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Analysis of research trends in interactive learning media at the secondary school level: A bibliometric study assisted by VOSviewer

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ABSTRACT

Research on interactive learning media in secondary education has grown rapidly, but its publications are still distributed across different subjects, platforms, methods, and school contexts. This condition makes the dominant research direction and emerging themes difficult to identify systematically. This study aims to map publication trends, keyword clusters, and thematic shifts in interactive learning media research at the secondary school level from 2020 to 2024. A bibliometric method was used by analyzing 500 articles retrieved from Google Scholar through Publish or Perish. The data were screened, cleaned, and organized using Microsoft Excel, then visualized with VOSviewer through network, overlay, and density visualization. The findings show that the number of publications increased from 2020 to 2023, reaching a peak in 2023 with 123 articles, before declining slightly in 2024. Keyword mapping produced eight clusters dominated by Android-based media, interactive multimedia, Articulate Storyline, Lectora Inspire, iSpring Suite, web-based media, validity, practicality, effectiveness, and student learning outcomes. The overlay visualization indicates a thematic shift from product development toward studies that examine media effectiveness and learning impact. The scientific contribution of this study lies in providing a focused bibliometric map of interactive learning media research in junior high school, senior high school, and vocational high school contexts. These findings can guide future researchers and educators in designing interactive media that are not only technically feasible but also pedagogically meaningful and oriented toward measurable learning outcomes.

1. Introduction

The advancement of information and communication technology (ICT) has had a major impact on the education sector. The use of technology not only expands access to learning resources but also encourages various student-centered learning innovations. One widely developed innovation is interactive learning media, namely media that integrates text, images, audio, video, and animation to create a more engaging and meaningful learning experience

[1]. Interactive media has been reported to support students' learning responses, participation, and critical thinking through active interaction with learning materials [2], [3]. In addition, twenty-first-century learning emphasizes mastery of the 4C skills, namely critical thinking, creativity, collaboration, and communication. This demand
requires learning media that can stimulate active engagement and problem solving both individually and collaboratively [4], [5].

At the secondary school level, various studies have shown that interactive learning media has a positive impact on the quality of learning. Android-based interactive media has been used to improve students' responses and participation in learning [2]. Interactive multimedia development using presentation-based tools and learning software has also been implemented in mathematics and science learning [6], [7]. Interactive media can also support students' critical thinking through visual presentation, simulation, and interactive activities [3]. These findings indicate that interactive media contributes to improving learning quality across different subjects and levels of secondary education.

Although the number of publications on interactive learning media continues to increase, the studies are still distributed across various topics, development approaches, and educational contexts. This fragmentation makes it difficult to view the overall research landscape, including thematic tendencies, keyword networks, and dominant research focuses. Previous bibliometric work using VOSviewer and Publish or Perish shows that bibliometric mapping can help researchers identify publication trends and research development more systematically [10]. Therefore, an updated bibliometric study is needed to specifically map the development of interactive learning media research at the secondary school level.

Bibliometric analysis is an appropriate approach for identifying the structure of knowledge through publication patterns, keywords, and topic relationships. Software such as VOSviewer enables researchers to visualize collaboration networks, concept clusters, and thematic development over a specific period [9]. VOSviewer provides network visualization, density visualization, and overlay visualization, which facilitate the analysis of scientific trends, particularly when combined with bibliometric data extracted from databases such as Google Scholar through Publish or Perish [10]. Thus, bibliometric analysis assisted by VOSviewer can provide a comprehensive overview of research directions in interactive learning media at the secondary school level.

Previous studies have mostly examined interactive learning media in limited contexts, such as Android-based applications, interactive multimedia, web-based learning, or specific software used in particular subjects. These studies are important, but they generally emphasize product development, feasibility testing, or the effectiveness of one medium in a single classroom setting. In addition, bibliometric studies in educational technology have often used broader themes, such as digital learning or technology-based instruction, so they have not specifically explained how interactive learning media research develops across junior high school, senior high school, and vocational high school. This creates a research gap because the field still lacks a focused map that shows publication growth, dominant keywords, and thematic movement in interactive learning media studies at the secondary school level. Therefore, this study positions itself as a bibliometric mapping study that provides a more specific overview of research trends in interactive learning media during the 2020-2024 period.

