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Global Research Trends of Digital Learning Media in Science Education: A Bibliometric Analysis

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Abstract: This research aims to identify global research trends on digital learning media in science education through a bibliometric analysis approach. A total of 915 publications were found in the Scopus database related to keywords. Based on criteria, 100 documents were selected and analyzed from 2018 to 2022. Bibliometric data was processed using VOSviewer version 1.6.17. The results of the analysis show that every year there is a significant increase in digital learning media research in science education. The active author with highest publications is Reyna, J., with 6 articles and 52 citations. Then, VOSviewer mapping revealed several current themes related to digital learning media which are divided into 7 clusters; such as ICT, digital explanation, and representation in clusters in cluster 1; artificial intelligence, mobile learning, internet forums in cluster 2; educational technology, human experimentation, and video recording in cluster 3; online learning, digital learning, and multimedia learning in cluster 4; gamification, social networks and YouTube in cluster 5; augmented reality in cluster 6; digital technology, distance learning, and the internet in cluster 7. The results of this research provide a comprehensive understanding and can be used as a basis for further research.

Keywords: Bibliometric analysis; Digital learning media; Science education; VOSviewer

Introduction

Education is a system made up of different elements. The quality of the training components can influence the quality and results of the training process (Hastuti et al., 2023; Ozturk & Hill, 2020). Traditional monotonous teaching makes it difficult to understand the concepts learned (Sundaram & Ramesh, 2022). Therefore, one of the most important factors influencing the learning process and learning outcomes is the learning environment. Instructional media are tools that teachers use to support students' learning experiences (Neumann & Merchant, 2022; Ogan et al., 2020). The role of media in the learning process will provide a pleasant experience, which refers to a series of ongoing, personally satisfying, and successful learning experiences. Therefore, it relieves stress and anxiety, boredom in remembering study habits, and mindless repetition (Sudarma et al., 2022).

To create a learning experience based on student characteristics, teacher competencies are needed (Tang et al., 2021). Science is a subject that can have an application in 21st century learning. The characteristic of scientific field is the understanding of things, processes and related processes (Rosenthal, 2020; Tamami & Rahmatullah, 2021). So, in learning process teacher must be able to facilitate these things in learning. Apart from that, learning science is also defined as studying natural phenomena, identifying and formulating natural phenomena based on observations, and finding solutions to problems (Susanto et al., 2022). The different forms used in science (eg, images, scientific symbols or language) represent different aspects of scientific understanding (Nielsen et al., 2022). These activities provide opportunities to explore ideas, conduct experiments, record results and share information. The practical connection between scientific experiments and the behavior used indicates that there is a need for experiments that facilitate thinking and reasoning in science. When a new attempt or step is made, students can easily understand the learning process and are motivated to learn (Bakhri et al., 2023).

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In the first stages of technological development, learning must be able to adapt and follow this change (Erstad et al., 2021). With unlimited access to a range of information, it is now important to meet the demand for quality and engaging learning content (Lantz-Andersson et al., 2022; Starkey, 2020). Technology in education makes the teaching and learning process interesting, flexible and flexible for students. For example, the International Computer and Information Literacy Study (ICILS) asked eighth-grade teachers in twelve countries what they thought about digital tools. The ICILS survey found that 87% of teachers in the participating countries believe that ICT helps students work at a level that meets their learning needs, and 78% said that ICT allows students to work together more effectively (Fraillon et al., 2019).

Thus, the development or use of digital learning resources is an attempt to improve the quality of education. These new digital technologies can bring about new changes for education, learning can be done anytime and anywhere because it is adaptive (Tang et al., 2021). In addition, digital learning resources are interactive and visual analysis. This can increase students' motivation and interest in the natural sciences (Safitri et al., 2022; Thoms et al., 2022). The use of digital technology enables the presentation of teaching materials in different forms of learning at different phases. Multimedia presentations can be easily prepared with multimedia information. Provide students with a unique and diverse experience (Prasetya et al., 2020). Thus, An effective approach can ensure that clear learning and timely information can be achieved to help students cope better and navigate their learning paths (Sanusi et al., 2022; Vilarta Rodriguez et al., 2020).

