Bibliometric Analysis Regarding the Development of Learning Media and Students' Critical Thinking Skills (2019-2022)

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Abstract. Physics is something that is considered difficult, most students only understand physics from formulas, without knowing the basic concepts in physics. Therefore, it is important to use visual media in the physics learning process so that it can bridge abstract material into concrete. Then a bibliometric analysis was carried out on the research that had been conducted to analyze the linkages between the development of physics learning media and critical thinking skills. This research was conducted using the VOS viewer software, an application that applies Co-Occurrence and Co-Authorship calculations. A metadata search conducted through Scopus obtained 1,655 documents related to the development of physics learning media with research in 2019-2022. The results of the study obtained that physics learning media is closely related to students' critical thinking skills. However, there are still few documents produced regarding the relevance of these topics, so this research must be re-examined in depth.

1. Introduction

The development of technology and information in this modern era is very influential for the daily life of all people, both students and students. One of them is the use of smartphones. The level of development of smartphone devices which is getting higher and relatively cheaper is a supporting factor for increasing smartphone users. The implementation of information and communication technology in learning is a must, because the application of information and communication technology can be an indicator of success in learning [1]. In addition, life in the 21st century requires students to master various skills, one of which is critical thinking skills [2]. The digital marketing research institute E-marketer estimates that by 2018 the number of active smartphone users in Indonesia will reach more than 100 million people. The more students who own and use mobile devices, the greater the opportunities for using technological devices in education. Learning media that utilize cell phone technology is called mobile learning. Mobile learning is an alternative to developing learning media. The presence of mobile learning is intended as a complement to learning and provides opportunities for students to learn material that is not mastered anywhere and anytime [3]. In addition to cognitive abilities, the use of android media in learning physics is also able to improve other abilities such as scientific and high-level thinking [4]. Problem-solving measures students' ability to apply physics knowledge to accomplish an objective. Assessing students' components of skills involved in problem-solving could help in improving the strategy of the learning process [5].

Physics material is material related to everyday life, so teachers are required to be able to explain these concepts in a real form. Learning physics is something that is considered difficult, most students who have studied physics only understand physics from formulas, without knowing the basic concepts implied in physics itself. Learning physics is not just about knowing mathematics, but furthermore students are expected to be able to understand the concepts contained therein, write them into physical parameters or symbols, understand problems and solve them mathematically. Not infrequently this is what causes students' displeasure towards this subject to become even greater [6]. This is what often makes physics scary for them. Therefore, teaching staff are required to be more able to convey physics in a form that is easier to understand and more attractive so as to reduce the image that physics is scary. Teachers or educators must be able to use technology to improve the quality of the teaching and learning process in each educational unit [7]. An educator is required to have skills that support his duties in

teaching. One of these skills is how an educator can use instructional media [8]. In an effort to create interactive and creative learning, it is necessary to use interactive and interesting learning media [9]. With appropriate teaching methods and interesting physics learning media, it is not impossible to reduce the scary image of physics. The use of visual media in the physics learning process can bridge abstract material into concrete [10].

This increases the motivation to learn physics in students which has an impact on increasing understanding of the material being taught and stimulates students to always look for information related to physics lessons. With the rapid development of information technology, solutions to the above problems should be resolved as quickly as possible [11]. Media are various types of components in the student's environment that can stimulate them to learn [12]. Emphasis on aspects of thinking and developing thinking skills in learning physics will greatly help students' memory of the physics formulas being studied [13]. An understanding of a physics formula which essentially describes the interrelationships between several physics concepts will make it easier for students to be able to recall it and if necessary can easily describe it again. Preliminary study of students' critical thinking skills that have been conducted at SMA Negeri 5 Purworejo, it is known that students' critical thinking skills are seen from the aspect of identifying problems as much as 82%, collecting various relevant information as much as 78%, compiling alternative problem solving as much as 41%, making conclusions as much as 62%, express opinions as much as 61%, and evaluate arguments as much as 47% [14]. From these results it was concluded that further research was needed to improve students' critical thinking skills. Students can be said to be able to think critically when they can speak using the right reasons, both logically and systematically to solve a problem [15]. Critical thinking is a discipline of independent thinking that exemplifies the perfection of thinking according to a certain mode or realm of thinking [16]. Based on the results of interviews with physics teachers and observations made at SMA Negeri 5 Purworejo, it was found that many students already have cellphones, especially Android-based smartphones, but have not been used optimally and the learning media used is still in book form in the form of Student Worksheets (LKS) and books. the physics package has not been able to improve students' critical thinking skills [17]. The assessment process carried out also did not use a special assessment form to determine student abilities. Based on this statement, an analysis of the research that has been carried out is carried out to find out the link between the development of physics learning media and students' critical thinking skills, using articles spanning 2019-2022 which can also be used as a basis for further research regarding the development of physics learning media.

