JPPIPA 9(10) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Analysis of Research Opportunities in Science Education Related to Learning Media: A Systematic Literature Network Analysis

Rahmi Zulva[1,2], Agus Setiawan[3*], Andi Suhandi[3]

[1] Doktoral Pendidikan IPA Universitas Pendidikan Indonesia, Bandung, Indonesia.
[2] Pendidikan Fisika, Universitas PGRI Sumatera Barat, Padang, Indonesia.
[3] Pendidikan IPA Universitas Pendidikan Indonesia, Bandung, Indonesia.

Received: August 31, 2023
Revised: October 15, 2023
Accepted: October 25, 2023
Published: October 31, 2023

Corresponding Author:
Agus Setiawan
agus_setiawan@upi.edu

DOI: 10.29303/jppipa.v9i10.5150

Abstract: The aim of this study is to describe the trend data of research related to learning media. The research method used is the Systematic Literature Network Analysis (SLNA) method. The data for this study consists of research articles on learning media without any time limitations. Articles were collected from the Scopus database, which includes IEEE, Springer, and the search application Publish or Perish (PoP). In the search engine, articles on learning media were first found in 2002, and a total of 1708 articles were retrieved. After filtering by title, 120 articles were obtained, and based on the keywords from these articles, 80 eligible articles were identified for analysis. The analysis results show that the number of studies and research citations fluctuate. Topics frequently discussed in the context of learning media include skills, approaches, and the latest on interactive multimedia. For further research directions, it can be associated with the use of interactive multimedia in explaining science learning that uses a phenomenon-based learning model. This is because science learning can explain phenomena that occur in everyday life.

Keywords: Learning media; Multimedia interactive; Systematic literature network analysis

Introduction

Media serves as a means of communication and a source of information. Media can be referred to as 'instructional media' when it contains a message with an educational purpose. Instructional media is a tool, medium, intermediary, and connector for disseminating, conveying, or delivering a message and ideas, so as to stimulate the mind, feelings, actions, interests, and attention of students in such a way that the teaching and learning process occurs within the student (Cahyadi, 2019).

While educational media is defined as things that are used, seen, heard, discussed, added to the material that supports these activities (Rather, 2004). As a practical guide to analyze the characteristics of media and learning methods as well as their uses, one might use the popular framework called Dale's Cone of Experience. In this framework, 11 media are mentioned, namely verbal symbols, visual symbols, recordings, films, educational television, exhibits, study trips, demonstrations, dramatic experiences, contrived experiences, and direct-purposeful experiences. Within this framework, it can be seen that learners can benefit from abstract learning activities.

Using instructional media in the teaching and learning process is one effort to enhance the effectiveness and quality of the learning process, which in turn can improve the quality of student learning outcomes. Instructional media encompasses everything related to both software and hardware that can be utilized to convey the content of teaching materials from the learning source to the students (either individual or group), which can stimulate the mind, feelings, attention, and interest of learners in such a way that the learning process (inside or outside the classroom)

How to Cite:
Zulva, R., Setiawan, A., & Suhandi, A. (2023). Analysis of Research Opportunities in Science Education Related to Learning Media: A Systematic Literature Network Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 929–938. https://doi.org/10.29303/jppipa.v9i10.5150

becomes more effective (Jalinus, 2016). The chosen media should be truly effective and efficient (Puspita et al., 2017). The use of media must be tailored to the learning objectives, material, interests, needs, and conditions of the students (Aras, 2019; Lestari et al., 2018). By considering these factors, instructional media can foster motivation and enhance learning activities (Setiawan, 2019). The appropriate use of online learning media can assist students in understanding the learning material delivered by teachers. However, in reality, many educators still face difficulties in using instructional media.

Learning media it has become the main study in many studies. Various kinds of learning media are the focus to improve student understanding and student skills. Some of the media commonly used in the learning process include audio media, audio-visual media, technology or digital-based media (applications/websites/podcasts).

Several studies have been continuously conducted to address the various challenges educators face when using instructional media. However, opportunities for innovative research can still be pursued based on the objectives and issues surrounding the current use of learning media. One way to find opportunities for new, innovative research is by conducting a systematic literature review or secondary studies aimed at discovering and identifying all materials relevant to the topic to be analyzed systematically, following a set of predefined procedures (Kitchenham et al., 2015). A systematic literature review identifies whether relevant research has already been conducted, determining if new primary research is needed (Petticrew et al., 2008). Traditionally in education, literature reviews can be used to make claims about what we know and don't know about a phenomenon, subject, or specific topic, thus opening up new research opportunities in education and teaching (Zawacki-Richter et al., 2019).

Previous literature reviews have focused on the development of instructional media, such as smartphone flipbooks, virtual reality, web-based computer games, PHET, and video learning, all of which aim to enhance students' skills (Banda et al., 2023; Danielsson et al., 2006; Ermawati et al., 2021; Kößler et al., 2015; Lui et al., 2023). Systematic literature reviews play a crucial role in academic research, helping to build a body of knowledge and examine the novelty of further studies (Kunisch et al., 2018).