Based on this background, this study aims to analyze publication trends, keyword clusters, and research developments related to interactive learning media in secondary schools over the last five years using bibliometric analysis assisted by VOSviewer. The novelty of this study lies in its focused scope on secondary education and its attempt to integrate publication trend

analysis with keyword-based thematic mapping. The results are expected to provide a comprehensive research map, clarify dominant and emerging topics, and offer practical direction for researchers and educators in developing more relevant and evidence-based interactive learning media.

2. Method

This study applied a desk research approach using bibliometric analysis. Google Scholar was used as the primary source of scientific publications because it indexes articles from various journals and academic repositories. Data collection was conducted in November 2025 using Publish or Perish (PoP), an application that extracts bibliometric data from Google Scholar according to the needs of the research.

The search process used the following keywords: “interactive learning media” OR “interactive multimedia” OR “interactive instructional media” OR “media pembelajaran interaktif” AND “junior high school” OR “vocational high school” OR “senior high school” OR “SMP” OR “SMA” OR “SMK”. The search produced 500 journal articles published between 2020 and 2024. All data were exported in Research Information Systems (.ris) format for further analysis.

To ensure that the dataset was relevant to the research objective, the selection process was guided by inclusion and exclusion criteria. The inclusion criteria were: (1) articles discussing interactive learning media, interactive multimedia, or interactive instructional media; (2) articles published from 2020 to 2024; (3) articles related to junior high school, senior high school, or vocational high school; and (4) records indexed in Google Scholar and retrievable through Publish or Perish. The exclusion criteria were: (1) publications outside the secondary education context; (2) articles that did not discuss interactive learning media; (3) duplicate records; (4) incomplete bibliographic metadata; and (5) records whose keywords were not relevant for bibliometric mapping. The total of 500 articles was used because it represented the maximum initial retrieval from Publish or Perish after applying the search query and publication-year limitation.

The analysis began with data cleaning and initial processing using Microsoft Excel, followed by bibliometric mapping using VOSviewer. The cleaning stage included checking duplicate titles, reviewing the relevance of article metadata, standardizing keyword spelling, combining similar terms, and removing general or unrelated terms that did not represent the focus of interactive learning media. In VOSviewer, the analysis used co-occurrence of terms as the mapping basis. The minimum keyword occurrence was set at four times because this threshold was considered sufficient to retain frequently appearing terms while still allowing diverse themes to be represented. This parameter produced 79 initial keywords. After manual cleaning and relevance checking, 67 terms were retained and grouped into eight clusters. The final data were visualized using network visualization to identify relationships among keywords, overlay visualization to observe thematic movement over time, and density visualization to identify terms with the highest concentration. These procedures were used to make the bibliometric process more transparent and replicable.

3. Results and Discussion

This section presents the results of bibliometric analysis, including publication data, citation metrics, publication trends, keyword clusters, and VOSviewer visualizations.

3.1 Publication data and bibliometric index

Based on the publication search using Publish or Perish, this study collected 500 scientific articles related to interactive learning media at the secondary education level, including junior high school, senior high school, and vocational high school. The data included article titles,

author names, publication years, journal names, citation counts, and URLs. The publication years analyzed ranged from 2020 to 2024, with a citation period covering 2020 to 2025. This finding is consistent with the increasing interest in interactive media in education over the last five years, as shown by various studies on interactive multimedia, Android-based media, mathematics games, and learning software [1], [2], [6]-[8].

Overall, the 500 articles received 10,267 citations. The average number of citations per year was 2,053.40, while the average number of citations per article was 20.53. The h-index of the dataset was 45, and the g-index was 86, indicating a relatively high level of productivity and citation impact in this research field. The average number of authors per article was 2.73, with an average of 219.82 articles per author and 4,715.54 citations per author. Other indices, such as hI.norm (27), hI.annual (5.40), and hA-index (24), further indicate that research on interactive learning media has shown significant productivity and academic influence during the period analyzed.

These results show that research on interactive learning media at the secondary school level has grown rapidly in terms of both publication volume and citation intensity. This condition indicates that the topic has high relevance and continues to attract scholarly attention. Nevertheless, topic fragmentation, methodological variation, and inconsistent keyword use suggest that further research is still needed, especially research that maps topics more systematically through bibliometric analysis and network visualization such as VOSviewer.

The citation indicators also suggest that interactive learning media is not only frequently discussed but also influential in educational technology research. The relatively high h-index and g-index show that several publications in this field have received consistent scholarly attention. This confirms the relevance of mapping the field systematically because the number of studies and their citation impact indicate that interactive learning media has become a mature yet still developing research area.