The current age of young students are those born between 1995 and 2010, also known as Generation Z (Gen Z). This period is a transition period for Generation Y, as technology becomes more and more advanced. Gen Z relationships are less complex (direct and immediate) (DiMattio & Hudacek, 2020; Ozkan & Solmaz, 2015). Their lives depend more on their knowledge and communication skills. The characteristics of Generation Z are, think globally, digital connectivity, mobility, familiar with technology, independent work, and prefer a visual nature (McCrindle & Fell, 2019). With the existence and availability of information and communication technology, learning should be able to be transformed according to the characteristics of the students (DiMattio & Hudacek, 2020; Suwana et al., 2020). In fact, there are various learning media available to meet the needs of various students. However, many scientists advocate a digital approach to learning, as they expect easier accessibility as well as better learning outcomes (Thoms et al., 2022). A number of studies have revealed the influence of digital media in learning. The results show that the use of digital tools significant impact on student learning outcomes (Nasim et al., 2022; Natsir et al., 2022) students' attitudes (Rodrigues et al., 2021) their motivation in learning (Safitri et al., 2022). Then, the use of digital media can improve students' skills reduce students' cognitive load when learning (Rosydiana et al., 2023; Sudarma et al., 2022) and can increase their understanding (Serevina et al., 2021).

Many studies have been conducted on the use of digital media. Therefore, it would be appropriate to combine the results with mapping using a systematic bibliometric analysis. Bibliometrics is an interdisciplinary science that deals with the quantitative analysis of all sources of information using mathematical and statistical methods (Liao et al., 2018). This type of methodology allows researchers to analyze research areas, taking into account citations, co-citations, geographical distribution and word frequency (Corsini et al., 2019). Based on this need, the researcher decided to examine studies related to the use of digital media in science learning which were scanned in the Scopus database. Digital media research trends in science learning are reviewed from various variables using bibliometric mapping methods or keyword analysis.

The research questions in this study are follows: RQ1. What are the trends in digital media research publications in science education every year? RQ2. Who is the active author of digital learning media in science education research? RQ3. What are the current issues regarding the use of digital media in science education?

The contributions of this study provide researchers with insight into the assessment of creativity in education, its impact and associated implications. Determine the intellectual structure of the research subject and its development, and identify the different subprograms and their conceptual framework (Díaz-García et al., 2022). Bibliometric analysis is a useful tool for identifying development pathways, new applications, research priorities and references within a subject based on geographic locations and research networks (Liao et al., 2018; Suryadi et al., 2023). This is how important topics or topics in science education, rapidly developing topics and eye-catching topics related to digital media emerge. Empirical researchers use their findings to inform future research.

Method

Research Design

The study used the method of systematic literature analysis, using data sources in the form of literature studies from various scientific journals available in the Scopus database. The author chose the Scopus database

because Scopus is one of the largest and most comprehensive indexes of published materials, contains metadata from trusted journals and supports bibliometric analysis (Liao et al., 2018). The bibliometric mapping used to identify articles about digital learning in science education. Bibliometric mapping is a spatial representation of relationships between various fields, topics, individual publications and authors (Moreno-Guerrero et al., 2020).

Bibliometric analysis helps trace the overall flow of scientific knowledge related to research, researchers, institutions and a specific scientific topic. To generate relevant discussions and conclusions, the author used the VOSviewer analysis tool version 1.6.17 as a data processing tool (identification and analysis tool). Briefly, the first step is identification data publication through the Scopus database. After that, compile the publication data obtained using Microsoft Excel. Next, the data will be mapped computationally using VOSviewer software. Then, the mapping results can be analyzed.

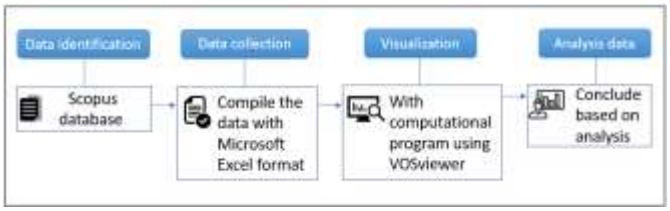

Figure 1. Research procedure

Method of Collecting Data

Document searches were carried out in October 2023 via the Scopus database using the keywords "Digital Learning Media" and "Science Education". In this search, 915 documents were found, consisting of 385 articles, 323 conference papers, 75 conference reviews, 53 book chapters, 41 reviews, 34 books, 3 editorials and 1 data paper. The documents were published from 1987-2023. Any data or material displayed is identified via scopus.com (in the "Search Results Analysis" feature). Next, researchers use inclusion and exclusion criteria to select appropriate documents.

