



Research Opportunity Analysis in The Implementation of Scientific Literacy with Learning Media: Systematic Literature Network Analysis

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Abstract:

This study aims to show research trend data related to learning media related to science literacy. This research uses the Systematic Literature Network Analysis (SLNA) method. The data used in this study is a collection of several articles based on Scopus data taken using the Publish or Perish (PoP) search. Based on this application, 6283 articles were obtained. Then, by filtering through the titles, 83 articles that were suitable for analysis were obtained. The analysis results show that topics often discussed in science literacy learning media are assessment, evaluation, technology, computers, the web, digital games, and many others. Based on this analysis, assessment is one of the future research directions related to science media literacy. Using the media in science literacy facilitates assessment, saves time, and presents visual phenomena that enrich students' understanding. Media can stimulate students to complete more concrete and real information to get clear and engaging experiences and improve scientific literacy related to scientific issues in the surrounding environment. With technologies such as computers, the web, and digital games, learning becomes more interactive, opening up great opportunities for scientific literacy for future in-depth research.

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Introduction

Education constantly changes over time (Bella et al., 2024). The changes that occur will undoubtedly impact everyday life, especially the development of student potential. Therefore, education with direction and purpose is needed (Putri et al., 2023; Putra et al., 2020; Sukarni et al., 2020). Good education comes from learning that is carried out at school. Learning is a learning process carried out by students to achieve the specified learning objectives (Putri et al., 2024). Education can be successful if the objectives of the education have been achieved through the learning process (Hasibuan & Sani., 2023).

Learning is closely related to learning outcomes (Nuriyani & Winarso, 2021). Based on the international assessment conducted by PISA, Indonesian students' ability in science received a score of 383 (OECD, 2023). Based on the results of the PISA data, Indonesia has experienced a decrease in scores in the field of science. Science literacy is important in science learning outcomes (Irsan., 2021). This aligns with PISA, which states that science literacy is an educational outcome and a core concept in science assessment.

Science literacy is one of the 16 abilities expected in the 21st century. Science literacy has four interconnected domains: knowledge, context, competence, and attitude. Science literacy is applying knowledge to identify, explain, construct, and conclude in solving life problems scientifically (OECD, 2019). As a manager, teachers can collect the results of the student learning process and student success in achieving student learning goals using technology-based learning activities (Auliya et al., 2021). In the world of education, technology has an important role in the learning process to become more modern (Sutisna et al., 2020).

Continuous changes in the world of education due to technological developments such as computers, smartphones, tablets, and others encourage innovation in learning media (Walipah et al., 2024). The utilization of technology is one part that needs to be considered by educators who can use it in learning to create meaningful experiences and increase student activeness (Nurwulandari., 2024). In addition, technology can increase student motivation and interest in learning (Nurillah et al., 2022). ICT utilization can be used in education as an ICT-based learning media (Fajriatun et al., 2022).

In designing learning, teacher creativity is needed in utilizing various learning media to make it easier for students to understand learning (Maisarah et al., 2023). Using the media in learning can facilitate the delivery of science concepts and become a tool to smooth the abstract learning process through animation, images, text, audio, and video (Sihombing et al., 2023; Maulani et al., 2021). The application of technology in learning media can explain and display micro materials that are easier to learn and comprehensive (Ekaputra & Widarwati., 2023; Ravi & Polonia., 2021).

Several studies have been conducted continuously to overcome these problems. However, opportunities for innovative research can still be carried out based on the purpose of using current media/technology. One way to find innovative research opportunities is to conduct a systematic literature review to find the right interesting and relevant topics to analyze. This literature review can be enhanced by visualization through bibliometric analysis (Linnenlueke et al., 2020). So, this study will use the Systematic Literature Network Analysis research type to describe data

trends related to the media used for scientific literacy. Unlike previous studies, this article will present research topics related to scientific literacy and digital media. This study will show research topics that are important for improving students' scientific literacy with the help of media but are rarely glanced at and explored to become the latest research that needs further study. This will open up opportunities to conduct studies on appropriate or recommended media for scientific literacy.

Research Method

This research uses the systematic literature network analysis (SLNA) method, which is adapted by combining systematic literature review research (SLR) with bibliometric networks (BA). The SLR stages use the CIMO (Context, Intervention, Mechanism, and Outcome) approach. This approach formulates research questions, finds studies (keywords, time, document type), and selects a body of literature (Colucchia et al., 2019). Using the citation network analysis stage with the keyword occurrence network at the bibliographic stage. The following are the steps used in this research.