Table 1. List of articles and citation metrics on interactive learning media

Author(s)	Article Title	Year	Citations
Hikmah, S. N., & Maskar, S.	Pemanfaatan aplikasi Microsoft PowerPoint pada siswa SMP kelas VIII dalam pembelajaran koordinat kartesius	2020	1292
Lubis, A. H.	The Interactive Multimedia Based on Theo-Centric Approach as Learning Media during the Covid-19 Pandemic	2023	715
Kartini, K. S., & Putra, I. N. T. A.	Respon siswa terhadap pengembangan media pembelajaran interaktif berbasis Android	2020	344
Gulo, S., & Harefa, A. O.	Pengembangan media pembelajaran interaktif berbasis PowerPoint	2022	214
Sulistiani, H., Putra, A. D., Rahmanto, Y., & Fahrizqi, E. B.	Pendampingan dan pelatihan pengembangan media pembelajaran interaktif dan video editing di SMKN 7 Bandar Lampung	2021	200
Wulandari, S.	Media pembelajaran interaktif untuk meningkatkan minat siswa belajar matematika di SMP 1 Bukit Sundi	2020	187
Hendi, A., Caswita, C., & Haenilah, E. Y.	Pengembangan media pembelajaran interaktif berbasis strategi metakognitif untuk meningkatkan kemampuan berpikir kritis siswa	2020	144
Carolina, Y. D.	Augmented reality sebagai media pembelajaran interaktif 3D untuk meningkatkan motivasi belajar siswa digital native	2023	134

Ali, A., Maniboey, L. C., Megawati, R., Djarwo, C. F., & Listiani, H.	Media pembelajaran interaktif: Teori komprehensif dan pengembangan media pembelajaran interaktif di sekolah	2024	134
Martin, R. T., Syafril, S., & Yusri, M. A. K.	Android-based interactive multimedia development using iSpring Suite 11 in informatics engineering class X senior high school	2024	125
Widodo, W., Sudibyo, E., Suryanti, S., Sari, D. A. P., & Inzanah, I.	The effectiveness of gadget-based interactive multimedia in improving Generation Z's scientific literacy	2020	120
Novita, R., & Harahap, S. Z.	Pengembangan media pembelajaran interaktif pada mata pelajaran sistem komputer di SMK	2020	117
Kasna, R. L., Syafril, S., & Novrianti, N.	The development of interactive multimedia using Smart Apps Creator applications in class VII junior high school informatics subjects	2023	114
Nadzif, M., & Irhasyuarna, Y.	Pengembangan media pembelajaran interaktif IPA berbasis Articulate Storyline pada materi sistem tata surya SMP	2022	111
Harahap, L. K., & Siregar, A. D.	Pengembangan media pembelajaran interaktif berbasis Adobe Flash CS6 untuk meningkatkan motivasi dan hasil belajar pada materi kesetimbangan kimia	2020	95

Table 1 presents the most cited articles related to interactive learning media in secondary education. The listed articles show that high citation impact is not limited to one subject area; rather, it appears in mathematics, science, informatics, vocational education, and digital learning contexts. This pattern indicates that interactive learning media has cross-disciplinary relevance. Several highly cited studies emphasize PowerPoint-based media, Android applications, augmented reality, interactive multimedia, and learning software. Therefore, the table suggests that the most visible research directions are closely related to technology-supported media development and classroom implementation. This strengthens the argument that interactive learning media should be understood not merely as a digital product, but as an instructional tool that can influence motivation, conceptual understanding, engagement, and learning outcomes.

3.2 Publication Trend

This section presents the publication trend of studies on interactive learning media at the secondary school level from 2020 to 2024. The data were grouped based on publication year to identify the annual development of research in junior high schools, senior high schools, and vocational high schools. The summary of the publication data is presented in Table 2, while the trend visualization is shown in Fig. 1.

Table 2. Development of interactive learning media research in secondary schools

Publication Year	Number of Publications
2020	74
2021	90
2022	121
2023	123
2024	92
Total	**500**
Average	**100**

Based on Table 2, the number of publications on interactive learning media shows a generally increasing trend during the 2020–2024 period. The data indicate that research interest in this topic grew consistently from 2020 to 2023, although a slight decrease occurred in 2024. To provide a clearer visual representation of this pattern, the publication trend is illustrated in Fig. 1.

