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Bibliometric Study: Effectiveness of Physics Learning Media in The Merdeka Belajar Curriculum to Improve Students' Critical Thinking Skills

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Abstract: This research aims to determine the effectiveness of physics learning media in the Merdeka Belajar curriculum in improving students' critical thinking abilities. The article writing method is through literature study by integrating the PRISMA stages in it. The process of searching for relevant article sources was carried out using Publish or Perish software in the 2022-2023 interval. The metadata obtained was then analyzed using VOSviewer software to obtain a qualitative descriptive bibliometric meta-analysis. The results of the qualitative bibliometric analysis show that the physics learning media (PhET simulations, quiz platforms, MOOCs, videos, YouTube content, Adobe Animate) in the Merdeka Belajar curriculum is proven to be effective in improving students' critical thinking abilities. Apart from that, this research has been updated in the form of new ideas in bibliometric analysis on topics related to the Merdeka Belajar curriculum. The impact of this research is that it can provide updates in the world of research related to research on topics that revolve around the Independent Curriculum. This is certainly able to enrich references for future progress in the world of education, especially in the use of types of learning media that are appropriate to the curriculum used.

Keywords: Bibliometric; Critical thinking; Curriculum; Learning media; Merdeka belajar physics

Introduction

The Merdeka Belajar curriculum is a type of curriculum that contains various intracurricular learning processes (Cahyono, 2022; Hadi et al., 2023; Nikmah et al., 2023; Novia et al., 2023; Okyranida et al., 2023; Yunaini et al., 2022). This intracurricular learning is accompanied by a more optimal presentation of content to students so that they have effective time in the process of deepening that the material and strengthening competence (Novia et al., 2023; Taufik et al., 2021). The Merdeka Belajar curriculum has the advantage of a high level of flexibility as evidenced by the freedom in the process of selecting learning media (Irawati et al., 2022; Maipita et al., 2020; Tedjokoesoemo et al., 2023). Apart from that, it is necessary It is known that the Merdeka Belajar curriculum is a curriculum that provides freedom for each student in determining everything they are interested in in the post-recovery period (Ciita et al., 2023; Jusniar & Auliah, 2023; Kamila et al., 2023; Rotty et al., 2022). Thus, learning media is needed that suit their needs so that their academic and non-academic potential develops optimally (Rijal et al., 2022).

Learning media is anything that can be used as a means of conveying knowledge to students (Akrim, 2018; Bakhri et al., 2023; DPJ & Lengkana, 2023; Hardiansyah, 2022; Lahaya et al., 2023; Nisa et al., 2021). Good learning media is learning media that suit students' needs, is interactive, in line with current developments, and is easy to access (Arista & Kuswanto, 2018; Helsa & Kenedi, 2019; Saripudin et al., 2021). By having learning media that suits the students' backgrounds, it is hoped that it will be able to make it easier for students to understand the learning material presented (Komikesari et al., 2020; Oktaviani &

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Mandasari, 2020; Sujarwo et al., 2022; Widarti et al., 2020).

On the other hand, physics as one of the subjects included in the extracurricular learning of the Merdeka Belajar curriculum has a frightening impression for most students (Delima, 2018; Sulaeman et al., 2022; Utari et al., 2021). This arises because of the difficulties experienced by most students in working on questions that are integrated with various kinds of formula equations (Kimba et al., 2018). The frightening impression that arises due to the difficulty factor during the problem solving process has a further impact in the form of decreasing students' interest and motivation in studying physics (boring physics) (Johansson et al., 2018; Shute et al., 2019). Problems like this need to be given solutions so that they do not affect the process of achieving existing learning objectives (Taub et al., 2020). Various studies have been carried out in an effort to find a solution to this problem, but no research has been carried out to explore trends in solving this problem in a coherent and systematic manner.