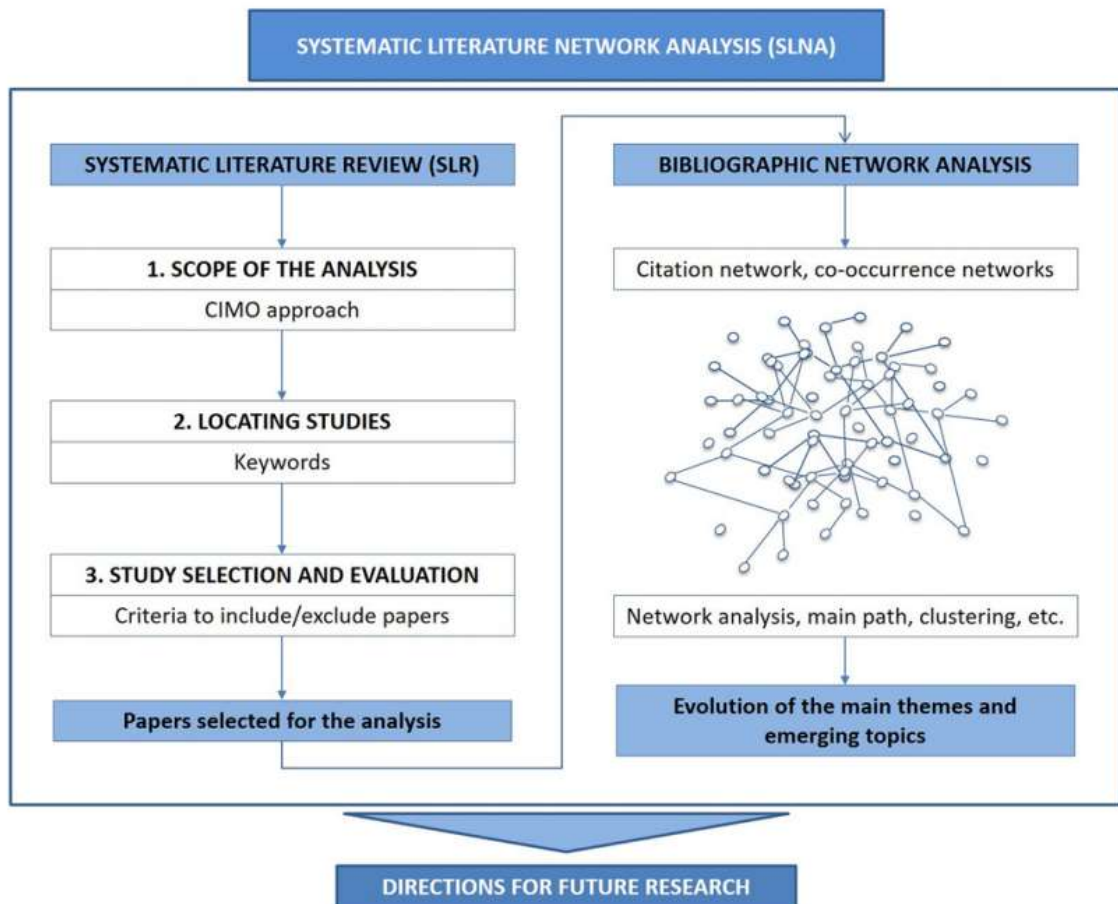


Figure 1. SLNA steps

Source: Strozzi et al., 2017

The article data taken is sourced from the Scopus database. Scopus is a scientific data journal managed by Elsevier. Data was collected in September 2024 by tracking papers with the help of Publish or Perish and Science Direct software. The data

collected from the beginning of the research until now is from 1976 to 2024. The papers used were only in the form of research articles. Then, they again filtered one paper relevant to the research objectives. The data results are taken in the .csv file format and filtered further in Excel. Then, to display bibliometrics, data transcripts, and visualizations are uploaded in the form of .csv and .ris with the help of VOSViewer software (Abdullah, 2022; Effendi et al., 2021; Williams, 2020). In the last stage, the data were examined descriptively to answer the research objectives.

Results and Discussion

1. Stage One: SLR Review

a. Analysis scope

This research went through the stages of analyzing the literature review to avoid ambiguity and maintain consistency in the scope of the review (Wibowo & Putri, 2021). The scope of the review using the CIMO approach in this study consists of context: the field of science (science literacy); Intervention: learning media and technology; mechanism: in line with the treatment and learning strategies in the article; results: the articles selected are articles that can affect students' science literacy.

b. Find a study

Data was collected using Publish or Perish software and the Scopus database. The data collection used titles related to "learning media," "science literacy," and "science literacy learning media." The focus of the data search was on education and learning. The article search was conducted without considering the time limit. Research related to science literacy learning media was found from 1976 to 2024.

c. Study selection and evaluation

Based on the search for articles, 6283 articles were obtained, further refined by manually deleting 407 articles based on the CIMO approach and keywords. Then, the document type was analyzed, consisting of journal articles and proceedings, while books, magazines, and notes were discarded, resulting in 83 articles. Including criteria are identified in selecting these articles as detailed in Table 1, a Journal matrix of articles that meet the inclusion criteria. Then, in Table 2, journal articles meet the inclusion criteria.

Table 1. Inclusion Criteria for Study Selection and Evaluation

Inclusion Criteria	Reason
Published in a peer-reviewed journal	Journals reviewed are of higher quality
Selection of papers without restriction on year of publication	The articles are not time-limited, in order to focus on the evolution of the field.
Screening of papers using title, abstract, keywords	Selected articles have high relevance because they use keywords that must be present in the article and abstract.

Table 2: Journal Matrix of Eligible Articles

Jurnal	F	%	Indeks scopus	Indeks WoS
Frontiers in Communication	1	1,204819	Q1/SJR:0.59	WoS/ESCI
Cultural Studies of Science Education	3	3,614458	Q1/SJR:0.73	WoS/SCIE:ESI
International Journal of Public Opinion Research	1	1,204819	Q1/SJR:0.84	WoS/SSCI:ESI

Jurnal	F	%	Indeks scopus	Indeks WoS
Chinese Journal of Communication	1	1,204819	Q1/SJR:0.87	WoS/SSCI:ESI
European Journal of Educational Research	1	1,204819	Q1/SJR:0.93	
BMJ Open	1	1,204819	Q1/SJR:0.97	WoS/SCIE:ESI
International Journal of Science Education	2	2,409639	Q1/SJR:0.97	WoS/SSCI:ESI
Research in Science Education	4	4,819277	Q1/SJR:1.05	WoS/SSCI:ESI
Science and Education	1	1,204819	Q1/SJR:1.12	
Public Understanding of Science	1	1,204819	Q1/SJR:1.32	WoS/SSCI:ESI
Science Education	1	1,204819	Q1/SJR:1.54	WoS/SSCI:ESI
Journal of Science Education and Technology	1	1,204819	Q1/SJR:1.6	WoS/SCIE:ESI
Science Communication	1	1,204819	Q1/SJR:1.83	WoS/SSCI:ESI
Journal of Research in Science Teaching	1	1,204819	Q1/SJR:1.91	WoS/SSCI:ESI
Computers in Human Behavior	1	1,204819	Q1/SJR:2.64	WoS/SSCI:ESI
Computers and Education	3	3,614458	Q1/SJR:3.65	WoS/SCIE:ESI
Eurasia Journal of Mathematics, Science and Technology Education	1	1,204819	Q2/SJR:0.45	-
Journal of Turkish Science Education	2	2,409639	Q2/SJR:0.5	
Frontiers in Psychology	2	2,409639	Q2/SJR:0.8	WoS/SSCI:CCSBS
International Journal of Innovative Research and Scientific Studies	1	1,204819	Q3/SJR:0,2	
Arab Media and Society	1	1,204819	Q3/SJR:0.11	
Applied Mathematics and Nonlinear Sciences	1	1,204819	Q3/SJR:0.25	
International Journal of Evaluation and Research in Education	2	2,409639	Q3/SJR:0.34	
Jurnal Pendidikan IPA Indonesia	5	6,024096	Q3/SJR:0.38	
FEMS Microbiology Letters	1	1,204819	Q3/SJR:0.51	WoS/SCIE:ESI
International Journal of Interdisciplinary Educational Studies	1	1,204819	Q4/SJR:0.11	
AIP Conference Proceedings	14	16,86747		
C and C 2015 - Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition	1	1,204819		
E3S Web of Conferences	1	1,204819		
International Journal of Environmental and Science Education	1	1,204819		
International Journal of Instruction	1	1,204819		WoS/ESCI
Journal of Education and Learning	1	1,204819		
Journal of Physics: Conference Series	21	25,3012		