2. Methods

This research was conducted using bibliometric analysis method. Bibliometric analysis or method (bibliometrics) sometimes also referred to as scientometrics is part of the research evaluation methodology, and from the various literatures that have been produced, it is possible to carry out bibliometric analysis using a separate method [18]. This bibliometric analysis is based on research that will reveal the development of literature, such as the number of publications, articles, research approaches and author productivity. The result of the bibliometric mapping from the VOSviewer application that implements Co-Occurrence calculations. Co-occurrence analysis can reveal research topics statistically. Co-occurrence analysis is simply simply counting data in pairs in a collection unit [19]. Besides that, the VOS viewer also implements Co-Authorship which is used to find relationships between various studies based on research documents produced by researchers. Co-authorship networks are a tool for uncovering collaboration directions and identifying researchers and institutions that lead research [20].

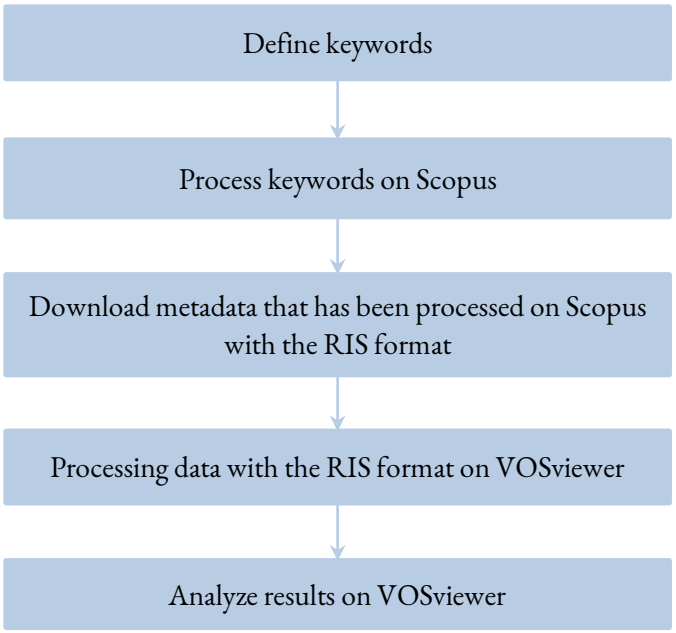

Figure 1. Research steps with bibliometric analysis

3. Results and Discussion

3.1 Development of learning media (overlay visualization)

Metadata searches conducted through Scopus obtained 1,655 documents related to the development of physics learning media. Then the metadata obtained was processed with VOS viewers software with research spanning 2019-2022. This shows that with this time span, many researchers have conducted research on the development of physics learning media. In this time span, it proves that the articles on the development of instructional media mostly discuss the relationship between learning media and students and the learning system. This is evidenced in Figure 2 of the following overlay visualization.

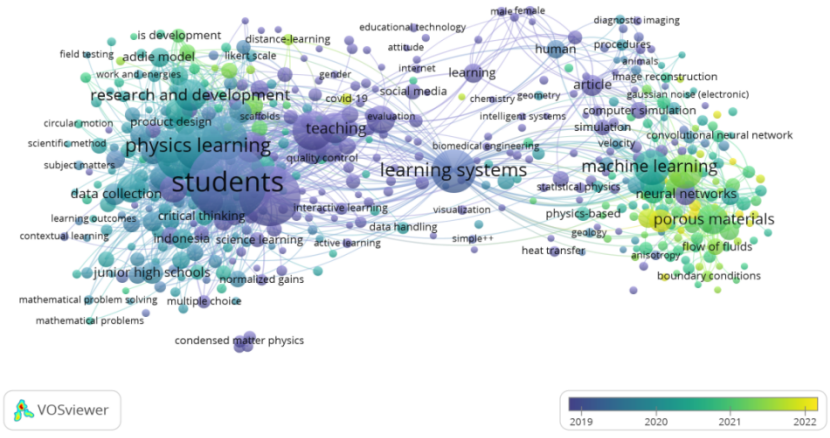

Figure 2. Overlay visualization co-occurrence.