On the other hand, bibliometric analysis is becoming an analytical trend in the world of research (Chawla & Goyal, 2022; Peng & Ye, 2021; Sahoo, 2022). In this context, bibliometric analysis makes it easy for researchers to obtain data related to the effectiveness of physics learning media in the Merdeka Belajar curriculum in large quantities and in a relatively short time. Knowing journal authors with a high level of productivity regarding the study topic can be used to find out who cites the journal, the journals cited, and the number of authors who cite the journal in question (Albort-Morant et al., 2018; Boyack & Klavans, 2019; Gaviria-Marin et al., 2018; L. Huang et al., 2020; Kokol et al., 2021; Rodríguez Jiménez et al., 2019). However, currently there are still not many research trends that examine the effectiveness of physics learning media in the Merdeka Belajar curriculum that have been identified. Therefore, this research focuses on the effectiveness of physics learning media in the Merdeka Belajar curriculum, which is an important topic to research.

Through this research, it is hoped that it will be able to provide information to readers that interactive physics learning media can create a pleasant learning atmosphere, foster students' motivation and interest in learning physics, and can improve learning outcomes. Thus, bibliometric analysis can be utilized in efforts to improve the quality of the education sector through optimizing the physics learning media for the Merdeka Belajar curriculum (Effendi et al., 2021).

Method

A systematic literature is used to make it easier to compile, synthesize, analyze, describe and examine empirical studies related to the keywords used in the research, namely "Physics Learning Media in The Merdeka Belajar Curriculum" (Siddaway et al., 2019; Snyder, 2019). Thus, to ensure that the review process runs systematically, researchers use this method (Li et al., 2019; Newman & Gough, 2020).

This research also utilizes a literature review study that focuses on presenting selected items for systematic reviews and meta-analysis as well as the network meta-analysis method which is usually abbreviated as PRISMA. The PRISMA meta-analysis method has general research stages, namely providing criteria for the subject, determining appropriate research studies (identification process), search strategy (searching for appropriate titles and abstracts), searching and filtering to identify important points in related literature sources, describe and review selected sources, and describe, analyze and synthesize research (Mainey et al., 2020; Meiyanti et al., 2018; Papakonstantinou et al., 2020). All matters relating to research have determined eligibility criteria to minimize bias (Hooshyar et al., 2019; Mohamed Shaffril et al., 2021). Apart from that, data strengthening was obtained through literature review studies using reference sources in the form of books and journals with a high level of credibility (Fink, 2019). The following are the research stages according to PRISMA analysis as shown in Figure 1.

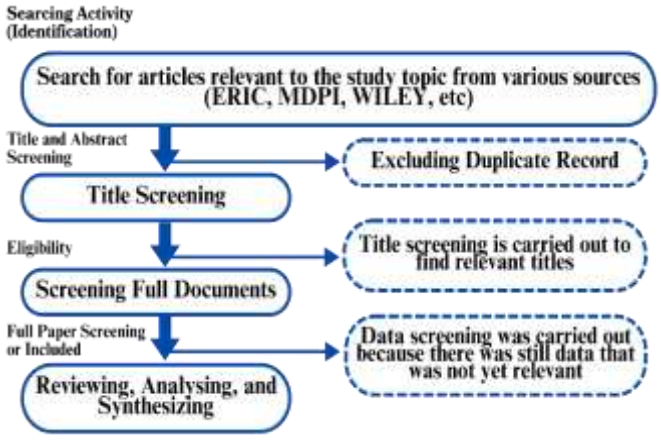

Figure 1. PRISMA methods (Soeharto et al., 2019)

The data used in this research was obtained via Publish or Perish (PoP) sourced from the Google Scholar database. PoP itself is software that functions as an alternative for searching for sources in the form of journals with a high level of credibility (Demir, 2018; Moosa, 2018). Meanwhile, Google Scholar was chosen as a source to obtain relevant articles regarding the topic

"Physics Learning Media in The Merdeka Belajar Curriculum" because the Merdeka Belajar curriculum model is only applied in the Indonesian region (Al Yakin et al., 2023; Hidayat et al., 2021). Thus, Google Scholar is suitable to be used as a source of data because it focuses on a national scale.