A Systematic Literature Review can be enhanced with visualization through bibliometric analysis (Linnenluecke et al., 2020). Bibliometric analysis is the most common approach involving statistical methods to analyze bibliographic data. Analysis from both analytical and quantitative perspectives coordinates expertise in a particular field of study. Systematic Literature Review and Bibliometric Analysis can be integrated to depict research trends and discover new research opportunities (Duong et al., 2022; Lozada et al., 2021). Systematic literature review and bibliometric analysis are integrated into a quantitative-based method known as Systematic Literature Network Analysis (SLNA) (Khitous et al., 2020), relying on objective measures and algorithms to perform quantitative literature-based detection of emerging topics (Colicchia et al., 2019). With this objective in mind, a systematic literature network analysis was conducted to uncover how research on instructional media serves as a solution to issues in the learning process. Therefore, we complement existing research with our study.

The research question in this paper is: RQ: What form of instructional media can teach the phenomena found in science? Therefore, the state of the art of this research highlights recent breakthrough studies that show the latest developments in the field and to reveal its future trajectory, especially in relation to instructional media that helps explain scientific phenomena. This opens opportunities for conducting advanced studies on the results of research with the topic of instructional media, both at the secondary school level and at the university level. This research aims to describe trend data related to instructional media. The outcome of this publication will contribute to identifying topics that have been researched and new areas that still need to be developed through innovative research in instructional media.

Method

The method used in this research is the Systematic Literature Network Analysis (SLNA), which is adopted by combining the systematic literature review (SLR) with bibliographic network analysis (BA) and consists of two stages. This SLNA procedure is adapted from Colicchia et al. (2019).

The first procedure in SLNA is the Systematic Literature Review (SLR). SLR is a specific methodology that identifies existing studies, selects and evaluates their contributions, and analyzes and synthesizes data (Kunisch et al., 2018). The SLR procedure includes the following stages: *Scope of the analysis* using the CIMO approach, which stands for Context, Intervention, Mechanism, and Outcome. This approach is employed to formulate research questions and frame the literature review appropriately. *Locating Studies* by looking at keywords, gathering articles from Springer, IEEE, and PoP which are used as data sources. *Study Selection and Evaluation* by using include or exclude criteria for articles (type of document, language, and relevant topic). The

output of this stage is a collection of selected articles to be analyzed in the second stage.

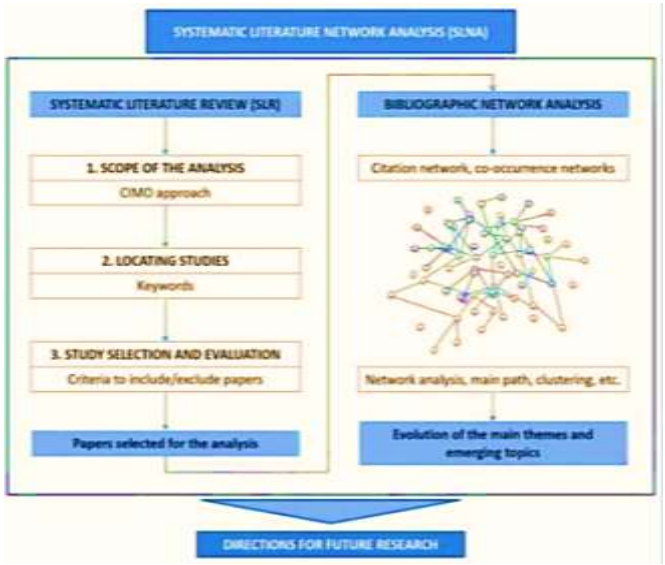

Figure 1. SLNA methodology in the current research

Next, the second stage in SLNA is the Bibliometric Analysis phase. At this stage, article data is tabulated in Excel and prepared in CSV (comma delimited) format, so that the data can be input using VOSViewer. The analysis in this second stage of SLNA includes: Citation Network and co-occurrence network. The Citation Network relies on the reference list of articles in journals. References point to previous works that have influenced a research development. The citation network analysis indicates the interconnections or relationships between researchers, keyword analysis (co-occurrence network) for theme clustering. Theme clusters show relationships between topics, specifically the topics most frequently researched or the most influential within the research time frame. The output of this stage is the evolution of main themes and emerging new topics. Upon completing this second stage, future research directions will be obtained.

The article data analyzed in this study was sourced from the Scopus database. Scopus is a scientific journal database managed by the scientific information company, Elsevier. Article data in Scopus can be collected from sources such as Springer and IEEE, as well as through reference management software like Publish or Perish (PoP). Articles were searched using keywords: "learning media", "multimedia", or "hypermedia". The search was based on titles, keywords, and science learning without any time constraints. The first article was detected in 2002, and the latest article was from 2023 at the time of the search

Result and Discussion

First Stage: SLR Review

Scope of the Analysis

This step is crucial to avoid ambiguity in the review through definition and formulation of the review questions (Ali et al., 2017). To determine the scope of the SLR, the CIMO approach is utilized, as follows: Context; the context of the research partners being reviewed is research in the field of science education or physics education, specifically on the topic of instructional media. Intervention; the scope of intervention in the analyzed articles is the method or learning model used employing instructional media in the science or physics learning process, especially on the Lithosphere. Mechanism; this aligns with the treatment given and is closely related to the learning strategies in the reviewed articles. Outcome; the selected articles are those that impact various student knowledge and skills, such as concept understanding, thinking skills, visual skills, and also the 21st-century skills that students need.

Locating Studies

Data was collected through the IEEE and Springer databases, as well as the Publish or Perish application using the Scopus database. Data collection utilized titles related to instructional media, specifically "instructional media", "science instructional media", and "instructional media in the lithosphere". The data search focus was in the field of education or learning, further refined with the keywords "multimedia" or "interactive multimedia". The article search was conducted without any time constraints. Research on instructional media was found starting from the year 2002 up to 2023.