3.2 Development of learning media (Density visualization)

This is also proven in Figure 3 below that the brighter the color display, the more people do research. Conversely, the darker the color displayed, the fewer people who do research related to the development of physics learning media. The research update shows that the brighter the color appears, the more

people who do research. On the other hand, when the color gets darker and smaller, it is still rare to conduct research [21]. Based on the picture, the keywords "learning physics", "students", "critical thinking", "learning system", and "learning" appear the most in several research articles, this is evidenced by the appearance of these keywords in yellow. While the keywords that appear in green indicate the keywords that appear most rarely in several research articles [22]. In other words, the problem of developing physics learning media has appeared quite a lot in the titles and abstracts of several scientific articles.

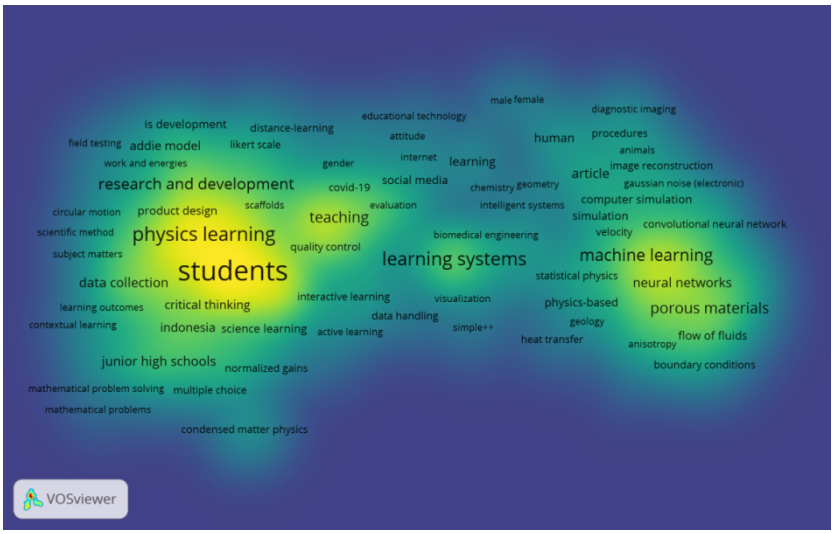

Figure 3. Density visualization co-occurence

3.3 Distribution of Physics Learning Media Documents

Through the graph below it can be seen that Indonesia is in the top rank of the five countries based on the highest number of documents produced related to physics learning media. After Indonesia with 78 documents, followed by America with 311 documents, China with 74 documents, Germany with 63 documents and English with 45 documents.

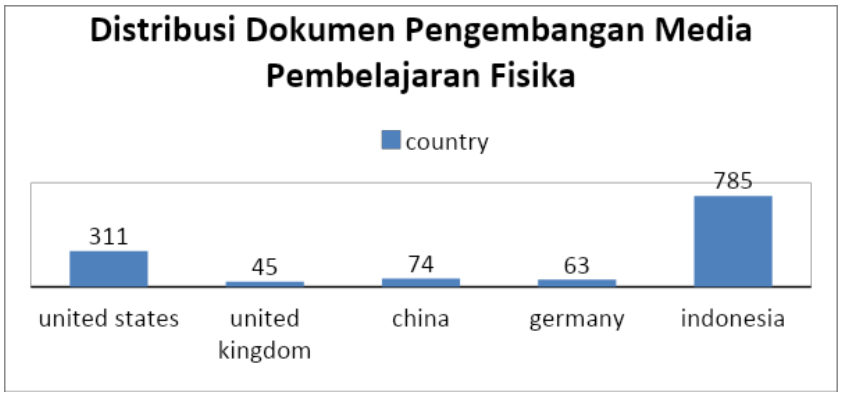

Figure 4. Distribution of physics learning media documents in several countries

3.4 Changes in the number of documents every year

While the distribution of the number of documents regarding the development of physics learning media is shown in the following figure 5. Based on the graph, it proves that the most publications of documents related to this topic occurred in 2021 with a total of 308, the most publications in the second and third order respectively occurred in 2020 and 2019, namely 280 and 251 documents. Then followed

in 2022 as many as 206 documents. Based on this statement, it proves that there are many authors who have an interest in discussing the topic of learning media development.