This research was conducted on October 29, 2023. During the search process, researchers investigated several articles published by Google Scolar and indexed by trusted institutions to obtain data regarding "Physics Learning Media in The Merdeka Belajar Curriculum" via PoP for further storage. in .csv and .ris format.

To analyze research on this topic, researchers conducted a special search on the indexing institution, namely Google Scholar, using a document analysis approach. In this approach process, the keyword "Physics Learning Media in The Merdeka Belajar Curriculum" was used and 3,040 articles were obtained that had been published by Google Scholar (without time lag). However, this number decreased when the reduction process was carried out based on searches for publications in the last year (2022-2023), namely with a total of only 1,880 articles obtained. The reduction process is carried out by setting year intervals starting from 2022-2023 because the Merdeka Belajar curriculum will only be implemented starting at that time (2022). Next, the data that has been obtained is then processed using MS software. Excel and VOSviewer.

VOSviewer is software that has the ability to read datasets from various sources (Scopus, Web of Science, Google Scholar, etc.), capable of analyzing various types of bibliometric analysis (Co-Authorship, Co-Occurrence, Citation, Bibliographic Coupling, and Co -Citation), and is able to provide visualization of research data (Caputo & Kargina, 2022; Orduña-Malea & Costas, 2021; Oyewola & Dada, 2022). The purpose of using this software in this research is to obtain bibliometric data mapping (McAllister et al., 2022; Nandiyanto et al., 2021). While the Ms. software Excel is used to visualize data obtained from PoP in .csv format in the form of diagrams and graphs. Thus, the bibliometric analysis model with the help of Ms. This kind of Excel is done to make it easier for readers to understand the meaning of the study topic, providing a real picture of the research data which is realized in the form of visualization overlays, diagrams and graphs.

The following is the flow of the research stages as a whole to facilitate understanding of the research regarding the topic being researched as shown in Figure 2.

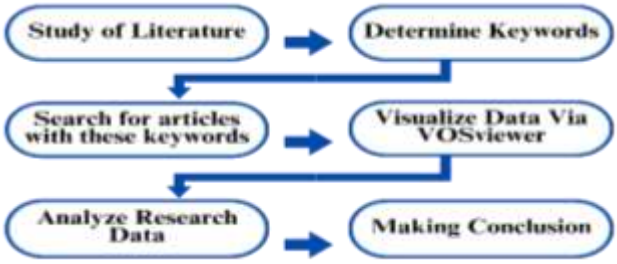

Figure 2. Research phase flow

Result and Discussion

The following is a detailed discussion of the data obtained using the keyword "Physics Learning Media in the Merdeka Belajar Curriculum".

Research Trends of Physics Learning Media in The Merdeka Belajar Curriculum

Figure 3 above shows the number of publications in 2022 and 2023. The number of publications in 2020 only reached 77 documents and in 2023 there were 115 publications. Thus, it can be said that the number of publications from 2022 to 2023 has increased by 38 publications.