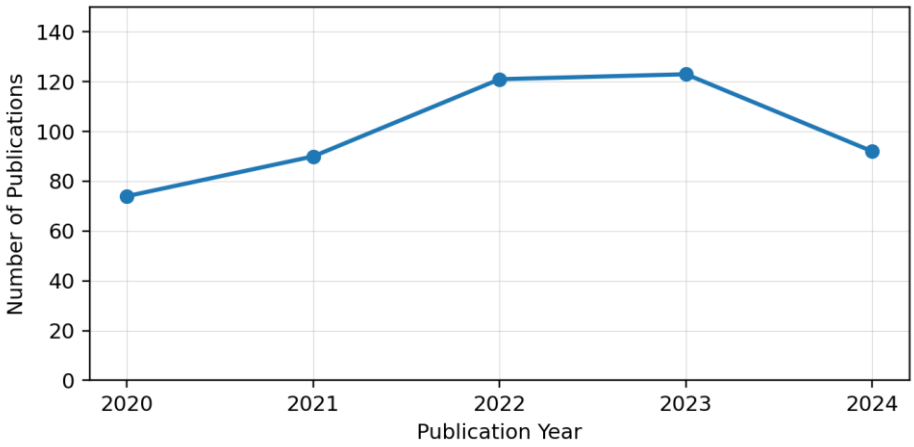

Fig. 1. Publication trend of interactive learning media research in secondary schools

Table 2 and Fig. 1 show that publications on interactive learning media increased from 2020 to 2023. The number of publications rose from 74 articles in 2020 to 90 articles in 2021, then increased sharply to 121 articles in 2022 and reached the highest point in 2023 with 123 articles. Although the number decreased to 92 articles in 2024, the overall trend still indicates positive development during the five-year period. This pattern suggests that interactive learning media became a strong research focus during the period of rapid digital learning adoption and remained relevant after classroom learning began to return to more regular conditions.

The increase in publications reflects growing academic attention to technology-based learning innovation, particularly in secondary and vocational education. The peak in 2023 may indicate the continuation of post-pandemic interest in digital and interactive learning solutions. Meanwhile, the slight decline in 2024 should not be interpreted as a weakening of the topic. Instead, it may suggest that research is beginning to move from broad media development toward more specific issues, such as effectiveness, student learning outcomes, learning engagement, and the pedagogical quality of interactive media.

3.3 Keyword cluster mapping

The keyword mapping was obtained after the data were filtered and cleaned by removing irrelevant keywords. The final result showed 67 terms related to the theme of interactive learning media in secondary education, forming eight main clusters. Each cluster represents a different research focus, educational context, and topic tendency. The clusters are described as follows:

Cluster 1 contained 16 items and was represented by red, including android, high school, interactive multimedia development, interactive multimedia product, interactive multmedium, iSpring Suite, learning, Lectora, Lectora Inspire, practically, sample, senior high school, senior high school student, type, validity, and vocational high school. This cluster represents studies focusing on the development of Android-based interactive multimedia and software such as Lectora Inspire and iSpring Suite at senior high school and vocational high school levels [7], [11]. The main focus includes validity, practicality, and effectiveness of media used to support learning.

Cluster 2 contained 14 items and was represented by green, including Articulate Storyline, feasibility, interaktif berbasis, media, media interaktif, media pembelajaran interaktif, medium, pengembangan medium, sma n, sma negeri, smk, smk negeri, smp, and smp negeri. This cluster emphasizes the development of interactive learning media at junior high school, senior high school, and vocational high school levels. Feasibility and effectiveness are central aspects in evaluating successful media implementation.

Cluster 3 contained 13 items and was represented by blue, including development, effectiveness, implementation, interactive multimedia, junior high school, mathematics subject, model, problem, research, RME, smp n, stage, and website. This cluster focuses on the implementation of web-based interactive media in mathematics learning at junior high school level, with dominant topics such as effectiveness, learning models, and the Realistic Mathematics Education (RME) approach [12].

Cluster 4 contained nine items and was represented by yellow, including analysis, interactive learning medium, interactive medium, junior high school student, mathematics, practice, researcher, study, and web. This cluster reflects studies analyzing the implementation of web-based interactive learning media among junior high school students, especially in mathematics. The studies often discuss learning practices and empirical findings.

Cluster 5 contained six items and was represented by purple, including class, effect, Google Sites, outcome, student, and use. This cluster describes research related to the use of Google Sites as interactive learning media, focusing on its effect on student learning outcomes.

Cluster 6 contained five items and was represented by orange, including cycle, interactive, interactive learning media, teacher, and training. This cluster indicates studies related to teacher training in developing and using interactive learning media.