Study Selection and Evaluation

A search resulted in 1708 articles, which were then further refined by manually removing duplicates, leaving 1580 articles. The type of documents to be analyzed consisted of articles in journals and proceedings, while books and magazines were discarded, resulting in 1250 articles. The final selection stage involved choosing articles relevant to instructional media in science or physics education. This yielded 119 articles, of which 80 were accessible. A set of inclusion criteria was identified for transparency in the process and to evaluate the relevance of the papers to be selected, as detailed in Table 1. The journal metrics of articles that meet the inclusion criteria can be seen in Table 2.

Table 1. Inclusion Criteria for Study Selection and Evaluation

Inclusion Criteria	Rationale
Published in peer-reviewed journals	Peer-reviewed journals are considered to be of higher quality than non-peer reviewed articles
Selection of papers without restriction on publication year	Widest possible time window to comply with the purpose of the study, that is, focus on the evolutionary view of the field
Selection of papers with restriction on the Search Field, that is, "Title-Abstract-Keywords"	Selected articles present high relevance, since keywords must be present in the articles' title, abstract or keywords
Published in English	English is the dominant language in the field of supply chain management research

Table 2. Journal Metrics of Eligible Articles

Journal	F	%Indeks by H-Indeks/SJR 2022	WoS H indeks/JIF for SSCI or JCI for ESCI
IEEE Access	1	1.25	Q1/ SJR:0.93	WoS (SSCIE/0.93)
IEEE Transactions on Multimedia	1	1.25	Q1/ SJR:1.64	WoS (SSCIE/2.26)
Technology, Knowledge and Learning	5	6.25	Q1/ SJR: 1.11	WoS (ESCI/1.93)
Journal of Science Education and Technology	23	28.75	Q1/ SJR: 1.28	WoS (SCIE, SSCI/1.47)
International Journal of Science and Mathematics Education	1	1.25	Q1/ SJR: 1.06	WoS (SSCI/1.23)
Research in Science Education	3	3.75	Q1/ SJR: 1.16	WoS (SSCI/2.32)
International Journal of Technology and Design Education	3	3.75	Q1/ SJR: 0.84	WoS (SCIE, SSCI/0.88)
Cultural Studies of Science Education	1	1.25	Q1/ SJR: 0.86	WoS (SSCI, AHCI/1.06)
International Journal of STEM Education	1	1.25	Q1/ SJR: 1.67	WoS (SCIE, SSCI/2.46)
Learning, Media and Technology	1	1.25	Q1/ SJR: 1.88	WoS (SSCI/2.66)
Education and Information Technologies	1	1.25	Q1/ SJR: 1.25	WoS (SSCI/1.90)
International Journal of Instruction	1	1.25	Q2/ SJR: 0.61	WoS (ESCI/0.69)
Interactive Technology and Smart Education	1	1.25	Q1/ SJR: 1.18	WoS (ESCI/1.31)
Annals of Anatomy	1	1.25	Q1/ SJR: 0.71	WoS (SCIE/1.46)
Nurse Education Today	1	1.25	Q1/ SJR: 0.95	WoS (SCIE, SSCI/1.67)
International Journal of Interactive Mobile Technologies	2	2.5	Q3/ SJR: 0.41	
International Journal of Instruction	1	1.25	Q1/ SJR: 0.61	WoS (ESCI/0.69)
Eurasia Journal of Mathematics, Science and Technology Education	1	1.25	Q3/ SJR: 0.36	
Jurnal Pendidikan IPA Indonesia	5	6.25		WoS (ESCI/0.11)
International Journal of Engineering Pedagogy	1	1.25	Q2/ SJR: 0.46	
Smart Learning Environments	1	1.25	Q1/ SJR: 0.97	WoS (ESCI/1.60)
Journal for the Education of Gifted Young Scientists	1	1.25	IOP Publishing	WoS (ESCI/0.61)
Indian Journal of Pharmaceutical Education and Research	1	1.25	Q3/ SJR: 0.19	WoS (SCIE/0.23)
Global Media and China	1	1.25	Q1/ SJR: 0.57	WoS (ESCI/0.41)
Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	1	1.25	Q3/ SJR: 0.32	
International Journal of Emerging Technologies in Learning	1	1.25	Q2/ SJR: 0.54	
ACM International Conference Proceeding Series	1	1.25		
International Journal of Engineering and Technology(UAE)	1	1.25		
Journal of Physics: Conference Series	3	3.75		
AIP Conference Proceedings	1	1.25		
IOP Conference Series: Materials Science and Engineering	1	1.25		
1st International Conference on Cybernetics and Intelligent System (ICORIS)	1	1.25		
International Conference on Information Technology Based Higher Education and Training (ITHET)	1	1.25		
International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC)	1	1.25		

Journal	F	%Indeks by H-Indeks/SJR 2022	WoS H indeks/JIF for SSCI or JCI for ESCI
1st International Conference on Cybernetics and Intelligent System (ICORIS)	1	1.25	
International Conference on Computer & Information Sciences (ICCOINS)	1	1.25	
International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC)	1	1.25	
International Conference on Information Technology Systems and Innovation (ICITSI)	1	1.25	
6th International Conference on Cyber and IT Service Management (CITSM)	2	2.50	
International Conference on Information Management and Technology (ICIMTech)	1	1.25	
19th IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD)	1	1.25	
Proceedings of the IEEE	1	1.25	

Table 2 displays the metric data for the 80 articles that qualified from the SLR analysis. Articles frequently appeared in the Journal of Science Education and Technology. The number of documents relevant to the instructional media topic each year can be seen in Figure 2.