Data criteria include accuracy, consistency, timeline and document type. The documents collected in this research are journal articles about digital learning media in science education published in 2018-2022. The research objectives of this article are clearly defined and the data collection methods are fully explained. References in a document that support the main claims. Then, the research design used is in accordance with the research objectives. Research questions will be answered when the research objectives are achieved.

Each document is analyzed based on criteria that have been determined in stages (see Figure 2). Based on the analysis, 100 documents were found match with the specific criteria.

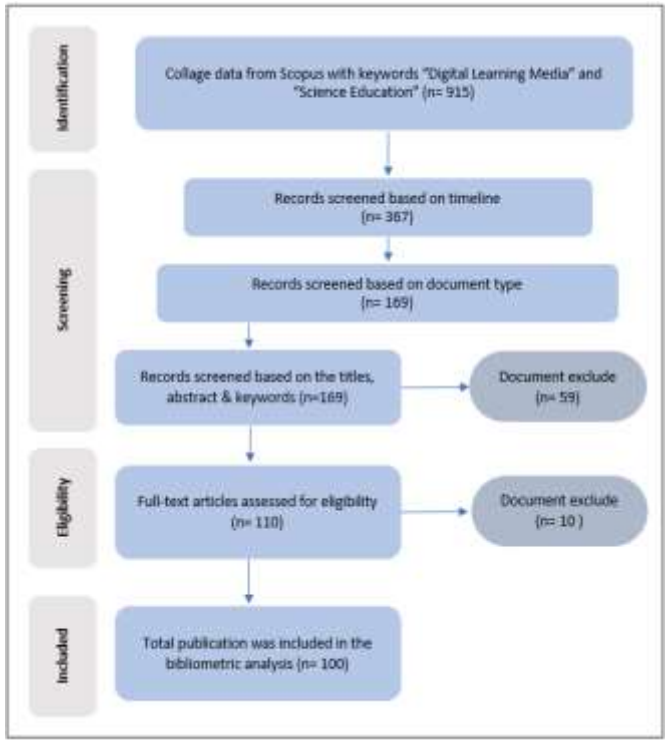

Figure 2. Identification and data collection stages

Data Analysis

All article data that has been collected and meets the research criteria is then exported into a comma-separated value (*.csv) file format (Díaz-García et al., 2022), which is then processed using VOSviewer software version 1.6.17. The software can display and interpret bibliographic information maps through visualization and analysis. Factors considered include annual publication trends, citations, author productivity, country productivity. The results of the analysis in this research will be used to determine the thematic evolution and latest research trends on the topic of digital learning media in science education (Moreno-Guerrero et al., 2020; Wilsa et al., 2023). This information will be useful for empirical researchers looking for research gaps. Based on data analysis, the final step of this research is to determine research gaps and future research plans about digital learning media in science education.

Result and Discussion

This research reviews topics related to digital learning media in science education by analyzing publication characteristics (Starkey, 2020). Analysis shows that research on digital learning media has been researched from 1987 until now (see Figure 3).

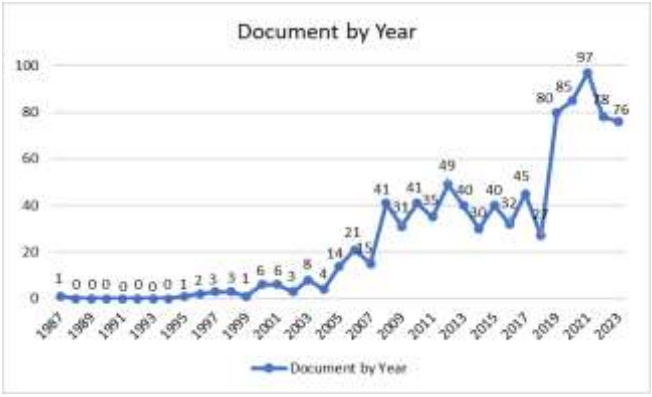

Figure 3. Publication of digital learning media in science education documents

Figure 3 shows the increase number of publications related to digital educational media in science education from 2005 until now. A total of 915 research documents were found regarding digital learning media in science learning identified through Scopus. Based on the graph, research on digital learning media in science learning in 2018 until now has experienced a drastic increase. The results of this analysis can be used as a basis for developing inclusion and exclusion criteria in this bibliometric analysis. Inclusion criteria and exclusion criteria are used to determine the eligibility of articles, documents that are not appropriate will be excluded because they are considered outside the scope (Karakose et al., 2023). By doing so, we improved consistently the quality of research (Corsini et al., 2019). Therefore, the analysis only focused on research published in 2018-2022.