Cluster 7 contained three items and was represented by brown, including android application, application, and subject. This cluster describes research focusing on Android-based applications for learning various subjects in secondary schools.

Cluster 8 contained one item and was represented by gray, namely form. This cluster represents studies discussing the design and format of interactive learning media from technical and content presentation perspectives.

The relationships among keywords in each cluster reveal three dominant patterns. First, many studies are still oriented toward media development, as shown by terms related to Android, Articulate Storyline, Lectora Inspire, iSpring Suite, and web-based media. Second, the presence of validity, practicality, and effectiveness indicates that most studies follow a development-and-evaluation pattern. Third, the appearance of terms related to students, learning outcomes, and mathematics learning shows that interactive media research is gradually connected to learning impact rather than only product feasibility. These patterns indicate diverse research directions, ranging from software-based media development to classroom implementation at junior high school, senior high school, and vocational high school levels [7], [11], [14].

The cluster results also show that research on interactive learning media still needs deeper pedagogical analysis. The dominance of development-related terms suggests that many studies have focused on producing and validating media, whereas fewer studies appear to examine how particular interactive features support higher-order thinking, student engagement, self-regulated learning, or long-term learning outcomes. Therefore, the cluster mapping not only identifies dominant topics but also highlights opportunities for future research to move from product-oriented studies toward impact-oriented studies.

3.4 Network visualization

Network visualization was used to identify the relationships among frequently occurring terms in the dataset. This visualization shows how keywords are connected and how research topics form clusters in interactive learning media studies. The network visualization result is presented in Fig. 2.

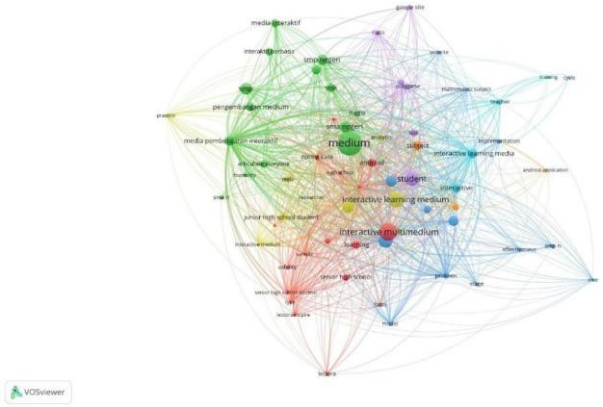

Fig. 2. Network visualization of interactive learning media research in secondary schools

Fig. 2 presents a network visualization showing the relationships among terms that frequently appear in interactive learning media research. The central position of terms such as medium, interactive learning media, student, interactive, and learning indicates that the conceptual core of this research field is strongly connected to students' learning activities. The presence of more specific terms, such as interactive multimedia and Android application, shows that platform-based media development is an important subtheme. This network structure suggests that interactive learning media research is built around two connected orientations: the development of digital media and the use of that media to support students' learning processes.

3.5 Overlay visualization

Overlay visualization was used to examine the development of research topics based on publication year. This visualization helps identify shifts in research focus over time. The overlay visualization result is presented in Fig. 3.

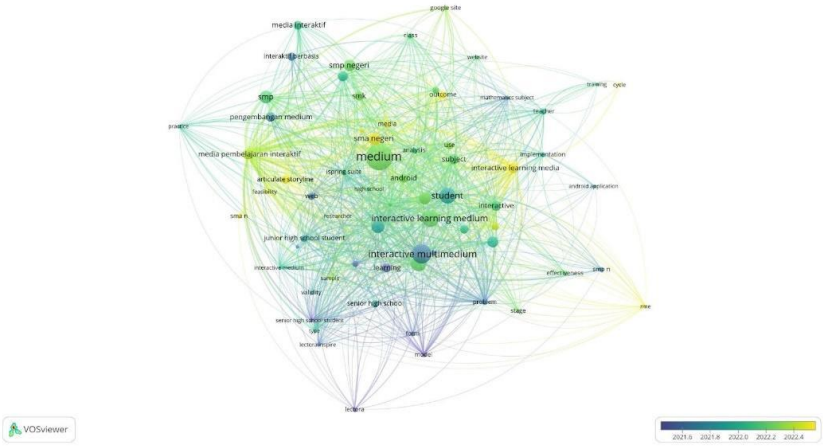

Fig. 3. Overlay visualization of interactive learning media research in secondary schools

Fig. 3 shows an overlay visualization that illustrates the development of dominant themes over time. Earlier studies tended to focus on the development of interactive media and Android-based applications, while later studies increasingly emphasized the effects of interactive media on

students and its effectiveness in learning. This thematic shift shows that the research field has begun to move from asking whether interactive media can be developed to asking how far such media can improve the learning process.