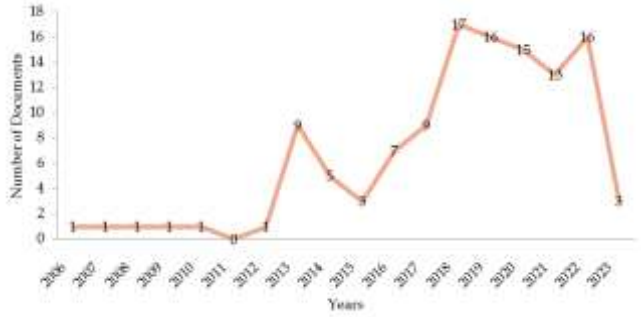

Figure 2. Number of Documents relevant to the instructional media topic

The trend in the number of relevant articles shown in Figure 2 indicates an increase in research on media from 2006 to 2013. In 2014 and 2015, there was a decline in research numbers, which then increased again from 2017 to 2018. In 2019, there was a decrease lasting until 2021 due to the effects of the COVID pandemic. During the pandemic, all activities were conducted online, with many using IT-based instructional media. However, in that period, research on instructional media decreased, then rose again in 2022 and declined once more in 2023.

Second Stage: Bibliometric Analysis.
Citation Network Analysis.

Citation Network Analysis (CAN) is a method based on citations and, as a consequence, this method can only be applied to connected components only.

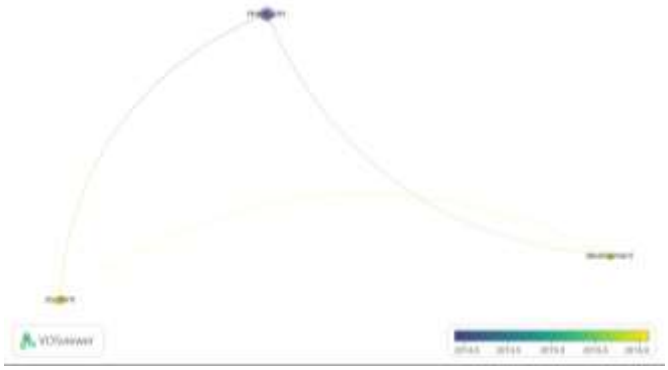

Figure 3. Relationship between titles in the instructional media review from 80 articles

From Figure 3, it can be inferred that the relationship between the titles of the articles is relatively small. This indicates that the published articles have little relation to each other.

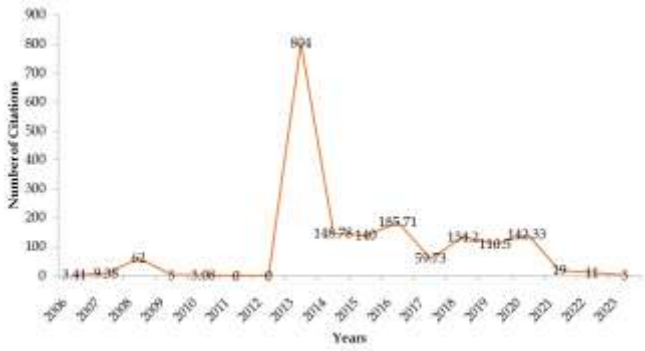

Figure 4. Number of article citations with the topic of learning media every year

The trend analysis of the number of article citations from 2006 to 2023 shows fluctuations. From 2006 to 2013, there was a drastic increase in the number of article citations. In 2013, the number of cited articles

was higher than in other years. From 2014 to 2023, there was a drastic decline in the number of article citations. This indicates that between 2013 and 2023, not much research was conducted on learning media. In bibliometric analytics, citation score analysis is necessary as presented in Table 3.

Table 3. Top Ten Articles with the Most Citations

Cites	Authors	Title	Year	Source	Publisher
435	Kung Hun Chen, Chin Chung Tsai	Affordances of Augmented Reality in Science Learning: Suggestions for Future Research	2013	Journal of Science Education and Technology	Springer
167	Ming-Chaun Li, Chin-Chung Tsai	Game-Based Learning in Science Education: A Review of Relevant Research	2013	Journal of Science Education and Technology	Springer
130	Helen Crompton, Diane Burke Kristen H. Gregory, Catharina Grabe	The Use of Mobile Learning in Science: A Systematic Review	2016	Journal of Science Education and Technology	Springer
88	Kamisah Osman; Tien Tien Lee	Impact of Interactive Multimedia Module with Pedagogical Agents on Students Understandaing and Motivation in the Learning of Electrochemistry	2014	International Journal of Science and Mathematics Education	Springer
76	Janice L. Anderson, Mike Barnett	Learning Physics with Digital Game Simulations in Middle School Science	2013	Learning Physics with Digital Game Simulations in Middle School Science	Springer
62	T. S. Huang; C. K. Dagli; S. Rajaram; E. Y. Chang; M. I. Mandel; G. E. Poliner; D. P. W. Ellis	Active Learning for Interactive Multimedia Retrieval	2008	Proceedings of the IEEE	IEEE
57	Katrin Hochberg; Sebastian Becker; Malte Louis; Pascal Klein; Jochen Kuhn	Using Smartphones as Experimental Tools a Follow-up: Cognitive Effects by Video Analysis and Reduction of Cognitive Load by Multiple Representations	2020	Journal of Science Education and Technology	Springer
52	Chang-Hwa Wang; Cheng-ping Chen	Employing Augmented-Reality-Embedded Instruction to Disperse the Imparities of Individual Differences in Earth Science Learning	2015	Journal of Science Education and Technology	Springer
52	Miri Barak & Rania Hussein-Farraj	Integrating Model-Based Learning and Animations for Enhancing Students Understanding of Proteins Structure and Function	2013	Research in Science Education	Springer
47	Javier Corredor; Matthew Gaydos	Seeing Change in Time: Video Games to Teach about Temporal Change in Scientific Phenomena	2014	Journal of Science Education and Technology	Springer