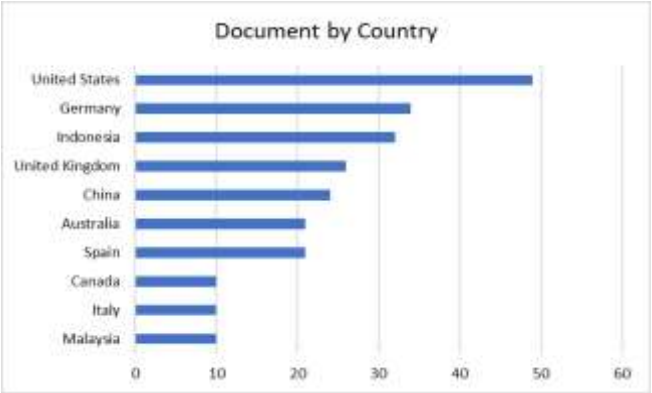

Figure 4. Top 10 countries for digital learning media in science education, source: processed via Scopus, 2023

Figure 4 shows the top 10 countries where authors most frequently review and publish research articles related to digital media in science education. United States with 49 documents (536 citations), Germany with 34 documents (250 citations), Indonesia with 32 documents (125 citations), United Kingdom with 26 documents (254 citations), China with 24 documents (93 citations), Spain with 21 documents (219 citations), Australia with 21 documents (194 citations), Canada with 10 documents (90 citations), Italy with 10 documents (77 citations), and Malaysia with 10 documents (130 citations). It can be concluded that the country of origin of the most authors and the most citations regarding digital learning media research in science education is the United States. Then the highest number of citations was followed by the United Kingdom, Germany, Spain, Australia, Indonesia and other countries. This indicates that research on digital learning media has been applied by various countries in science learning.

In addition to identifying the country of origin, we identified and collected several research papers related to digital learning tools in science education. In Figure 5, total the number of document type are consist of 169 documents for Articles; 112 documents for Conference papers; 29 documents for Conference Review; Book chapters totaling 23 documents; Review containing 20 documents; Book of 12 documents; and Paper data for 1 document. From Figure 5 can be concluded that there are different types of documents for research on digital learning resources in science education, most of which are in the form of documents in the form of scientific articles and conference papers.

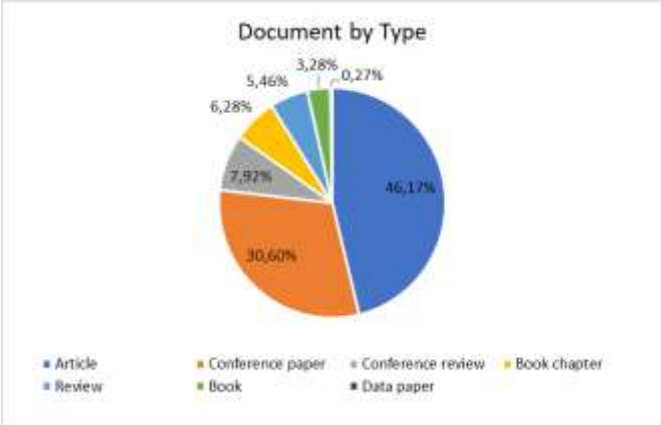

Figure 5. Types of documents with the most publications on digital learning media, source: processed via Scopus, 2023

Figure 5 shows that 46.17% of research on digital learning media in science education is published in research articles. So, the research trends analysis of digital learning media in this research is focused on articles.

Research on digital media for learning in science education is not new, but teachers' interest in this area has increased significantly in recent years. 161 authors published 915 publications. Based on the documents and features identified by Scopus, 100 articles were analyzed to determine the authors who had the most influence on research in 2018-2022. Figure 6 showed the most relevant

author in the last five years are, Reyna, J. (6 articles) with 52 citations; Meier, P. (5 articles) with 35 citations; Dittmar, J. (2 articles) with 4 citations; Martzoukou, K. (1 article) with 49 citations; Hu, J (1 article) with 33 citations; Jacobsen, D.Y. (1 article) with 31 citations; Chen, C. (1 article) with 30 citations; de Souza, G. (1 article) with 29 citations; Hietajarvi, I. (1 article) with 29 citations; and Fjortoft, H. (1 article) with 22 citations.