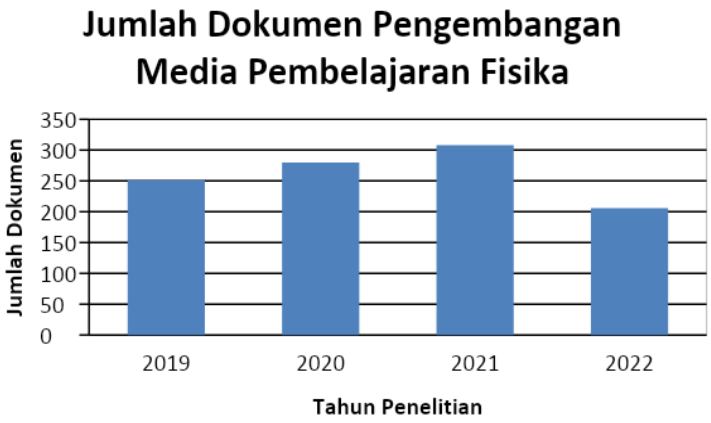

Figure 5. The number of documents for the development of physics learning media each year

3.5 Authors from various countries

By analyzing using the VOS viewer software through the Co-authorship type of analysis, the authors are obtained according to Figure 6, which shows the top author and its cluster. Through the metadata obtained, the author's research development related to the development of physics learning media and critical thinking skills can be studied in one of his studies. Based on the picture in cluster 1 in red with one of the studies discussing the use of physics learning videos to increase student learning interest [23]. Furthermore, in cluster 2 it is blue, with one of the studies discussing the development of learning models using local wisdom-based comics which of course can aim to improve students' critical thinking skills in learning physics [24]. Then followed by purple cluster 3, with one of the studies discussing the implementation of augmented reality-based physics learning media that can be carried out in schools in utilizing technological developments [25]. Furthermore, cluster 4 is orange, with one of the studies discussing the development of multimedia computers to improve students' critical thinking skills [26]. Then followed by cluster 5 in brown, with one of the studies discussing the development of media practicum tools in physics learning that can help students hone and develop critical thinking skills and student skills [27].

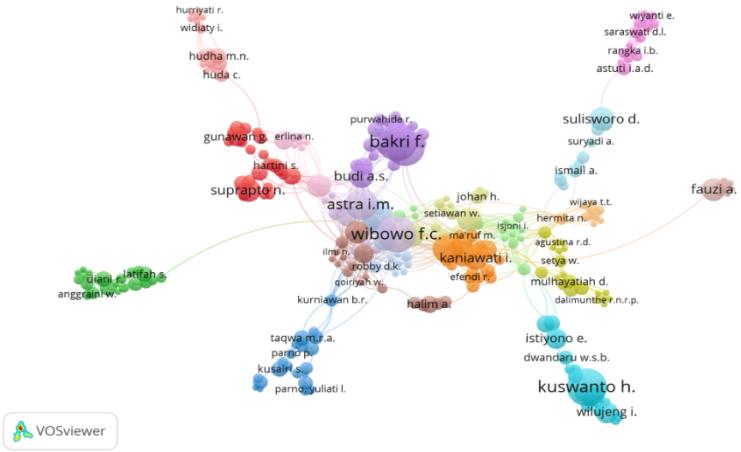

Figure 6. Authors from various countries

3.6 Top 10 media development research authors in Indonesia

Based on the graph in Figure 7, it shows the 10 top authors who produced the most documents related to research on the development of physics learning media in the 2019-2022 period. The most documents were 28 documents developed by Bakri F., 27 documents were developed by Kuswanto H., then 26 documents were developed by Wibowo F.C. and Mulyati D. then followed by Astra I.M. who developed 19 documents and Samsudin A. 16 documents. While Suhandi and Budi a.s. developed 11 documents. As well as Budi a.s. and Darman a. developed as many as 10 documents.