Table 2 shows the journal matrix data on 83 articles filtered using SLR analysis. Articles that often appear are related to journals that discuss science literacy and learning media. The number of relevant documents in each year can be seen in Figure 2.

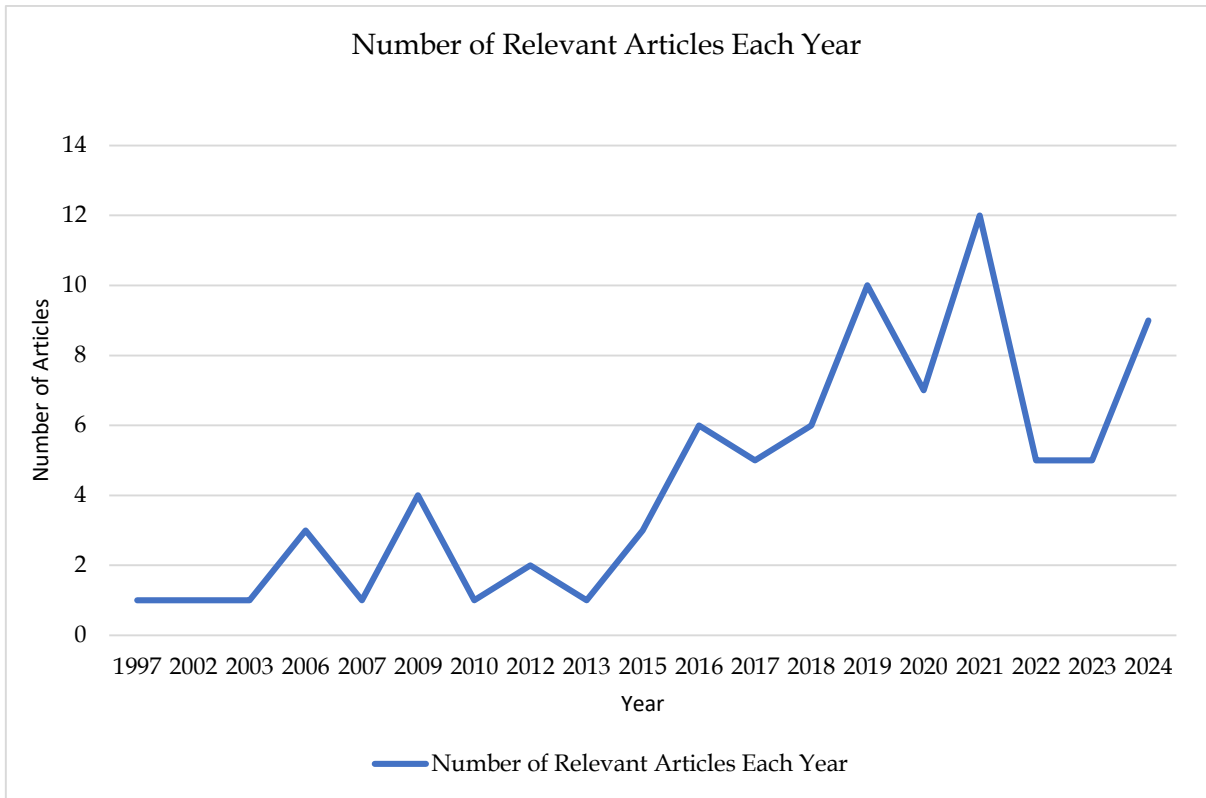


Figure 2. Number of Relevant Articles Each Year

Figure 2 shows the number of articles relevant to science literacy media each year. Based on these articles, research on science literacy media often experiences fluctuations. The extreme fluctuation occurred from 2020 to 2022 due to the COVID-19 pandemic. In 2021, the frequency of research reached 12 articles relevant to science literacy media; this was due to the development of technology-based learning due to learning demands and the impact of COVID-19 (Ghufron et al., 2024). However, in 2022, there was a step decline. However, recently, in 2024, there was an increase again. This shows that research related to media for science literacy is back in demand. Currently, the use of digital media to improve students' science literacy is increasingly being researched (Seema, 2024).

2. Phase two: Bibliometric Analysis

a. Citation network analysis.

Citation network analysis (CAN) is implemented based on article citations. This method is done on connected components. Figure 3 shows the number of citations each year on science literacy media.

