative Thinking Physics is still dominated by the Indonesian area, particularly the islands of Sumatra and Java. By and large, this data enables this study to address the issue of what research trends have occurred in the field of Creative Thinking Physics during the previous 60 years. Based on the above exposure, the author recomends conducting research in areas other than Java and Sumatera for Indonesia.

CONCLUSION AND SUGGESTION

On the basis of the foregoing findings and discussion, it can be stated that research on creative thinking in the field of physics from 1960 to 2020 remains extremely scarce. 102 article papers have been published. According to the kind / type of document that many have examined, it is in the form of articles totaling up to 20 pieces and proceedings totaling up to fifty pieces. This research collects data from a variety of research topics that are connected to one another. This article uses bibliometric analysis to display a variety of literature in order to discover the major themes within each research or topic. According to the findings of this study, the VOS viewer identified 35 clusters that characterize thirty-five significant research topics that exist in the domain today, with seven dominating research themes.

Two limitations apply to this study. To begin, this research is typically constrained by the small number of keywords collected and also by the Scopus database utilized to collect articles. Second, while this research makes use of formal software (pop software, vosviewer, Mendeley, Microsoft Excel, and Gpsvisualizer.com), the author's subjective evaluation happened and may continue to result in mistakes. Subsequent study is advised to extend the sample size by increasing the keywords utilized and creating a more accessible database. Additionally, it may be used to compare the findings of other bibliometric analyses and provide recommendations (such as Bibexcel and Histcite). It is advised that

more study be conducted to offer a more thorough explanation, as there is currently very little research on creative thinking abilities in physics.

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