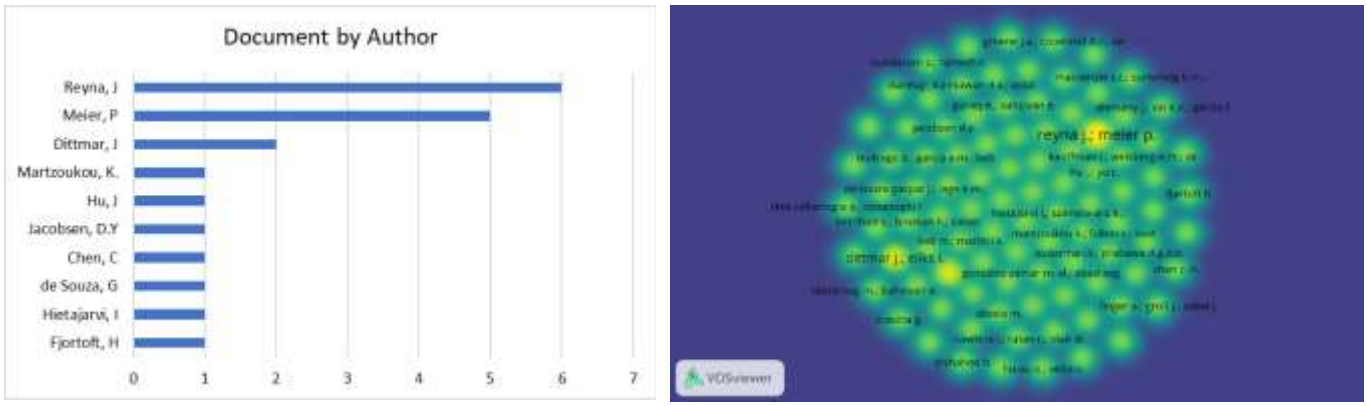

Figure 6. Top 10 author for digital learning in science education with the highest publications on Scopus database

Research Topic Mapping: Content & Issue Analysis

Based on the documents that have been identified through Scopus and the characteristics that have been determined, 100 documents with the document type in the form of articles were analyzed using VOSviewer. In the first part, a threshold of 96 from 711 keywords was found with 2 minimum number of occurrences. The occurrence of keywords can complement research topics in scientific fields and provide additional support to scientific research (Li et al., 2016) The research findings revealed several research themes related to the use of digital media in science education, as shown in Figure 7.

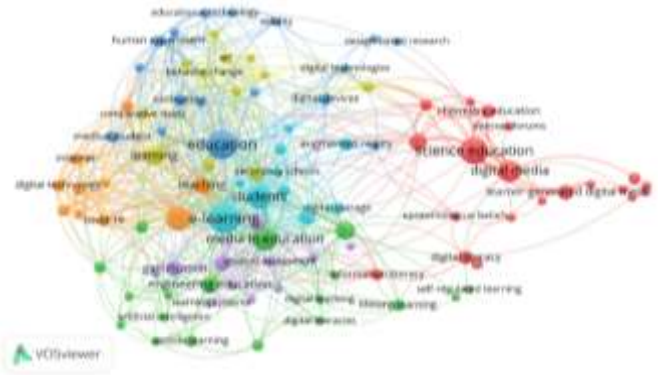

Figure 7. Network visualization (type of analyze: Co-occurrence), source: processed via VOSviewer, 2023