Table 3 shows the ten most frequently cited articles in the learning process that utilize learning media. It can be seen that the article by Kung Hun Chen, Chin Chung Tsai (2013) regarding the accessibility of AR in science learning is the research recommendation for the future with the most citations. This is followed by the article by Ming-Chaun Li, Chin-Chung Tsai (2013), on game-based learning in science education and the article by Helen Crompton, Diane Burke, Kristen H. Gregory,

Catharina Grabe (2016), on the use of mobile learning in science. Hence, it can be said that these three studies have made the most significant contributions to further research on learning media. According to Dawson & Joksimovic (2014), citations can measure the relevance of publications, although widely cited articles do not necessarily represent groundbreaking research. It can be assumed that citations reflect how the cited articles influence new studies (Zhao & Strotman, 2015).

Co-Occurance Network

Network analysis uses the total number of words to identify influential title words, and each word is counted once, regardless of how many times it appears in the same article (Xia et al., 2021).

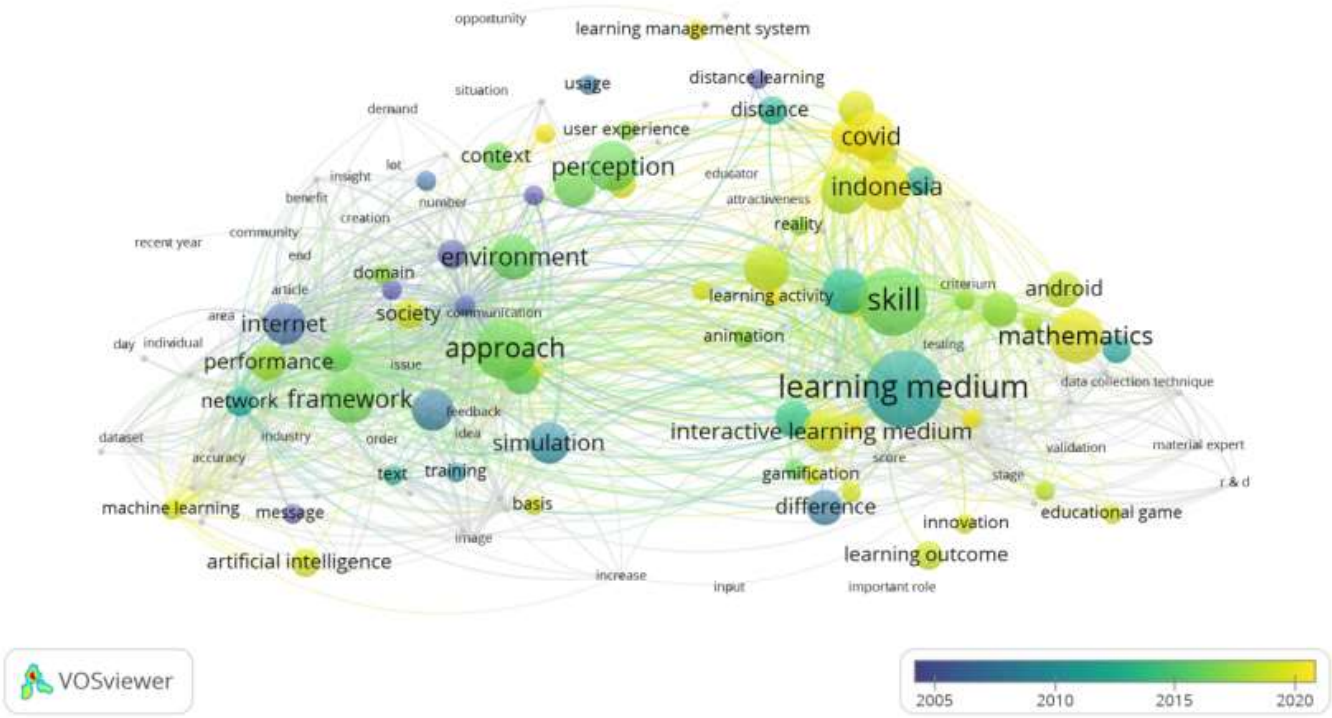

Figure 5. Overlay network of co-occurrence research related to learning media

Based on Figure 5, the relationship between the keywords that constitute the topic of learning media can be identified. The overlay network analysis reveals several words that emerged as new topics for research in 2020, namely covid, interactive learning media, learning activities, and mathematics. The topic of learning media is the most extensively researched, followed by approach and skill topics. In this analysis, only the topic of learning media is used in educational research, especially in higher education.