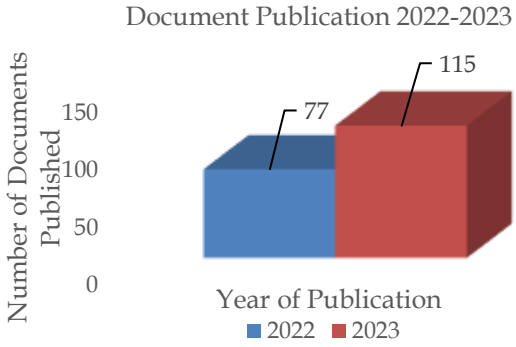

Figure 3. Top publications

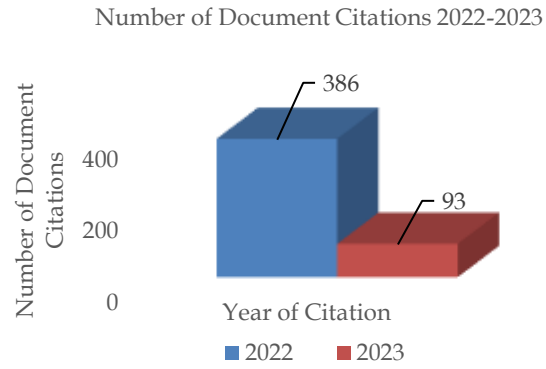

Figure 4. Top cited

Meanwhile, Figure 4 above shows the number of articles cited. In 2022 the number of articles cited will be

386, while in 2023 the number of documents cited will only be 93 documents. Thus, the number of citations from 2022 to 2023 has decreased by 293 citations. In general, the data in Figures 3 and 4 are inversely proportional to each other.

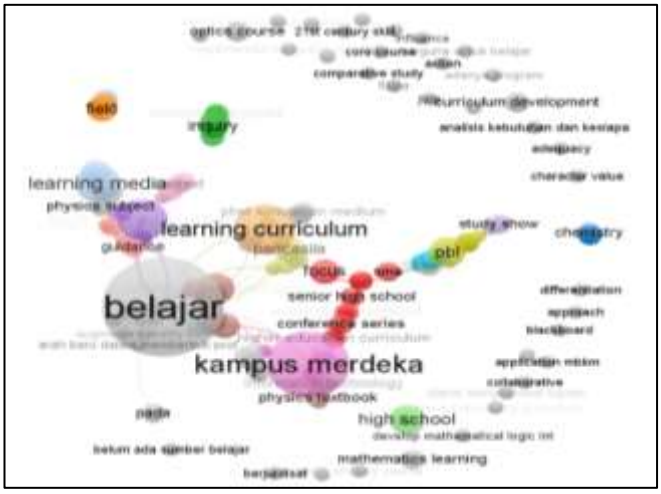

Figure 5. Network visualization

The Figure 5 above shows that the color of each keyword is different. Apart from color, the sizes of keyword nodes differ from each other. The size of the circle indicates the number of repetitions or not. The size of the largest circle indicates the number of keywords that appear in all bibliometrics (the most productive sources) (Y.-J. Huang et al., 2022; Oladinrin et al., 2023; Oyewola & Dada, 2022). And the opposite also applies, the smaller the size of the keyword circle, the keyword is repeated with lower intensity.

Based on Figure 5 above, 726 items are obtained which are contained in 72 clusters. The following explains the top six clusters based on the results of analysis using VOSviewer with the dominant topics discussing learning media related to the Merdeka Belajar curriculum and science skills being emphasized. Cluster 1 found 29 items that focused on cognitive factors, creative thinking skills, critical thinking skills, educational goals, Merdeka Belajar curriculum, model implementation, physics learning process, multimedia interactive games used in high schools. Cluster 2 found 28 items with a focus on behavior, inquiry curriculum models, corporate flip pdf e-modules, electronic modules, online learning media, Merdeka Belajar concepts, PhET simulations, and so on. Cluster 3 found 24 items that focused on comic-based learning media in chemistry lessons, the use of quiz media, moocs media, and so on which are used in high schools and independent campuses. Cluster 4 received 24 items with a focus on learning media such as video media and YouTube videos used in elementary schools. Cluster 5 obtained 23 items with a focus on Adobe Animate media, critical thinking abilities, e-module, Flip PDF, Flip PDF Corporate Edition used by high school students. Cluster 6 found 22 items with a focus on critical thinking, interactive media courses, LKPD, and Physics LKPD.