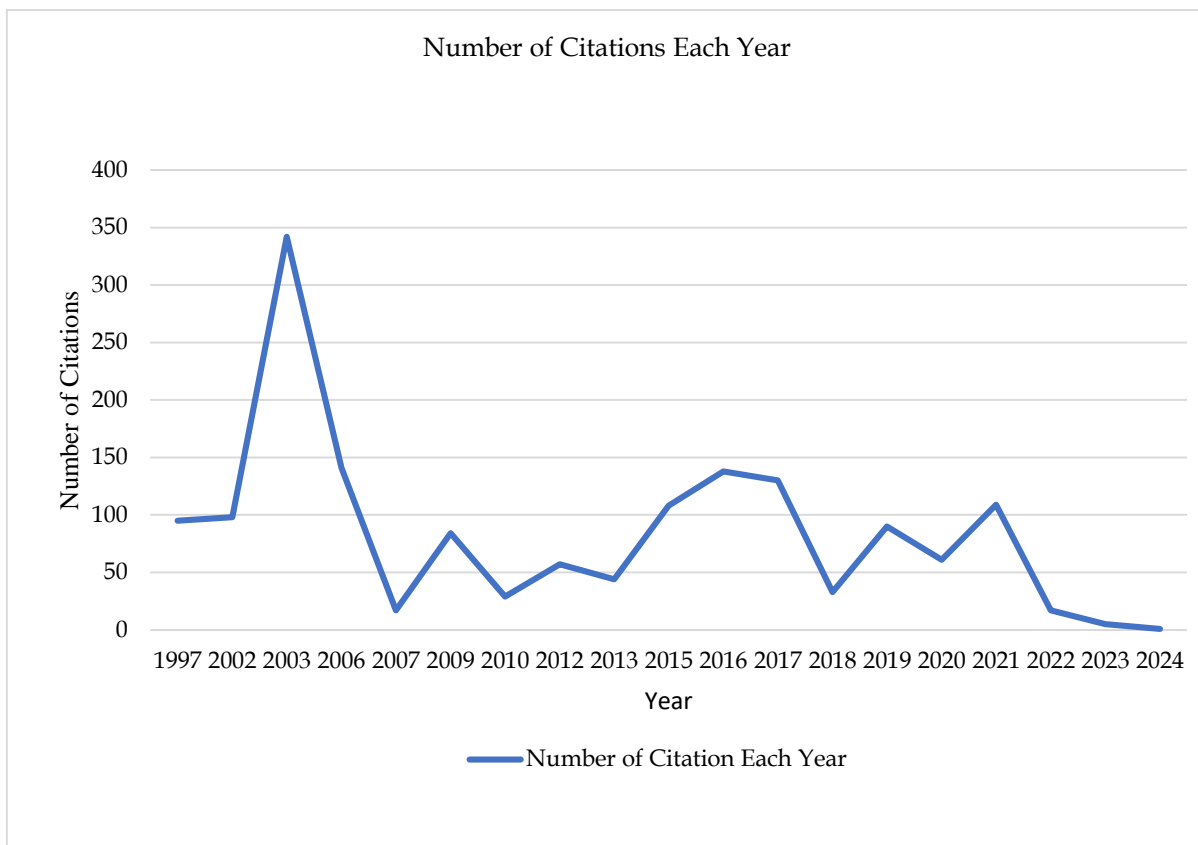


Figure 3: Number of Citations Each Year

Analysis of the trend of the number of citations from 1997 to 2023 shows a very significant fluctuation. In 2003, there was a drastic increase to 342 citations. However, from 2003 to 2024, the fluctuation was insignificant but tended to decrease. This shows that in the year not many researchers conducted research related to science media literacy research, especially from 2022 to 2024, there was a decline in the number of citations related to the research. This is also marked by a decline in the value of science literacy so various countries are looking for solutions to improve science literacy, one of which is using technology media (Nisa et al., 2021). In bibliometric analysis, citation score analysis is needed to see the development of the relationship and interaction between publications and scientific fields (Wijaya et al., 2024). Table 3 contains seven influential articles in research related to science media literacy.

Table 3. Seven Influential Articles on Science Literacy Media

Citation	Author	Article Title	Year	Journal
342	L.D. Yore	Examining the literacy component of science literacy: 25 years of language arts and science research	2003	International Journal of Science Education
95	C.A. Korpan	Assessing literacy in science: Evaluation of scientific news briefs	1997	Science Education
92	Aisyah	Learning Crude Oil by using scientific literacy comics	2017	Journal of Physics: Conference 2017
64	D. Brossard	Do they know what they read? Building a scientific literacy	2006	Science Communication

Citation	Author	Article Title	Year	Journal
		measurement instrument based on science media coverage		
61	C. Greenhow	Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application	2015	Computers in Human Behavior
53	J. Chen	Discrimination of the Contextual Features of Top Performers in Scientific Literacy Using a Machine Learning Approach	2021	Research in Science Education
45	H.C. She	Reflections on and implications of the Programme for International Student Assessment 2015 (PISA 2015) performance of students in Taiwan: The role of epistemic beliefs about science in scientific literacy	2019	Journal of Research in Science Teaching

Table 3 shows the top seven most cited articles in the science literacy media. In the first article written by L.D. Yore in 2003 with the title Examining The Literacy Component of Science Literacy: 25 Years of Language Arts and Science Research. This article examines the components needed in science literacy related to the science literacy medium. This article explains that during the 25 years of science literacy research, examining the literacy component of science literacy can be done with multimedia representation and technological assistance. Based on this research, one of the media used in evaluating science literacy is the World Wide Web. The use of technology on various websites has proven to be one of the most powerful solutions in scientific evaluation (Yore et al., 2003).

The second article, written by C.A. Korpan, titled "Assessing literacy in science: Evaluation of scientific news briefs," in 1977, revealed that the use of media in implementing the assessment was very good. The media used in this study are reports or news media. This media report helps students obtain information and evaluate science, which is part of science literacy (Korpan et al., 1997).

The third article by D. Brossard is titled "Do they know what they read? Building a scientific literacy measurement instrument based on science media coverage in 2006. This article explains that the development of science literacy instruments is a set of abilities whose information can be obtained using mass communication media. Television and newspapers were used at that time to obtain information to hone scientific literacy (Brossard & Shanahan, 2006). This shows that science literacy requires the media to help students find information through text, images, and videos.

The fourth article is Re-thinking Scientific Literacy out-of-school: Arguing Science Issues in a Niche Facebook Application, written by C. Greenhow in 2015. This article reveals that social media is one form of media technology that can be used as a learning tool through open sources that have information on scientific and social issues (Greenhow et al., 2015). This research proposes a theory of learning that collaborates with computer support and similar application designs to bridge formal learning.