Table 1. Specific Cluster

Keywords in Scopus Database: "Digital Learning Media" and "Science Education"	
Cluster 1 (Red)	(20 items) assessment, blended learning, chemistry education, digital explanation, digital literacy, digital media, digital media assignment, digital media literacies, epistemological beliefs, high school, ict, information literacy, internet forums, learner-generated digital, middle school, representations, science education, self-regulation, slowmation, and stem.
Cluster 2 (Green)	(18 items) academic research, artificial intelligence, augmented and virtual reality, digital libraries, digital literacies, digital-learning, engineering education, high education, higher education, lifelong learning, media in education, mobile learning, scoping review, self-regulated learning, stem education, teaching/learning strategies and web of science.
Cluster 3 (Dark Blue)	(17 items) blended learning, controlled study, curriculum, design-based research, digital devices, digital technologies, education, educational technology, human experiment, interactive learning environment, literacy, medical student, motivation, structural equation modeling, tertiary education, validity, and videorecording.
Cluster 4 (Yellow)	(12 items) art, behavior change, comparative study, computer graphics, digital learning, information processing, instructional design, learning, multimedia learning, online learning, simulation, and technology.
Cluster 5 (Purple)	(11 items) curricula, economic and social effects, gamification, learning system, personnel training, science communication, social networking (online), social networks, social sciences computing, student assessment, YouTube.
Cluster 6 (Light Blue)	(10 items) augmented reality, computer aided instruction, computer games, decision making, digital storage, e-learning, education computing, secondary education, secondary schools, and students.
Cluster 7 (Orange)	(10 items) covid-19, digital technology, distance education, distance learning, internet, pandemic, quantitative analysis, social media, teaching, and training.

The results of analysis or mapping via VOSviewer in Figure 7 show that there are 7 clusters as trending topics for digital learning media in science education, which is currently the focus of global researchers. From the seven clusters, 6 keywords were selected that had the most influence on the topic of digital learning media in science education. In the first cluster (Red), blended learning, ICT, digital explanation, representation, digital media literacy, and stem. The second cluster (green) is artificial intelligence, mobile learning, internet forums, digital-learning, augmented and virtual reality, and teaching/learning strategies. The third cluster (dark blue), namely educational technology, human experiment, video recording, digital devices, interactive learning environment, and digital technologies. The fourth cluster (yellow), namely online learning, digital learning, multimedia learning, simulation, technology, and computer graphics. The fifth cluster (purple), namely gamification, learning systems, social networking, YouTube, science communication, and student assessment. The sixth cluster (light blue), namely augmented reality, computer games, e-learning, decision making, computer aided instruction, educational computing. The seventh cluster (orange), namely digital technology, distance learning, internet, social media, distance education, and teaching. This research topic can be a reference for future researchers in developing research on digital learning media in science education. Thus, this research provides practical and theoretical contributions to create a diversity of literature on digital learning media issues in science education.

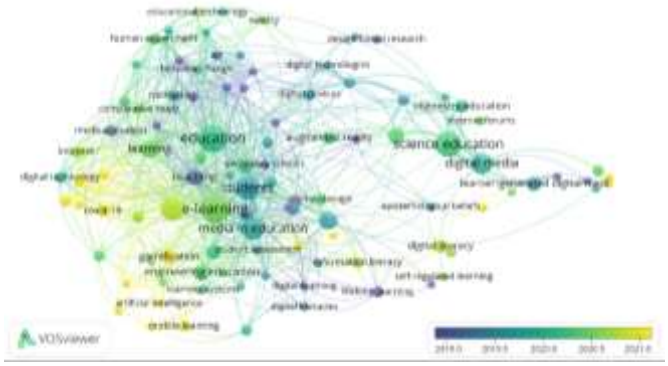

Figure 8. Overlay visualization (type of analyze: Co-occurrence), source: processed via VOSviewer, 2023

Furthermore, Figure 8 above shows the results of the overlay visualization of the bibliometric presentation in digital educational media. Overlay works the same as grid view, except that items are different colors. The overlaid visualization illustrates the relationship between terms and year of publication (Suryadi et al., 2023). The results of the bibliometric overlay visualization show that from 2018 to 2022, there are several current research trends (shown in the image in the lightest "yellow" color) that are of great interest to researchers around the world in related topics or topics (Khoeriah et al., 2022).

Moreover, the analysis results show that the keywords related to digital learning media research that are still developing and are interesting for further research include virtual reality, artificial intelligence, gamification, , digital explanation, digital literacy, stem, and mobile learning. The results of this identification and analysis are intended to support existing research and encourage academic inquiry that aims to prepare students to face contemporary changes in the world, particularly in the area of education (Kaban, 2023).

This study provides an overview of research into digital learning resources in the Scopus database. Data were collected, analyzed and visualized in bibliometric studies using VOSviewer software (Karaca & Kılcan, 2023). So, it can provide the general public with specific information on research trends in digital learning resources in science education. Information can be presented as an overview of annual trends in publications, citations, author productivity, and national productivity (Díaz-García et al., 2022; Wilsa et al., 2023). The analysis results show a positive increase in the number of studies related to digital learning resources published between 2018 and 2022. In this section we discuss the use of digital learning tools in science education to improve learning, as described in our sample articles. We identified the results grouped into 4 categories: positive impact of using digital media in science learning on students, digital media for facilitating blended and active learning, digital media for interactive learning and possibilities. integrate games into learning activities using digital media. The number of research articles at the level of identification based on feasibility, relevance and comparability of research topics is shown in Table 2.