Furthermore, based on Figure 5 above, it can also be seen that the distance between one keyword and another keyword also represents the level of relationship (Duan & Guan, 2021; Farooq, 2023; C. Huang et al., 2020). The closer the distance between one keyword and another, it can be said that the keywords have a close relationship (Meng et al., 2020). Just like when we click on the keyword "Learning", the active keywords are learning curriculum and Pancasila. Thus, it can be said that studying with the learning curriculum and Pancasila have a close relationship. However, in this context it is known that the distance between the learning curriculum is closer to Pancasila when compared between the learning curriculum and learning. This means that the learning curriculum has a high level of close relationship with Pancasila (Dewantara et al., 2019; Fitriasari & Masyitoh, 2020; Subaidi, 2020). Remembering that the learning curriculum implemented is the Merdeka Belajar curriculum. This close relationship is because the Merdeka Belajar curriculum contains a Pancasila student profile in it (Cahyono, 2022; Chamisijatin et al., 2023).

Emerging Topics

Apart from showing strengths between topics, VOSviewer software has other capabilities such as displaying new issues in research as well as old issues that have been studied in previous research.

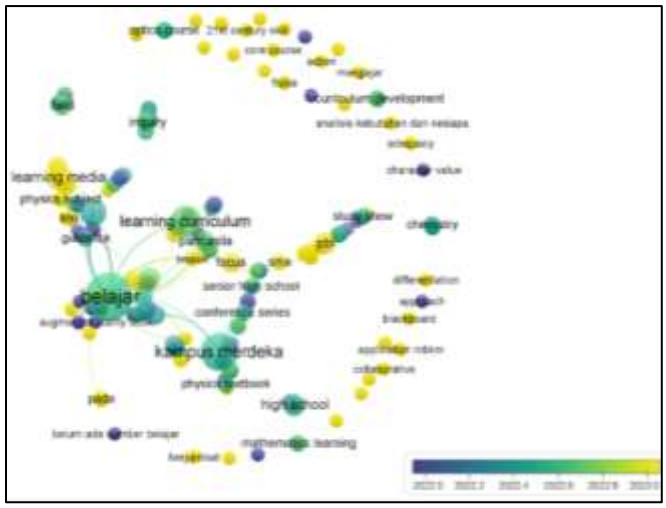

Figure 6. Emerging topics

Based on Figure 6 above, each circle has a different color. This shows that the keywords presented were used in research in different years (Yang et al., 2020). For

example, circles with a dominant color of purple are used in research in 2022, while circles for keywords with a dominant color of yellow are used in research in 2023.

The purple color indicates that the keywords (topics) used in the research are old issues. Old issues used in previous research such as augmented reality books, character values, approaches, and so on. The green color indicates that the topic is a research trend in the middle to the end of 2020. Topics that are a research trend (often studied in several studies) in this year's interval include topics about the Merdeka campus, learning, learning curriculum, physics textbooks, and soon. Meanwhile, the yellow color shows that research on this topic is developing in the world of research.

Future Research

The results of the VOSviewer study on "Physics learning media in the Merdeka BelajarCurriculum" show that there are several things that are part of research that should be carried out in the future, namely by searching for and selecting the desired problems. One of the interesting and important issues to be discussed in the field of education is the topic of science process skills which are basic skills for the 21st century (Gunawan et al., 2019). The image below shows several key words regarding "Physics Learning Media in The Merdeka Belajar curriculum" which can be used as an option for further research.