The fifth article is The Development of Local Wisdom-Based Natural Science Module to Improve Science Literacy of Students, written by B. Setiawan in 2017. This

article reveals that the presence of computers as media in schools can facilitate access to learning. Computers can increase student achievement results (Chen et al., 2021).

The sixth article, Reflections on and Implications of the Program for International Student Assessment 2015 (PISA 2015) is Performance of Students in Taiwan: The Role of Epistemic Beliefs About Science in Scientific Literacy, written by H.C. She in 2019. This study reveals that one of the advances in PISA is the change in assessment mode from paper-based to computer-based approaches. This computer approach can also improve the scientific learning of literature (She et al., 2019).

Aisyah wrote the seventh article, "Learning Crude Oil by Using Scientific Literacy Comics," in 2017. This study reveals that using media in the form of comics can improve students' science literacy. This is because comics are developed with science indicators. The material is presented in a science fiction genre, with the majority of images that can display and improve content, context, processes, and attitudes (Aisyah et al., 2017).

b. Co-occurrence network

The themes that emerged in learning media research in science literacy in the results of this study were narrowed down again by taking time to see the latest research trends. In making this emergency network, it is narrowed down from 2016 to 2024. The data comes from the title and abstract of the article. The data used the number of words to identify words with influential titles. The collected data was analyzed and visualized using VOSViewer software. The results obtained were 136 keywords, but only 30 relevant keywords were used for analysis. Keywords with similar meanings and low relevance scores were removed before analysis. The analysis results yielded 4 clusters in Table 4. The visualization of the keyword network is shown in Figure 4.

Table 4. Keyword Cluster

Cluster	Color	Number of Keywords	Keywords.
Cluster 1	Red	13 Items	Analysis
			Assessment
			Computer
			Experience
			Importance
			Internet
			Media literacy
			Need
			New media literacy
			Practice
			Relation
			Scientific literacy
			Teaching
Cluster 2	Green	7 Items	Evaluation
			Information literacy
			Instruction
			Technology Acceptance
			Test

Cluster	Color	Number of Keywords	Keywords.
			Visual Literacy
			Web
Cluster 3	Blue	4 Items	Digital Game
			Learning
			Literacy Education
			Literacy Learning
			Teacher
			Time
Cluster 4	Yellow	4 Items	Development
			Grades
			Ict development
			Secondary school

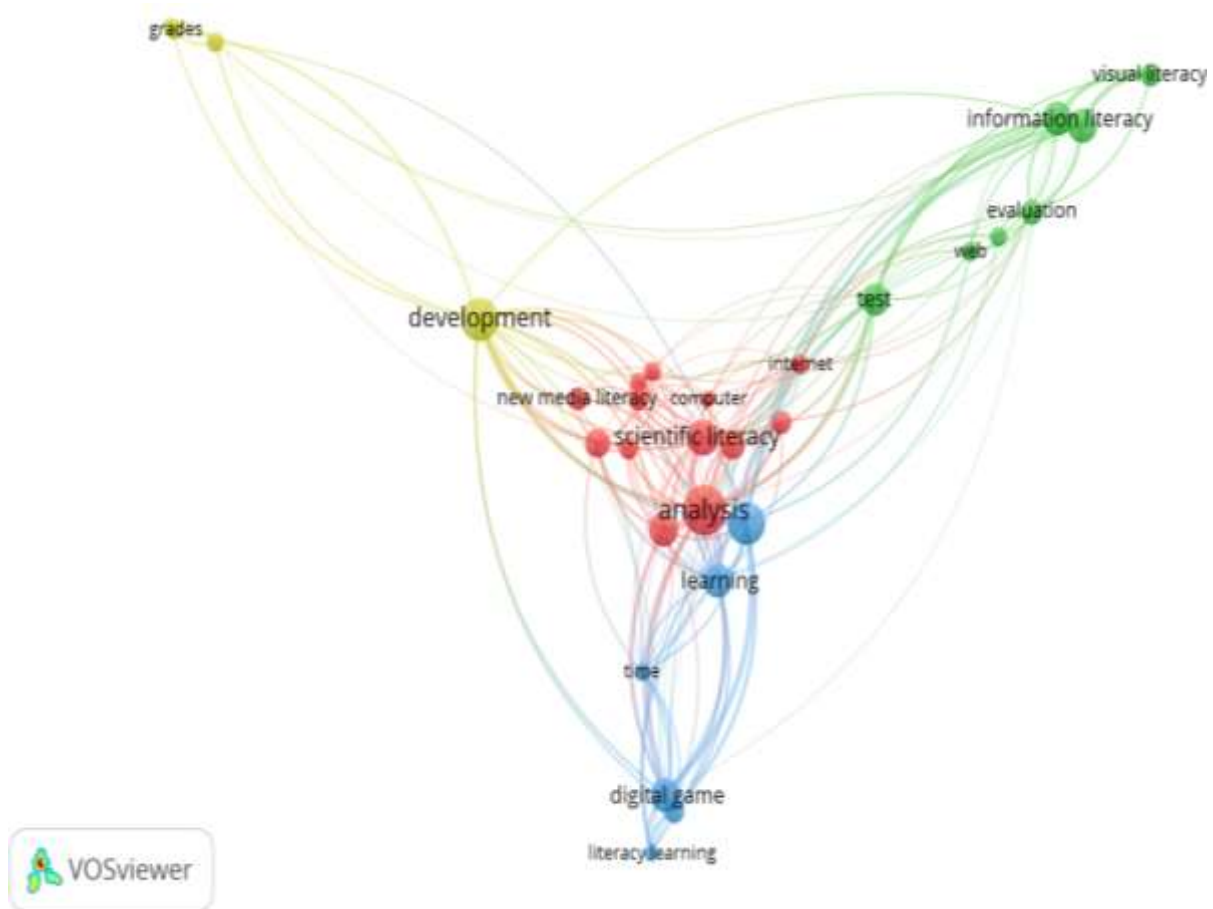


Figure 4. Visualization of Shared Word Analysis

Table 4 and Figure 4 show that four colors divide the keywords, namely red, which shows the most significant cluster with 14 keywords with the highest frequency of occurrence. Then green with seven keywords and followed by yellow and green clusters of 4 keywords each. In Figure 4, it can be seen that there is a circle indicating the keyword. The connecting line indicates the simultaneous occurrence of the keyword, and the difference in the circle size illustrates the frequency of the keyword's appearance (Fang & Law, 2021). To see the development of keyword occurrence by year can be seen in Figure 5.