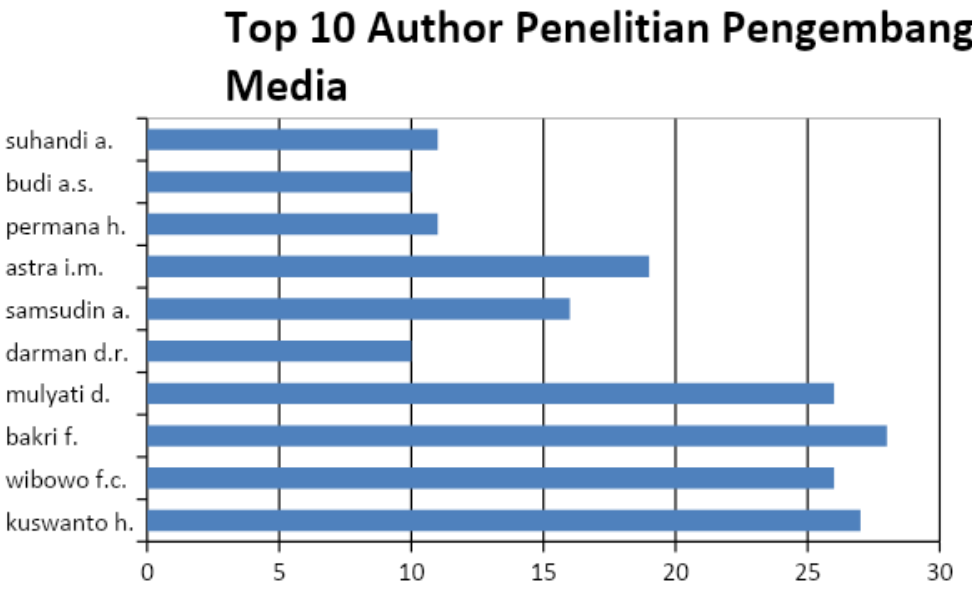

Figure 7. Top 10 media development research authors

3.7 Keyword relation

After being analyzed using the VOS viewer software through the type of keyword Co-occurrence analysis, five clusters (red, green, blue, yellow and purple) were obtained which showed the relationship between one topic and another.

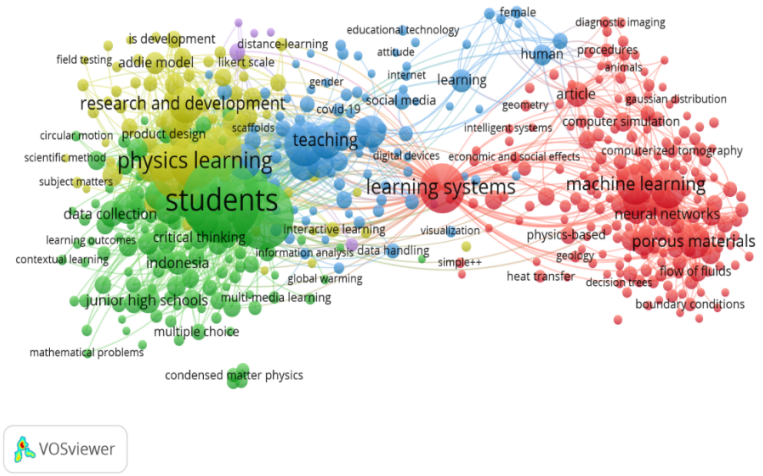

Figure 8. Network visualization co-occurence

Based on Figure 8, it displays a network visualization that has five clusters. In cluster 1 with red color which consists of 196 items, this cluster is dominated by the physics learning system. Where the word "learning system" is closely related to the process of acquiring skills, knowledge, understanding and new values. One media that has an important role in education is learning media, various kinds of learning media have been used, from conventional learning media such as simple media to modern learning media such as electronic learning media [28]. Cluster 1 has relationships with other clusters related to media development in physics learning, teaching and learning processes, critical thinking skills, technology and so on. In teaching and learning activities, learning media is one of the factors that can help and support the achievement of predetermined learning objectives [29]. This is shown in Figure 9 below.