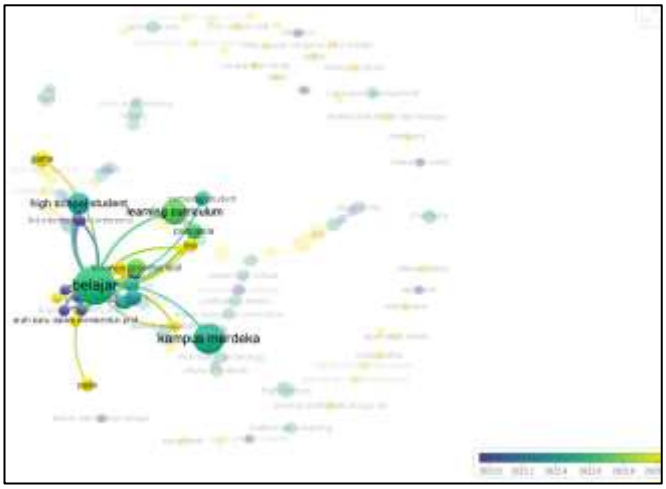

Figure 7. Future research

Apart from science process skills, what is important to study is what learning media can be applied in learning activities (Puspitarini & Hanif, 2019; Yustina et al., 2020). The types of learning media are important to study because they are one of the things that can support the process of achieving educational goals (Andriyani & Suniasih, 2021). Apart from that, the process of assessing appropriate learning media to be applied in the learning process will of course have an impact on the learning atmosphere in the class, the ease of the process of conveying information, and also improving student learning outcomes while studying material, especially physics. The following is presented regarding the types of learning media that have been proven to be effectively applied in learning activities using the Merdeka Belajar curriculum.

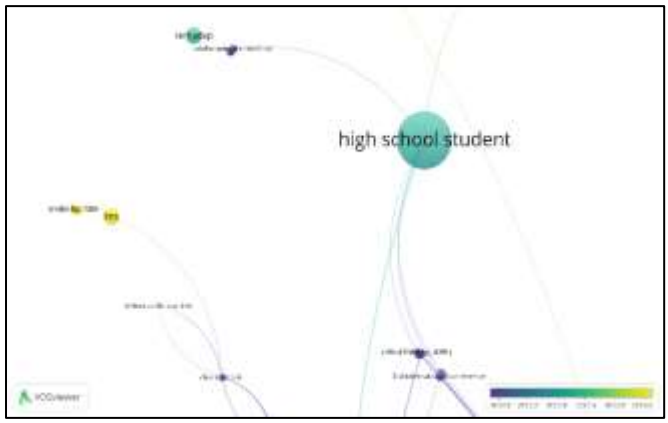

Figure 8. The relationship between learning media and critical thinking ability

Based on Figure 8 above, information is obtained that learning media such as Adobe Animate media obtained from cluster 3 visualization are used during the learning process using the Merdeka Belajarcurriculum. Apart from Adobe Animate media, there are also types of learning media from several clusters 1 to 6, namely online learning media such as PhET simulations, quiz media, MOOCS (Massive Open Online Courses) media, videos, YouTube videos, Adobe Animate media, and course interactive media.

Apart from that, based on Figure 8 above, information is obtained that one example of science process skills emphasized in 21st century learning is the ability to think critically (Changwong et al., 2018; Rahman, 2019; Sutiani, 2021) which is related to the learning media used. Critical thinking skills can make it easier for students to solve problems (Bezanilla et al., 2019; Nurkhin & Pramusinto, 2020). If linked and analyzed in depth with the keyword "Physics Learning Media in The Merdeka Belajar Curriculum", then learning media in this context is used as a means to help efforts to improve students' critical thinking abilities during the learning process based on the Merdeka Belajar curriculum. It is proven that Adobe Animate learning media is able to improve students' critical thinking skills. Apart from that, if we link Figure 5 and Figure 8 again, the types of learning media from several of the clusters mentioned are related to critical thinking abilities. Thus, it can be concluded that the learning media used during learning and teaching activities in

schools are able to effectively improve students' critical thinking abilities.