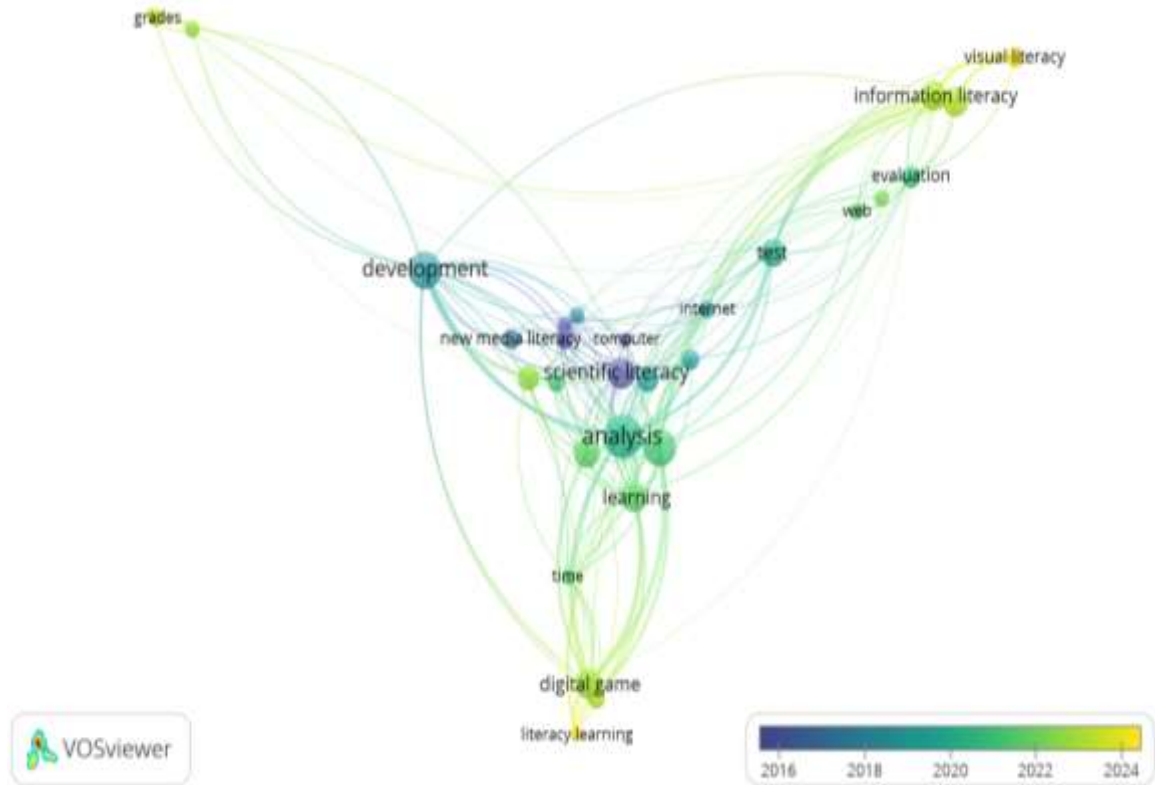


Figure 5. Visualization of Overlay of Co-Word Analysis Results

The development of research related to science literacy media has used digital technology, namely computers (Lestari, 2020). However, in 2020, technological assistance was provided on the Internet (Naila & Khasna, 2021) and the web (Anindita, Hayti & Widiyanto, 2023). It happened because of the impact of the COVID-19 outbreak, resulting in distance learning (Siahaan, 2020). This has become research that is widely researched by researchers, especially related to research in the field of education.

This research is the first to conduct SLNA on science literacy learning media research. Science literacy is a hot topic that is often discussed in the world of education. The results of the analysis carried out related to science literacy learning media experienced fluctuations but tended to increase. The increase related to this research was seen in 2006. In 2021, there was a reasonably high increase, namely 12 articles. This can also be seen in the visualization in Figure 6 regarding the development of literacy media.