Discusion

The analysis results indicate that the trend in the number of studies and research citations regarding learning media has fluctuated, and as of 2023, the number of studies has decreased. The decline in research on learning media is due to the lack of interest in this area of study. This could be because educators have not maximized the use of learning media. Based on the cluster analysis of keywords, it is known that research on learning media is the most conducted, and such research is not considered recent. Meanwhile, the keywords 'skill' and 'approach' are related to research on learning media, but these studies are among the newer topics and are associated with research on learning media. Thus, it can be said that research on learning media can measure skills or a learning approach.

Media is viewed as one of the factors that can enhance the effectiveness of the learning process. This is because media plays a strategic role and function that can directly or indirectly affect students' motivation, interest, and attention in learning. It can visualize abstract material being taught, making it easier for students to understand. Moreover, media can clarify learning content and has the ability to manipulate and present objects that are difficult for students to access. Learning media is crucial for teaching and learning activities as it supports the achievement of learning objectives more efficiently and quickly. Learning media is not just a teaching aid; it is also a strategy in learning.

Innovative studies have been conducted in researching learning media, such as the use of computers in learning (Danielsson et al., 2006) and the utilization of learning videos, which can influence the learning process and students' learning styles, leading to better learning outcomes (Kößler et al., 2015). In addition to using video media in the learning process, virtual simulation media can also be utilized. A virtual simulation is a computerized version of a model run over a period of time to study the implications of predefined interactions (Baser, 2006). Simulation-based learning is generally considered an alternative approach to expository guidance or direct lab exploration (Ronen et al., 2000). Practical-based learning is necessary to give students the opportunity to discover and apply concepts through simulation observation (Bakri et al., 2020). This allows students to directly manipulate initial conditions and immediately see the impact. Combining direct practical learning and online learning using simulations

can result in a better experience for students (Chen et al., 2015).

This research not only seeks opportunities regarding what is seldom or rarely studied in the use of learning media. The results of this analysis will enhance understanding, thereby guiding the success of subsequent research. The focus is not only on the use of types of learning media in the learning process but also on observing student skills and learning outcomes. Based on cluster analysis, many types of media still hold potential and relevance for further research, such as the use of interactive multimedia. Interactive multimedia is an integration of several other media elements, including text, images, graphics, animation, audio, and video, with an interactive mode of presentation that can create a learning experience for students as if experiencing real-life situations (Bardi et al., 2015; Rasyid et al., 2016). This interactive multimedia can take the form of smartphone flipbooks that assist in the learning process (Ermawati et al., 2021), digital games used to promote learning of science knowledge/concepts, thereby facilitating students' problem-solving skills (Li et al., 2013; Rahayu et al., 2019) and providing a better learning experience (Fujiati et al., 2019; Tobar-Muñoz et al., 2023), PHET to enhance motivation and understanding of student concepts (Banda et al., 2023), and animations to boost conceptual comprehension (Mills et al., 2019). Multimedia-based learning can take various forms, including video lectures, online tutorials, interactive simulations, virtual reality environments, and mobile learning applications. With a multimedia approach in various forms, students' conceptual understanding can be enhanced (Adamczyk et al., 2009; Osman et al., 2014; Pujiyono et al., 2017; Taufiq et al., 2014). Learning using mobile devices or laptops makes students enthusiastic about learning (Budiman et al., 2019; Lee, 2016), thereby improving students' science literacy (Widodo et al., 2020).

Furthermore, multimedia-based learning can be accessed anytime, anywhere, making it a flexible and convenient option for students with busy schedules or those unable to attend traditional class sessions (Barak et al., 2013; Reid et al., 2016). Overall, multimedia-based learning offers many benefits and can be a powerful tool for educators wanting to enhance their teaching practices and improve learning outcomes for their students, as well as train certain skills. Therefore, subsequent research on learning media, when viewed from clusters of studies that are still rarely conducted, yet this type of research is considered novel, is the use of interactive multimedia. This interactive multimedia can be integrated with phenomenon-based learning. Looking at the analysis of past conducted research, the development of interactive multimedia by integrating phenomenon-based learning has not yet been carried out.

Conclusion

The analysis results show that the number of studies and citations in this learning media has fluctuated. In the citation network analysis, the numbers are still relatively small, and the frequently appearing topics are about learning media, approach, skills, and only a few on interactive multimedia. This opens opportunities for conducting innovative research on learning media, especially on the topic of interactive multimedia.

Acknowledgments

I express my deepest gratitude to the Education Financing Center (PUSLAPDIK) of the Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) for granting me financial support through the Indonesia Education Scholarship (BPI) during my studies at Universitas Pendidikan Indonesia (UPI) Bandung.

Author Contributions

Rahmi Zulva contributed to conceptualizing research ideas, analyzing data, and writing articles. Agus Setiawan and Andi Suhandi as supervisors from research activities to writing and reviewing articles.

Funding

This research received no external funding.

Conflicts of Interest

The author declares no conflict of interest.