Table 1. Top 10 Articles with High Relevance

Authors	Title	Result
(Mairizwan et al., 2022)	Increasing the Competence of Physics Teachers in Designing PjBL-Based Teaching Aids for the Implementation of the Merdeka Curriculum	A 24.17% rise in physics teachers' competence in creating PjBL-based teaching aids in West Pasaman Regency is credited to a successful mentoring program that improved their PjBL mastery and aided Physics education design (Merdeka Belajar curriculum implementation).
(Restu et al., 2022)	Implementation Of The Merdeka Belajar-Kampus Merdeka Curriculum Based On The RI 4.00 Platform At Universitas Negeri Medan	The study shows continuous efforts in implementing the Merdeka Belajar-Kampus Merdeka curriculum through the RI 4.00 platform, including drafting guidance regulations, SKS conversion rules, and evaluation methods. Success relies on HOTS-based learning, IT integration, and strong support for educators and students in Merdeka Belajar-Kampus Merdeka.
(Rohmah et al., 2023)	Implementation of the "Merdeka Belajar" Curriculum in the Industrial 4.0 Era	The research covers the application, effectiveness, benefits, and challenges of the 'Merdeka' curriculum. It is simpler to implement compared to the 2013 curriculum, which is effective in promoting student choice and teacher facilitation. However, obstacles, including various media, exist in the 'Merdeka' curriculum implementation.
(Neswary & Prahani, 2023)	The Use of Digital Pocketbooks to Support Merdeka Curriculum in Physics Learning: Literature Review	The study discovered that using digital pocketbooks for physics in the Merdeka curriculum is effective, enhancing students' understanding and cognitive skills. However, they may consume smartphone memory.
(Wahyuningtyas & Ellianawati, 2023)	Analysis of The Suitability of Eleventh Grade Physics Textbooks with the Independent Curriculum	The book is highly suitable with Graduate Competency Standards (92.85%), Material Coverage (90%), and Depth of Material (91.42%). However, it's only sufficient for Learning Outcomes (74.28%) and Average Objective aspect (72.14%).
(Asnidar et al., 2023)	Implementation Of Merdeka Belajar-Kampus Merdeka And Response Of Physics Education Students At Syiah Kuala University FKIP	Seventy-one percent of Physics Education students from Syiah Kuala University's Faculty of Teacher Training and Education, who were involved in the Independent Learning-Campus Independent program, expressed satisfaction
(Kasman & Lubis, 2022)	Teachers' Performance Evaluation Instrument Designs in the Implementation of the New Learning Paradigm of the Merdeka Curriculum	Evaluation instruments for teachers in the Merdeka Curriculum's new learning paradigm are foundational for assessments. They measure teacher competencies, identify learning challenges, and provide valuable feedback for self-improvement. These evaluations contribute to enhancing education in schools and among teachers.
(Bakri & Permana, 2022)	Pelatihan Media Digital Berbasis Pembelajaran Saintifik untuk Mendukung Program Merdeka Belajar	The Merdeka Belajar program should incorporate enjoyable digital learning resources to aid comprehension and create a fun learning experience. Teacher training targets the creation of supportive digital learning resources for Merdeka Belajar
(Azzahra et al., 2022)	Analisis Kebutuhan Media Pembelajaran Fisika Berbasis Teknologi Di Sman 8 Tanjung Jabung Barat Pada Era Merdeka Belajar	Technology-based physics learning media analysis shows educators and students need it to enhance critical thinking, communication, collaboration, creativity, and motivation. It aligns with Merdeka Belajarcurriculum's 9C, BMI, and FLIPS skills, ensuring readiness for the 4.0 Industrial Revolution and Society 5.0.
(Rizki et al., 2023)	Adventuring Physics: Integration of Adventure Game and Augmented Reality Based on Android in Physics Learning	The validity assessment confirms the application's validity, feasibility, and reliability. Additionally, the practicality assessment indicates its strong suitability for physics learning, making it a motivating tool for students and showcasing the use of digital technology in education.

Top Author

Based on Figure 9 above, it is known that the image is a network visualization display which provides information that there are several authors with research that has high relevance to the keyword "Learning Media in The Merdeka Belajar Curriculum". Based on the data displayed by VOSViewer, it shows that there are 454 related authors. The eight clusters are depicted in Figure

8. Based on the Google Scholar database, it can be seen that Risdianto, E is the top author with the largest number of documents and is relevant to the keyword "Learning Media in The Merdeka Belajar Curriculum" when compared with Erita y (four documents) and Prahani, bk (four documents). This means that Risdianto, E becomes the Top Author on research topics in the Google Scholar database. This means that Risdianto, E is a contributor to the research "Physic Learning Media in The Merdeka Belajar Curriculum" on a national scale which is indexed by Google Scholar.