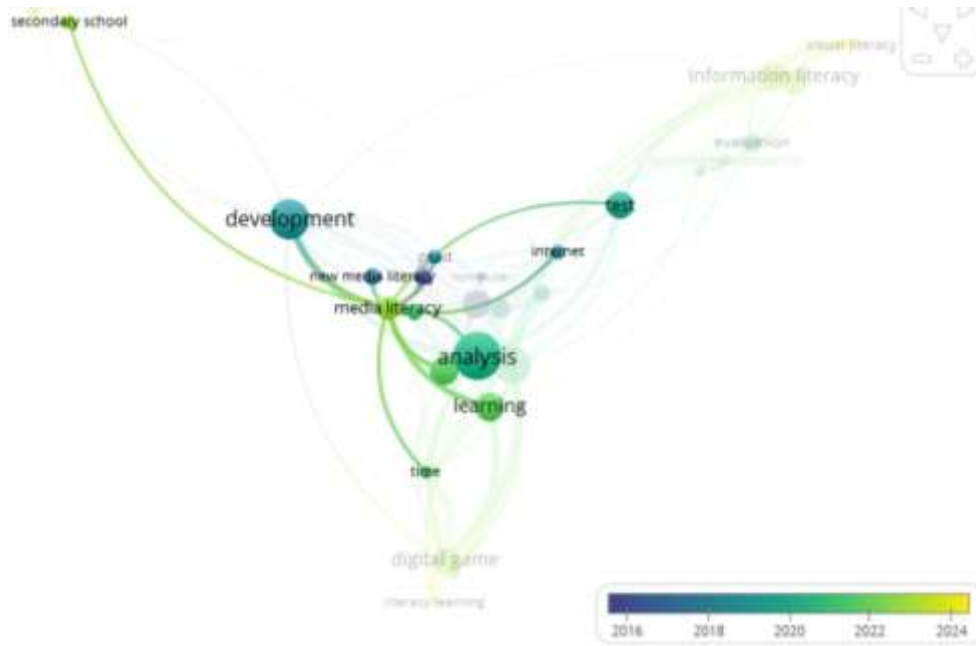


Figure 6: Visualization of literacy media development

The development of literacy media is marked with a dark green to light yellowish-green color. This shows that this literacy media began to be intensively researched from 2020 to 2024. The literacy media has been researched quite a lot since 2020. This is illustrated by a reasonably large circle in solid green. In addition, the "need" indicates that literacy media is needed. Therefore, to improve scientific literacy, media is needed for better scientific understanding (Twingsih & Elisanti, 2021). Then, the keyword "new media literacy" shows that new media is needed for scientific literacy. New media is a good solution to improving scientific literacy so far (Gu et al., 2019). The research related to scientific literacy can be seen in Figure 7.

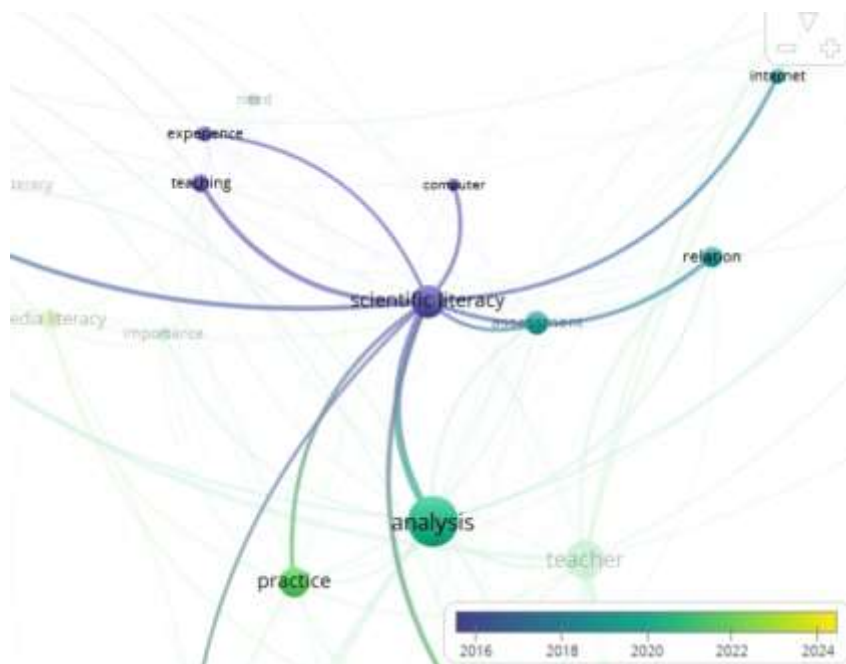


Figure 7. Visualization of Science Literacy Development

In Figure 7, scientific literacy relates to several keywords: experience, teaching, computers, practice, analysis, internet relations, and assessment. This visualization shows that assessment has a powerful relationship with scientific literacy. The use of appropriate and correct assessments will help in the process of improving scientific literacy (Champagne & Newell, 1992). Science literacy assessment began to be intensively researched in 2019. However, research on this science literacy assessment is still little and under-researched. A small green circle marks this. This science literacy assessment has research links with several keywords, as seen in Figure 8.