References

Adamczyk, C., Holzer, M., Putz, R., & Fischer, M. R. (2009). Student learning preferences and the impact of a multimedia learning tool in the dissection course at the University of Munich. *Annals of Anatomy - Anatomischer Anzeiger*, *191*(4), 339–348. https://doi.org/10.1016/j.aanat.2009.03.003

Ali, A., Mahfouz, A., & Arisha, A. (2017). Analysing supply chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review. *Supply Chain Management: An International Journal*, *22*(1), 16–39. https://doi.org/10.1108/SCM-06-2016-0197

Aras, L. (2019). Pengaruh Penggunaan Media Blok Pecahan Terhadap Minat Belajar Pada Mata Pelajaran Matematika Siswa Kelas III SD Kompleks Lariang Bangi Kecamatan Makassar Kota Makassar. *JIKAP PGSD: Jurnal Ilmiah Ilmu Kependidikan*, *3*(1), 40. https://doi.org/10.26858/jkp.v3i1.8164

Bakri, F., Permana, H., Wulandari, S., & Muliyati, D. (2020). Student worksheet with AR videos: Physics learning media in laboratory for senior high school students. *Journal of Technology and Science Education*, *10*(2), 231. https://doi.org/10.3926/jotse.891

Banda, H. J., & Nzabahimana, J. (2023). The Impact of Physics Education Technology (PhET) Interactive Simulation-Based Learning on Motivation and Academic Achievement Among Malawian Physics Students. *Journal of Science Education and Technology*, *32*(1), 127–141. https://doi.org/10.1007/s10956-022-10010-3

Barak, M., & Hussein-Farraj, R. (2013). Integrating Model-Based Learning and Animations for Enhancing Students' Understanding of Proteins Structure and Function. *Research in Science Education*, *43*(2), 619–636. https://doi.org/10.1007/s11165-012-9280-7

Bardi, B., & Jailani, J. (2015). Pengembangan Multimedia Berbasis Komputer untuk Pembelajaran Matematika Bagi Siswa SMA. *Jurnal Inovasi Teknologi Pendidikan*, *2*(1), 49–63. https://doi.org/10.21831/tp.v2i1.5203

Baser, M. (2006). Effect of Conceptual Change Oriented Instruction on Students' Understanding of Heat and Temperature Concepts. *Online Submission*, *4*(1), 64–79. Retrieved from http://files.eric.ed.gov/fulltext/ED495216.pdf

Budiman, E., Pusnitasari, N., Wati, M., Haeruddin, Widians, J. A., & Tejawati, A. (2019). Mobile learning media for computer science course. *International Electronics Symposium on Knowledge Creation and Intelligent Computing, IES-KCIC 2018 - Proceedings*, 262–267. https://doi.org/10.1109/KCIC.2018.8628559

Cahyadi, A. M. P. (2019). *Pengembangan Media Pembelajaran*. Laksita Indonesia.

Chen, C., & Wang, C.-H. (2015). Employing Augmented-Reality-Embedded Instruction to Disperse the Imparities of Individual Differences in Earth Science Learning. *Journal of Science Education and Technology*, *24*(6), 835–847. https://doi.org/10.1007/s10956-015-9567-3

Colicchia, C., Creazza, A., Noè, C., & Strozzi, F. (2019). Information sharing in supply chains: a review of risks and opportunities using the systematic literature network analysis (SLNA). *Supply Chain Management: An International Journal*, *24*(1), 5–21. https://doi.org/10.1108/SCM-01-2018-0003

Danielsson, K., & Wiberg, C. (2006). Participatory design of learning media: Designing educational computer games with and for teenagers. *Interactive Technology and Smart Education*, *3*(4), 275–291. https://doi.org/10.1108/17415650680000068

Duong, Q. H., Zhou, L., Meng, M., Nguyen, T. Van, Ieromonachou, P., & Nguyen, D. T. (2022). Understanding product returns: A systematic literature review using machine learning and bibliometric analysis. *International Journal of Production Economics*, *243*, 108340. https://doi.org/10.1016/j.ijpe.2021.108340

Ermawati, I. R., Dwi Kurniasih, M., Astuti, S., Fitriana, O., Wan Achmad, W. F., & Hilmi Hasan, M. (2021). Development of Blended Learning Media Using Character-Based Flipbook Smartphone. *Proceedings -International Conference on Computer and Information Sciences: Sustaining Tomorrow with Digital Innovation, ICCOINS 2021*, 39–42. https://doi.org/10.1109/ICCOINS49721.2021.9497135

Fujiati, F., Nasari, F., Rahayu, S. L., & Sanjaya, A. (2019). Educational Game as a Learning Media Using DGBL and Forward Chaining Methods. *2018 6th International Conference on Cyber and IT Service Management, CITSM 2018*. https://doi.org/10.1109/CITSM.2018.8674316

Jalinus, N. da. A. (2016). *Media dan Sumber Pembelajaran*. Kencana.

Khitous, F., Strozzi, F., Urbinati, A., & Alberti, F. (2020). A Systematic Literature Network Analysis of Existing Themes and Emerging Research Trends in Circular Economy. *Sustainability*, *12*(4), 1633. https://doi.org/10.3390/su12041633

Kitchenham, B. A., Budgen, D., & Brereton, P. (2015). *Evidence-based software engineering and systematic reviews*. CRC press.

Kößler, F. J., & Nitzschner, M. M. (2015). Learning Online: A Comparison of Different Media Types. *Technology, Knowledge and Learning*, *20*(2), 133–146. https://doi.org/10.1007/s10758-015-9250-z

Kunisch, S., Menz, M., Bartunek, J. M., Cardinal, L. B., & Denyer, D. (2018). Feature Topic at Organizational Research Methods. *Organizational Research Methods*, *21*(3), 519–523. https://doi.org/10.1177/1094428118770750

Lee, A. Y. L. (2016). Media education in the School 2.0 era: Teaching media literacy through laptop computers and iPads. *Global Media and China*, *1*(4), 435–449. https://doi.org/10.1177/2059436416667129