Over time, topics such as interactive learning medium and interactive multimedia became increasingly dominant. This trend reflects growing attention to the pedagogical use of interactive multimedia across educational levels. Therefore, future studies should not only report media feasibility but also examine how specific features, such as feedback, simulation, gamification, navigation, learner control, and interactivity, contribute to students' motivation, understanding, critical thinking, and learning performance.

3.6 Density visualization

Density visualization was used to identify the concentration of frequently occurring terms in research on interactive learning media at the secondary school level. This visualization helps show which terms have strong relationships and appear most often in the analyzed dataset. The density visualization result is presented in Fig. 4.

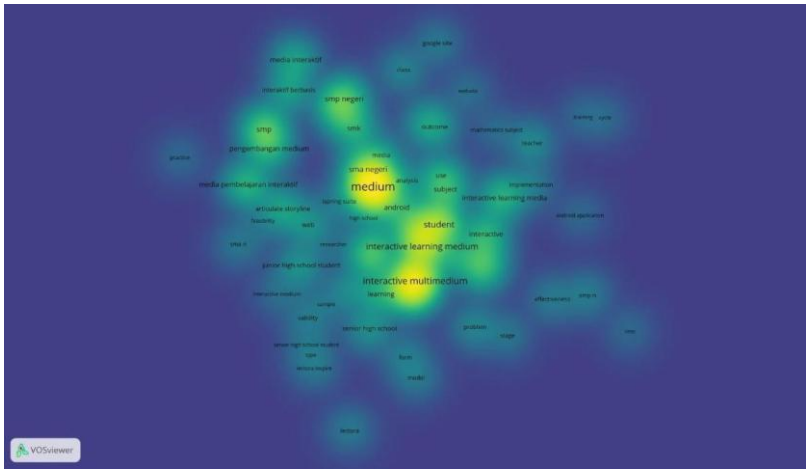

Fig. 4. Density visualization of interactive learning media research in secondary schools

Fig. 4 presents a density map showing the concentration of frequently co-occurring terms in the dataset. Brighter areas indicate terms that appear more frequently and have stronger relationships with other terms, while darker areas indicate lower term density. The brighter areas around medium, interactive learning medium, and interactive multimedia confirm that media-related terms dominate the research structure.

The terms student and learning also appear in brighter areas, indicating that the use of interactive media is closely connected to learners and learning processes. This density pattern confirms that the field is not only concerned with technological products but also with how those products are used in learning. In other words, interactive learning media research should increasingly emphasize the relationship between media design, student interaction, learning engagement, and measurable learning achievement.

4. Conclusion

This study contributes to the field of educational technology by providing a focused bibliometric map of interactive learning media research at the secondary school level. Based on the analysis of 500 Google Scholar-indexed articles published from 2020 to 2024, the study found that research on interactive learning media developed positively and reached its highest publication point in 2023. VOSviewer mapping identified eight main clusters, showing that the dominant research themes are related to media development using Android, Articulate

Storyline, Lectora Inspire, iSpring Suite, and web-based platforms, as well as studies on validity, practicality, effectiveness, and student learning outcomes.

The main scientific contribution of this study lies in its specific focus on junior high school, senior high school, and vocational high school contexts. The findings clarify the dominant topics, emerging trends, and thematic shifts in interactive learning media research. The visualization results indicate that the field is gradually moving from product development toward evaluating the pedagogical impact of interactive media. Practically, the results can help researchers and educators identify relevant platforms and research gaps for developing interactive media that are technically feasible, pedagogically meaningful, and oriented toward measurable learning outcomes.

This study has several limitations. First, it relied only on Google Scholar as the data source, so it may not cover all publications indexed in Scopus, Web of Science, Dimensions, or other databases. Second, the analysis was limited to metadata and keywords, without full-text content analysis. Third, keyword standardization may influence the number and composition of clusters produced by VOSviewer. Future research is recommended to combine multiple databases, apply systematic literature review or meta-analysis methods, and examine how specific interactive media features influence students' learning outcomes, critical thinking, motivation, engagement, and self-regulated learning.

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