Nowadays, the youngest generation is more connected than ever and uses the Internet for entertainment, chat, and social networking, with the increasing use of digital technology (Ozkan & Solmaz, 2015; Suwana et al., 2020). The digital revolution has changed the way children and people play, access information, communicate and learn. Children of the 21st century are surrounded by digital technology from an early age (Raju et al., 2021). From the mapping results, several interesting themes can be researched by empirical researchers related to digital learning media, for example, Virtual Reality (VR). From the mapping results, experienced researchers can explore various interesting topics related to digital educational media, such as virtual reality (VR). Virtual reality technology is

a potential innovation that can provide robust content and detailed information to support hands-on scientific learning. Elliot Hu-Au identified differences in general chemistry learning experiences, experimental understanding, laboratory safety knowledge, and laboratory safety behavior using virtual and virtual reality (VR) (Hu-Au & Okita, 2021). The results showed that the acquisition of general knowledge, laboratory skills, and safety procedure behavior were comparable in the RL and VR conditions, but cleaning behavior was unusual in VR. In addition, the experimental and non-threatening nature of virtual reality environments can allow students to develop and think about general chemistry and laboratory safety knowledge as in virtual reality situations. Another study aimed to investigate and compare student opinions about the use of digital tools among computer science students. The results showed positive attitudes, perceived benefits, and behavioral intentions. Learning strategies that mainly involve technical aspects such as programming or web development in computer labs (Raju et al., 2021).

Table 2. Top 10 Articles from Research Identification Based on Suitability and Relevance with Research Topics (Selected Based on Document Citation Level in Scopus)

Title	Authors	Year	Source	Cited by
Thirty years of research on online learning	Mayer, R.E.	2019	Applied Cognitive Psychology, 33(2), pp. 152-159	140
The interactivity of video and collaboration for learning achievement, instrinsic motivation, cognitive load, and behavioe patterns in digital game-based learning environment	Liao, C.-W., Chen, C.-H., Shih, S.-J.	2019	Computers and Education, 133, pp. 43–55	112
The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis	Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S.I., Reiss, K.M.	2020	Computers and Education, 153, 103897	109
Disinformation and misinformation triangle: A conceptual model for “fake news” epidemic, causal factors and interventions	Rubin, V.L.	2019	Journal of Documentation, 75(5), pp. 1013–1034	59
A mixed research-based model for pre-service science teachers’ digital literacy: Responses to “which beliefs” and “how and why they interact” questions	Güneş, E., Bahçivan, E.	2018	Computers and Education, 118, pp. 96–106	55
Whatsapp, teacher? student perspectives on teacher-student whatsapp interactions in secondary schools	Rosenberg, H., Asterhan, C.S.C.	2018	Journal of Information Technology Education: Research, 17, pp. 205–226	53
A study of higher education students' self-perceived digital competences for learning and everyday life online participation	Martzoukou, K., Fulton, C., Kostagiolas, P., Lavranos, C.	2020	Journal of Documentation, 76(6), pp. 1413–1458	49
Beyond knowledge: Examining digital literacy's role in the acquisition of understanding in science	Greene, J.A., Copeland, D.Z., Deekens, V.M., Yu, S.B.	2018	Computers and Education, 117, pp. 141–159	49
Mobile learning in higher education for the industrial revolution 4.0: Perception and response of physics practicum	Darmaji, Kurniawan, D.A., Astalini, Lumbantorua, A., Samosir, S.C.	2019	International Journal of Interactive Mobile Technologies, 13(9), pp. 4–20	42
Computational thinking, between papert and wing	Lodi, M., Martini, S.	2021	Science and Education, 30(4), pp. 883–908	40

