



Research Trends in The Development of Biology Learning Media in Indonesia: A Bibliometric Analysis

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ABSTRACT

Several bibliometric studies have been conducted to see the progress of Biology Learning Media (BLM), but these researches still provide a broad scope in evaluating the development of BLM. This study aims to provide a holistic overview of the trends in the use of BLM in Indonesia during 2018-2023 on the Scopus database. The method used is bibliometric analysis by identifying and analyzing the growth patterns of literature, authors, institutions, and keywords related to BLM development. The research procedure consisted of investigation, reduction, compilation, and interpretation. A total of 43 articles were analyzed using VOSviewer software to visualize bibliometric mapping. For the last five years, BLM-related publications peaked in 2019 with 13 articles. Universitas Negeri Malang is a foremost institution in BLM development. The most widely used BLM are android-based media, interactive multimedia, and website-based media. Ecology is the most widely taught learning topic, while cognitive (knowledge) is the most frequently measured learning outcome. We highlighted a paradigm change in the use of more massive Technology-based learning media. In the future, we suggest exploring various research topics in biology learning such as protists, genetics, or microbiology that can empower literacy as a primary topic in more innovative and dynamic learning.

Keyword: Bibliometric analysis, Biology Learning Media (BLM), Scopus

INTRODUCTION

Biological learning media (BLM) plays an essential role in the biology learning process. As learning tools, BLM is designed to support more effective understanding of biology concepts and create more meaningful learning experiences for students (Jacobson & Archodidou, 2000; Lee, 2016; Svoboda & Passmore, 2013). BLM involves various types of materials, tools, or technologies specifically designed to support learning (Kirkwood & Price, 2014). The implementation of BLM is an effective strategy in improving learning effectiveness (Weng et al., 2019).

The various benefits of using BLM have been widely studied for its effectiveness. Previous research has revealed that BLM can increase learning quality, provide access to

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education, support in the illustration of abstract concepts, make the content being studied easier to understand, and enable dynamic interaction between teachers and students (Jacobson & Archodidou, 2000; Kirkwood & Price, 2014; Weng et al., 2019). Appropriate learning media can also improve various competencies and cognitive learning outcomes of students, stimulate interest and curiosity, and increase motivation in the learning process (Murayama et al., 2019; Oudeyer et al., 2016).

A study on learning media development trends has been conducted by Arici et al., (2019) 147 articles on the Web of Science database. These findings reveal that the most widely developed learning media is mobile application-based which aims to measure cognitive learning outcomes, motivation, and attitudes. A similar study was also conducted by Munyemana et al., (2023) who revealed that BLM is more developed in certain topics using specific media. However, the research's broad scope gives an overly general evaluation of the subject being studied, so it cannot represent the development of BLM in other databases. Furthermore, there has been no prior research documenting the advancement of BLM in Indonesia, despite its crucial role in fostering success in biology education within the country.

As BLM-related publications develop in Indonesia, there are still many questions about their relevance to the urgency of using BLM in learning. So, a method is needed in seeing the current condition of the use of BLM in Indonesia. In measuring the trend of BLM can be conducted through bibliometric analysis. According to Donthu et al., (2021). bibliometric analysis is a commonly employed method for evaluating large amounts of scientific data. The goal is to quantify, evaluate, and interpret the growth of scientific articles and study (Donthu et al., 2021). With this analysis, it is possible to assess the trend of a research topic, research collaborations, authors and institutions related to the article (Donthu et al., 2021; Skute et al., 2019).

The results of the bibliometric analysis can serve as a basis for enhancing innovation and effectiveness in BLM development. This process can also provide additional encouragement to developers to focus on certain aspects of biology topics that may not have been fully accommodated. Therefore, this research is expected to give a comprehensive overview of trends in the biology learning media (BLM) use in Indonesia from 2018 to 2023 on the Scopus database.

METHOD

This study employs evaluative scientometrics, as described by Kusmahardhika et al., (2024). It utilizes bibliometric analysis to assess, dissect, and elucidate patterns within research and scientific publications, as outlined by Donthu et al., (2021). This analysis enables the quantification of the influence and significance of scientific publications, identification of research directions, and assessment of the accomplishments of individual researchers and institutions employing mathematical and statistical approaches (Donthu et al., 2021).

Procedure

The method used adopted from Kusmahardhika et al., (2024) as shown in Figure 1.

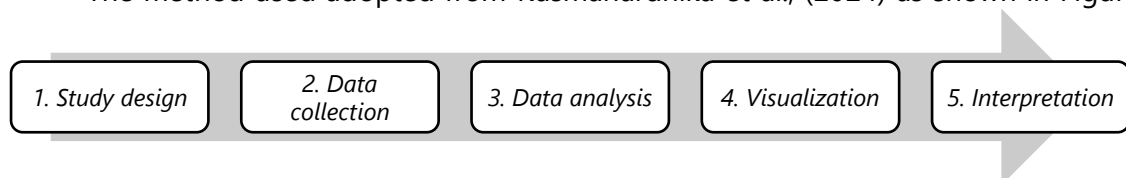


Figure 1. Five Steps Bibliometric Analysis Method

Stage 1: Study design. This phase is structured around the core inquiries tailored to the research aims, which are: (1) assessing the developmental trajectory of literature concerning BLM growth in Indonesia from 2018 to 2023, (2) scrutinizing author co-authorship and institutional connections utilizing bibliometric grouping methodologies, (3) identifying the most prolific institutions and resources based on publication frequency, and (4) uncovering emerging themes through keyword analysis.