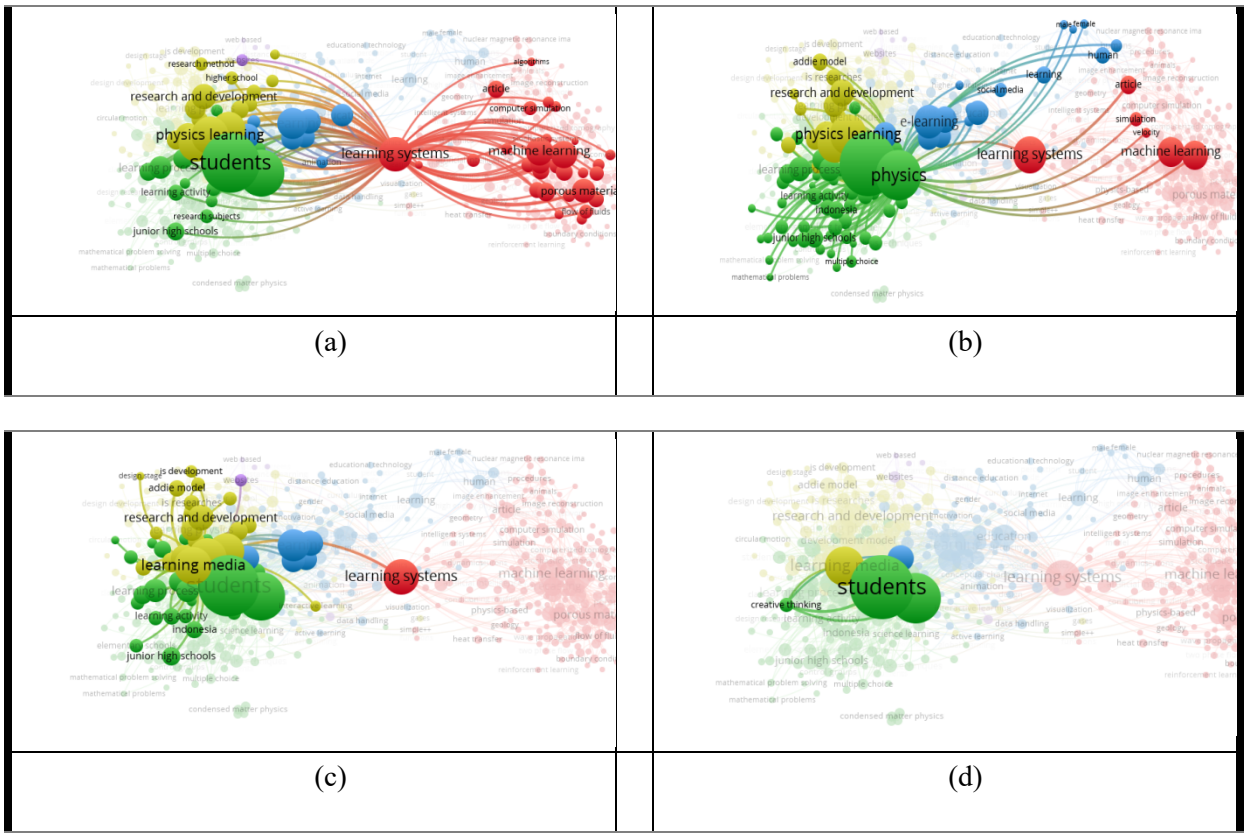

Figure 9. Networking visualization of learning systems (a) Networking visualization of physics learning (b) Networking visualization of learning media (c) Networking visualization of creative thinking (d)

Cluster 2, highlighted in green, consists of 116 items and is predominantly associated with "physics," which is relevant to the students' learning process in understanding the provided physics material in schools, as shown in Figure 9b. Moving on to Cluster 3, represented in blue and comprising 92 items, it is dominated by "E-Learning," as indicated in Figure 9b. This cluster has a correlation with the use of social media, impacting the effectiveness of learning.

Cluster 4, highlighted in yellow and totaling 72 items, is dominated by "physics learning" and "research and development," as depicted in Figure 9a. In physics education, instructors often deliver material to students in a monotonous manner, indicating the need for improvement. Meanwhile, Cluster 5, in purple, consists of 7 items and is dominated by "websites," as shown in Figure 7. The use of web blogs as a learning medium can also be interpreted as the utilization of HTML (HyperText Markup Language) in education [30].

Through Figure 7, it is evident that there is an interconnection among Clusters 1 to 5 in realizing effective physics learning through the use of learning media. The relationship between critical thinking

and students is depicted in Figure 9d, indicating that further research is needed to explore the connection between learning media and critical thinking.

4. Conclusions

The results of the study using the VOS Viewer to examine the relationship between the development of instructional media and critical thinking skills show that little research has been conducted on the topic of the interrelationships between the two. However, learning media and critical thinking skills have a very broad relationship with other topics. Learning media has a relationship with learning systems, learning processes, and research and development. Meanwhile, critical thinking skills are related to students, process skills, learning physics, learning systems, etc. Based on this discussion, it shows that little research has been conducted on the topic of the link between the development of instructional media and critical thinking skills, so there is a need for more in-depth research on the relationship between the two topics.

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