When we think of computer-based learning environments, the use of computers in various curricula comes to mind. Intelligent learning systems, on the other hand, focus on accumulated experiences by explaining the student's relationship to the subject (Sharma & Harkishan, 2022). Although research into the use of artificial intelligence in education has been ongoing for some time, other topics have also become popular in recent years. When analyzing trending topics year-over-year, artificial intelligence is more popular than any other topic after 2019 (Kaban, 2023). It is believed that even the most powerful artificial intelligence has its own values and worldviews, instincts such as the need for survival and stability like all living things (Karaca & Kılcan, 2023). Machine learning is one of the tools that can help educational institutions in various situations. Nowadays, we see the use of artificial intelligence in education in various forms, such as early warning systems (Jokhan et al., 2019), student academic performance (Aydoğdu, 2020; Khan et al., 2021) and

Intelligent Tutoring Systems (Sharma & Harkishan, 2022). Machine learning algorithms use historical data to estimate the probability of an event with reasonable accuracy. Therefore, predictive models are needed to predict student outcomes and enable teachers to respond to difficult students.

The National Science Education Standards, focuses on developing students' knowledge and understanding (NRC, 1996). In terms of digital learning, there is currently a growing interest in interactive and fun teaching methods that can motivate students to use their own experiences to solve problems in games (Ezezika et al., 2023). To improve game-based learning, game visualization and interactive elements can be integrated into the teaching and learning process (Covaci et al., 2018; Pinedo et al., 2022). The scientific literature on educational games often states that the use of game-based learning experiences positively increases learning outcomes. Incorporating gaming aspects into a topic can increase interest in the topic among students, who may be willing to invest time in the topic to make a profit, thus achieving the goal of increasing learning motivation (Sundaram & Ramesh, 2022). A study conducted in (Safitri et al., 2022) by developing digital game for scientific categories, using plant body parts as materials. This game is similar to a trivia game. The results show that students' motivation to learn increases significantly. The fun experience that students experience while playing the game motivates them to get involved in the learning process (Brown et al., 2018; Pinedo et al., 2022).

Therefore, Teachers must be able to adapt to digital teaching strategies at all levels of education. Furthermore, every teacher and student must learn to use the various online software used in distance education (Erstad et al., 2021; Hillmayr et al., 2020). Smartphones with mobile apps can help students understand numbers. Technology can facilitate access to information in several ways (Aprilia et al., 2023; Raihan et al., 2018). This clearly makes it easier for students to access various information. A new foundation is needed to build consensus and trust in technology. Teachers must therefore now be able to integrate technology into all learning processes. It is expected that the integration of this technology in the learning process will be more interesting, which will increase students' motivation to participate in the learning process. Several research findings show that the application of innovative teaching methods equipped with a mobile learning environment has an impact on students' learning outcomes (Ogan et al., 2020; Susanto et al., 2022; Tang et al., 2021).

Conclusion

Research trends related to digital learning media have increased significantly from 2018 until now. Many research publications on the topic of digital media for education are published in the Scopus database. Based on the identification process in the Scopus database, 100 articles were obtained that correspond to the topics examined in this research. The top 10 authors for digital learning in science education with the highest publications, there are Reyna, J. (6 articles) with 52 citations; Meier, P. (5 articles) with 35 citations; Dittmar, J. (2 articles) with 4 citations; Martzoukou, K. (1 article) with 49 citations; Hu, J (1 article) with 33 citations; Jacobsen, D.Y. (1 article) with 31 citations; Chen, C. (1 article) with 30 citations; de Souza, G. (1 article) with 29 citations; Hietajarvi, I. (1 article) with 29 citations; and Fjortoft, H. (1 article) with 22 citations. The research on digital teaching aids in science education can help future researchers understand the problems of digital teaching aids in science education. Therefore, this study makes practical and theoretical contributions to the development and updating of the diverse literature on digital learning resources. This research problem can also become research data that examines global research trends that have been explored, those not yet explored, and which will be studied in more detail in relation to digital learning resources in educational sciences. The researchers analyzed some rarely searched keywords explained in the previous discussion. These topics, such as virtual reality, artificial intelligence, gamification, digital explanation, digital literacy, stem, and mobile learning, are emerging topics that are currently under-researched and provide opportunities for further research and exploration.

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Author Contributions

Conceptualization, formal analysis by Nurullina Fajri (N.F), Diana Rochintaniawati (D.R) and Siti Sriyati (S.S); Nurullina Fajri (N.F), writing—original draft preparation, result and discussion; Diana Rochintaniawati (D.R), methodology, supervision and review; Siti Sriyati (S.S), supervision, conclusion and review.

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Conflicts of Interest
The authors declare no conflict of interest in the decision to publish the results.

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