Lestari, I. D., Halimatusha'diah, H., & Puji Lestari, F. A. (2018). Penggunaan Media Audio, Visual, Audiovisual, dalam Meningkatkan Pembelajaran kepada Guru-guru. *Jurnal PkM Pengabdian Kepada Masyarakat*, *1*(01), 55. https://doi.org/10.30998/jurnalpkm.v1i01.2361

Li, M.-C., & Tsai, C.-C. (2013). Game-Based Learning in Science Education: A Review of Relevant Research. *Journal of Science Education and Technology*, *22*(6),

877–898. https://doi.org/10.1007/s10956-013-9436-x

Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020). Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management*, *45*(2), 175–194. https://doi.org/10.1177/0312896219877678

Lozada, E., Guerrero-Ortiz, C., Coronel, A., & Medina, R. (2021). Classroom Methodologies for Teaching and Learning Ordinary Differential Equations: A Systemic Literature Review and Bibliometric Analysis. *Mathematics*, *9*(7), 745. https://doi.org/10.3390/math9070745

Lui, A. L. C., Not, C., & Wong, G. K. W. (2023). Theory-Based Learning Design with Immersive Virtual Reality in Science Education: a Systematic Review. *Journal of Science Education and Technology*, *32*(3), 390–432. https://doi.org/10.1007/s10956-023-10035-2

Mills, R., Tomas, L., & Lewthwaite, B. (2019). The Impact of Student-Constructed Animation on Middle School Students' Learning about Plate Tectonics. *Journal of Science Education and Technology*, *28*(2), 165–177. https://doi.org/10.1007/s10956-018-9755-z

Osman, K., & Lee, T. T. (2014). Impact of Interactive Multimedia Module With Pedagogical Agents on Students' Understanding And Motivation In The Learning of Electrochemistry. *International Journal of Science and Mathematics Education*, *12*(2), 395–421. https://doi.org/10.1007/s10763-013-9407-y

Petticrew, M., & Roberts, H. (2008). *Systematic reviews in the social sciences: A practical guide*. John Wiley & Sons.

Pujiyono, W., Hendriana, Y., & Susanti, I. D. (2017). Interactive learning media based on RPP ICT. *2016 International Conference on Information Technology Systems and Innovation, ICITSI 2016 - Proceedings*. https://doi.org/10.1109/ICITSI.2016.7858218

Puspita, A., Kurniawan, A. D., & Rahayu, H. M. (2017). Pengembangan Media Pembelajaran Booklet pada Materi Sistem Imun Terhadap Hasil Belajar Siswa Kelas XI SMAN 8 Pontianak. *Jurnal Bioeducation*, *4*(1), 64–73. https://doi.org/10.29406/524

Rahayu, S. L., Fujiati, & Dewi, R. (2019). Educational Games as A learning media of Character Education by Using Multimedia Development Life Cycle (MDLC). *2018 6th International Conference on Cyber and IT Service Management, CITSM 2018*. https://doi.org/10.1109/CITSM.2018.8674288

Rasyid, M., Azis, A. A., & Saleh, A. R. (2016). Pengembangan Media Pembelajaran Berbasis Multimedia dalam. *Jurnal Pendidikan Biologi*, *7*(2), 69–80.

Rather, A. R. (2004). *Essentials Instructional Technology*. Educational Technology Publications.

Reid, G., & Norris, S. P. (2016). Scientific media education in the classroom and beyond: a research agenda for the next decade. *Cultural Studies of Science Education*, *11*(1), 147–166. https://doi.org/10.1007/s11422-015-9709-1

Ronen, M., & Eliahu, M. (2000). Simulation — a bridge between theory and reality: the case of electric circuits. *Journal of Computer Assisted Learning*, *16*(1), 14–26. https://doi.org/10.1046/j.1365-2729.2000.00112.x

Setiawan, A. R. (2019). Pembelajaran Tematik Berorientasi Literasi Saintifik. *Jurnal Basicedu*, *4*(1), 51–69. https://doi.org/10.31004/basicedu.v4i1.298

Taufiq, M., Dewi, N. R., & Widiyatmoko, A. (2014). Pengembangan Media Pembelajaran IPA Terpadu Berkarakter Peduli Lingkungan Tema Konservasi Berpendekatan Science-Edutainment. *Jurnal Pendidikan IPA Indonesia*, *3*(2), 14–145. https://doi.org/10.15294/jpii.v3i2.3113

Tobar-Muñoz, H., Baldiris, S., & Fabregat, R. (2023). Co-Design of Augmented Reality Games for Learning with Teachers: A Methodological Approach. *Technology, Knowledge and Learning*, *28*(2), 901–923. https://doi.org/10.1007/s10758-023-09643-z

Widodo, W., Sudibyo, E., Suryanti, S., Sari, D. A. P., Inzanah, I., & Setiawan, B. (2020). The Effectiveness of Gadget-Based Interactive Multimedia in Improving Generation Z's Scientific Literacy. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 248–256. https://doi.org/10.15294/jpii.v9i2.23208

Xia, H., Tan, S., Huang, S., Gan, P., Zhong, C., Lü, M., Peng, Y., Zhou, X., & Tang, X. (2021). Scoping Review and Bibliometric Analysis of the Most Influential Publications in Achalasia Research from 1995 to 2020. *BioMed Research International*, *2021*, 1–12. https://doi.org/10.1155/2021/8836395

Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., & Buntins, K. (2019). Systematic Reviews in Educational Research: Methodology, Perspectives and Application. *Systematic Reviews in Educational Research: Methodology, Perspectives and Application*, 1–161. https://doi.org/10.1007/978-3-658-27602-7