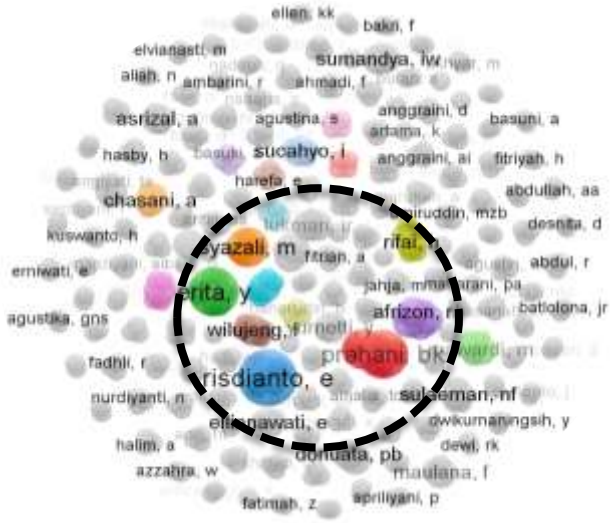

Figure 9. Researchers with high contributions in related research topics

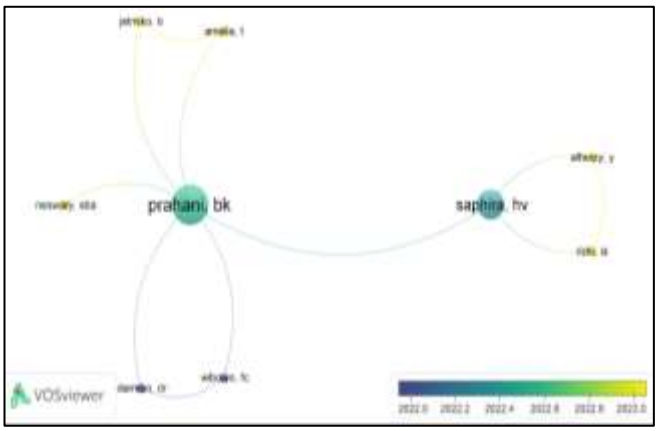

Figure 10. Author with high correlation with other authors

However, when VosViewer was re-set to not display all items (authors), data was obtained as in Figure 9. Based on Figure 10 above, it is known that Prahani bk is an author from Surabaya State University who has relationships with other authors. This means that Prahani bk is the Top 2 author with the highest number of documents and high correlation with other authors.

The limitation of this research is that it uses the Google Scholar database so that the data obtained only consists of visualizations of certain parts. Thus, it is recommended that further research related to "Physics Learning Media in The Merdeka Belajar Curriculum" use a database other than Google Scholar, such as the Scopus database so that it can map research trends related to these keywords broadly.

Conclusion

Based on analyzed data, consisting of 726 items in 72 clusters, this research highlights the effectiveness of various physics learning media, including PhET simulations, quiz platforms, MOOCs, videos, YouTube content, Adobe Animate, and interactive courses, in improving critical thinking skills in the Merdeka Belajar Curriculum. This research offers implications for future research in similar domains, serves as a valuable reference for literature reviews and contributes to advances in education, particularly regarding appropriate learning media for curricula. However, it is necessary to pay attention to existing limitations, such as the relatively small dataset due to the implementation of the Merdeka Belajar curriculum in 2022-2023 and the use of Google Scholar as the main database. Future researchers are advised to explore additional databases to gain more comprehensive insights and diverse visualization models.

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Author Contributions

Conceptualization, methodology, data curation, initial manuscript writing (original manuscript), and editing were carried out by AIS. Conceptualization, methodology, formal analysis, research validation, reviewing the results of the initial manuscript draft were carried out by SA.

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Conflict of Interest

The author declares that there are no conflicts of interest in this published work.

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