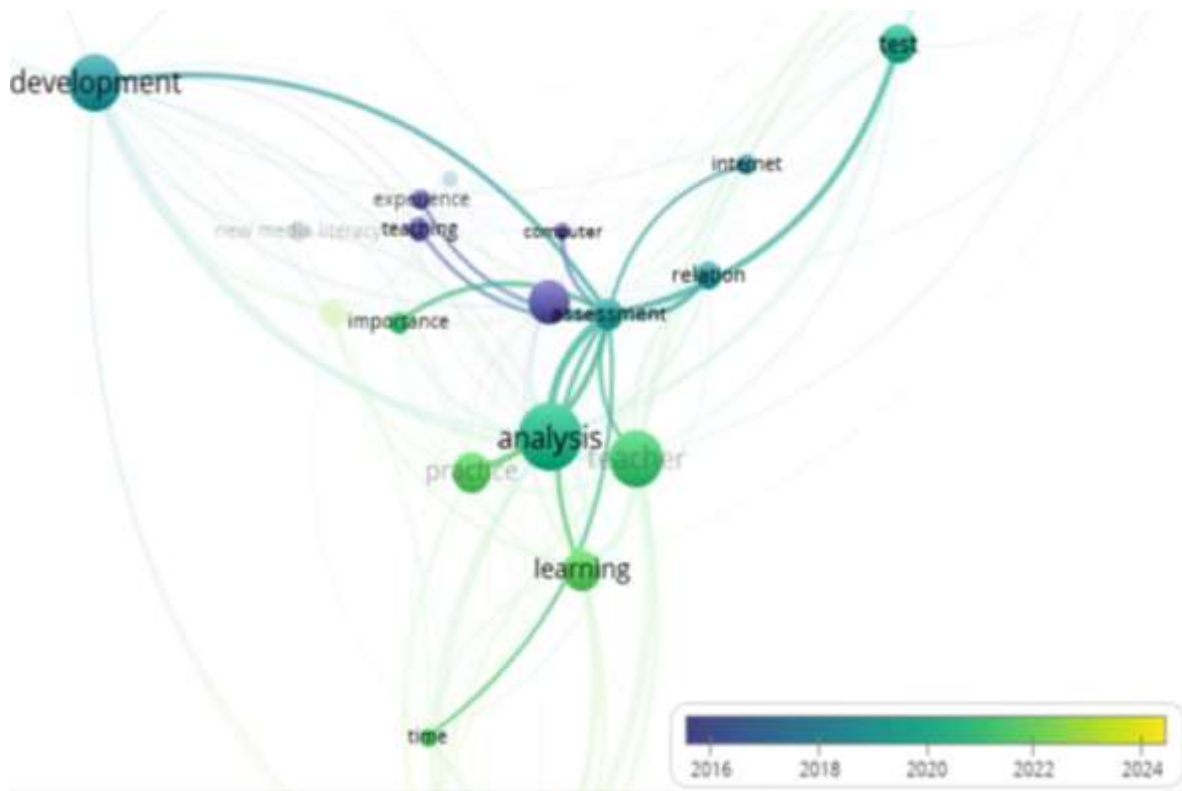


Figure 8: Visualization of the Development of Science Literacy Assessments

Science literacy assessment is related to several keywords. Before last year, science literacy assessment was mostly research on computers, experience, and teaching. However, in the last 10 years, science literacy assessment has been researched in development, learning, and making practical and effective assessments. Then there is also the internet and the creation of science literacy assessment tests. Related to several keywords, it can be concluded that a practical and effective test developer is needed using media for scientific literacy learning (Paduwinata et al., 2024). When connected to Figure 6, the learning media needed is a new learning media with the help of the internet (Jarman & McClune, 2007). For this medium to be the right choice, it is necessary to see the link between the test and other keywords. Visualization of the link between dates and other keywords can be seen in Figure 9.

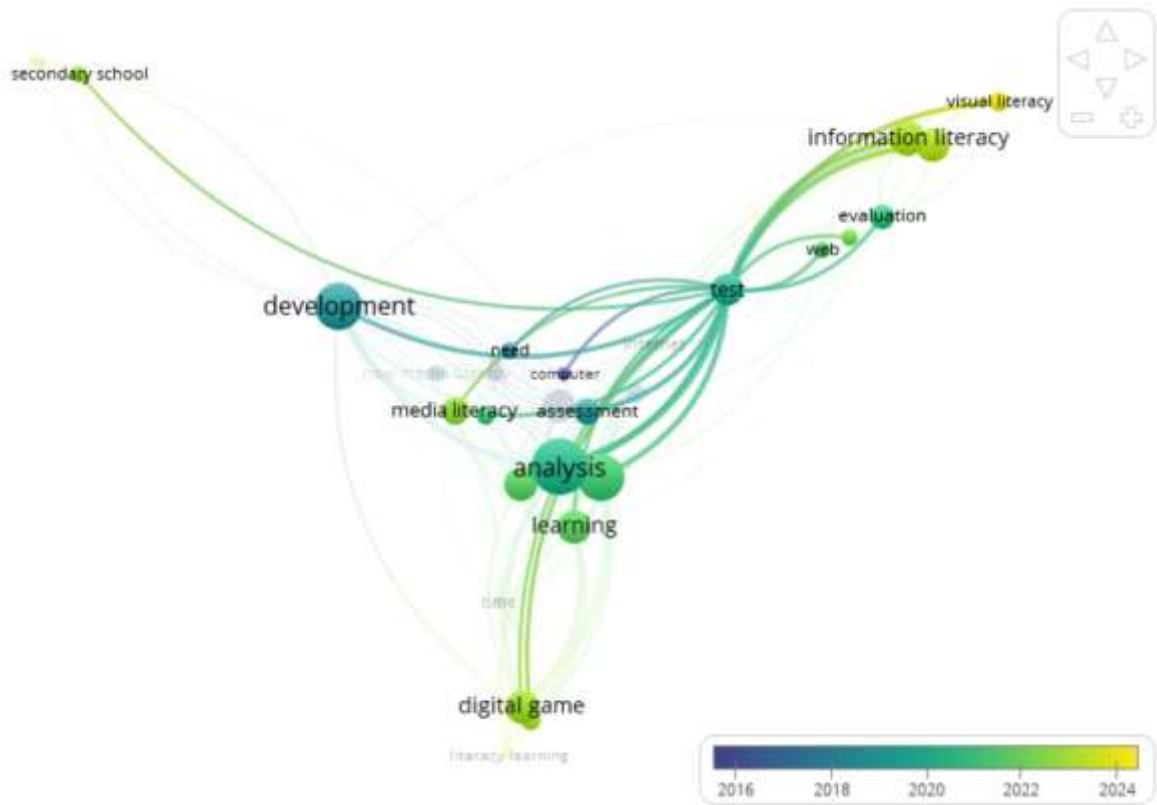


Figure 9. Visualization of Science Literacy Assessment Test Development

Figure 9 above shows the relationship between the test and other keywords in developing research related to this science literacy assessment test. The keywords for creating the new science literacy media are junior high school level, evaluation, information literacy, and visual literacy. Scientific literacy requires new media that pays attention to all aspects needed to become the right media according to needs (Amrullah et al., 2022). Previous researchers developed two types of test media to fulfill these criteria: digital games and the web. Based on the visualization of the development of the science literacy assessment test, it can be seen that digital games and the web only began to be intensively researched in 2022. However, digital games have been widely researched compared to the web. Therefore, based on the analysis, new media on the web is needed to help improve students' scientific literacy.

Conclusion

Based on the results of the analysis, it was revealed that there was an increasing trend in the number of publications with research topics related to learning media for science literacy starting from 1994 to the present. The results of this analysis were obtained from data sources/publications indexed by Scopus. Based on the analysis, several keywords could be an opportunity for further research, such as assessment, evaluation, technology, visual literacy, computer, web, digital games, and ICT. So far, science literacy is mainly integrated into the media and the development of teaching materials. However, based on the analysis, the use of media for science literacy can also be used as an assessment to facilitate assessment in saving time and displaying (visual) phenomena to deepen student understanding using technological assistance.

The assessment can be implemented using computers, the web, and digital games. This has potential for further research in the future. The limitation of this article is that the scientific literacy studied is specifically for junior high school students.

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