Stage 2: Data collection. This phase comprises three distinct steps: data collection, data filtering, and data cleaning. The first step was specifically collected on the Scopus database on November 21, 2023. Subsequently, information unrelated to the research subject was removed from titles, abstracts, and keywords as part of the data filtering and data cleaning process. The keyword searches for this study in the Scopus database are: TITLE-ABS-KEY (learning media) OR (learning tools) AND TITLE-ABS-KEY (biology education) OR TITLE-ABS-KEY (Biology learning). Based on those keywords, we discovered 43 articles matching the criteria in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> • Studies conducted related to the use of biology learning media in Indonesia • Journal articles and conference papers from the Scopus database (www.scopus.com) • Timeframe 2018-2023 	<ul style="list-style-type: none"> • The study conducted was not related to the use of biology learning media in Indonesia • Books, notes, book chapters, conference reports, and review papers • Before 2018

Stage 3: Data analysis. The collected metadata was exported in CSV format for bibliometric analysis using VOSviewer software. Co-authorship, co-citation, and co-occurrence patterns were the main areas of analysis. Co-authorship denotes collaboration among authors, institutions, and countries. Co-citation involves the simultaneous citation of multiple documents in another document. Co-occurrence is the simultaneous occurrence of two or more keywords, concepts, or subjects in published works.

Stage 4: Visualization. Through VOSviewer, the main objective of the visualization aspect of bibliometric analysis is transforming intricate bibliometric data into visually comprehensible and insightful visual representations. The usage of visualisation in scientific literature facilitates the identification of relationships between authors, keywords, publications, and themes. With this method, users can quickly identify study trends, collaboration patterns, and individual research contributions.

Stage 5: Interpretation. Interpreting the results of the analysis depends heavily on interpretation in bibliometric analysis. The bibliometric data, statistical data, and visual representations are thoroughly analysed by researchers to find underlying patterns, trends, and relevance possibilities inherent in the data. Contextual analysis is a necessary component of interpretation, as researchers work to clarify new trends and their significance in BLM.

RESULTS AND DISCUSSION

Results

The cumulative results of BLM usage in Indonesia comprise 43 documents during 2018 to 2023 with an average increase of ≤ 1 article. A total of 36 documents (83.7%) were

conference articles and 7 documents (16.2%) were journal articles. All articles (100.0%) were published in English. Publications in 2018 were 5 articles (11.6%), then increased to 13 articles (13.2%) in 2019. In 2020 the number of publications was 8 articles (18.6%) and decreased in 2021 to 6 papers (13.9%). In 2022 the number of publications was 3 articles (6.9%) and increased in 2023 to 8 articles (18.6%) (as of November 21, 2023).

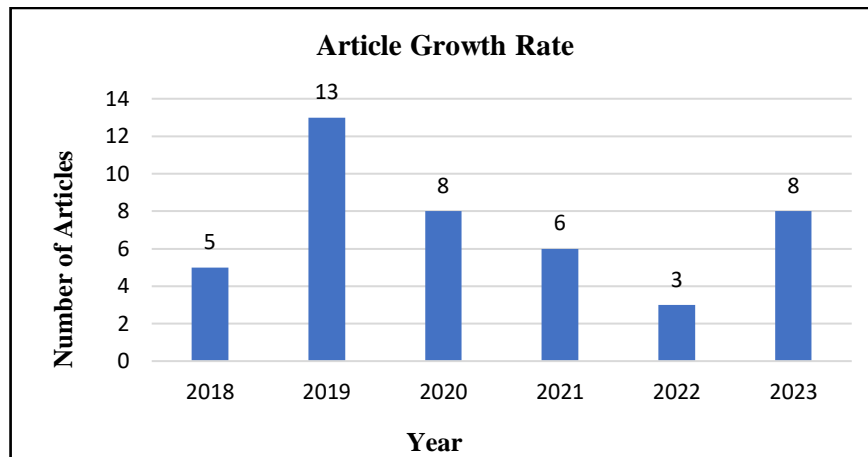


Figure 2. Article Growth Rate

The most productive authors

Figure 3 is a visualization map of the authorship network pertaining to BLM development is presented. The circles within the map denote individual authors, with the size of each circle reflecting the quantity of papers they have published in the Scopus database. The threshold (*minimum number of searches in VOSviewer*) set in the bibliometric analysis was 1, and 38 authors met this threshold based on the similarity of the same research topic (Figure 3). Boleng (Universitas Mulawarman), Darmawan (Universitas Tidar), Kurniawan (Universitas Pendidikan Indonesia), Lumowa (Universitas Mulawarman), Maryanti (UIN Sunan Gunung Djati), Ristanto (Universitas Negeri Jakarta), Susantini (Universitas Negeri Surabaya), and Suwono (Universitas Negeri Malang) were the most productive authors with an authorship percentage of 4.7%. Then followed by Abdullah (Universitas Trunojoyo Madura) and Abidinsyah (STKIP PGRI Banjarmasin) with a percentage of authorship of 2.3% (Figure 4). Figure 4 shows the 10 most productive authors.

The most productive institutions

Figure 5 is a visualization of the most productive institutions in BLM development. The publications demonstrate how institutions contributed to developing BLM in Indonesia from 2018 to 2023. With an article percentage of 14.0%, Universitas Negeri Malang is the university with the most publications, followed by Universitas Negeri Yogyakarta at 11.6%, Universitas Pendidikan Indonesia at 7.0%, Universitas Negeri Jakarta at 7.0%, Universitas Negeri Surabaya at 4.7%, UIN Sunan Gunung Djati at 4.7%, Universitas Siliwangi at 2.3%, STKIP PGRI Banjarmasin at 2.3%, Universitas Tidar at 2.3%, and Universitas Mulawarman at 2.3%.

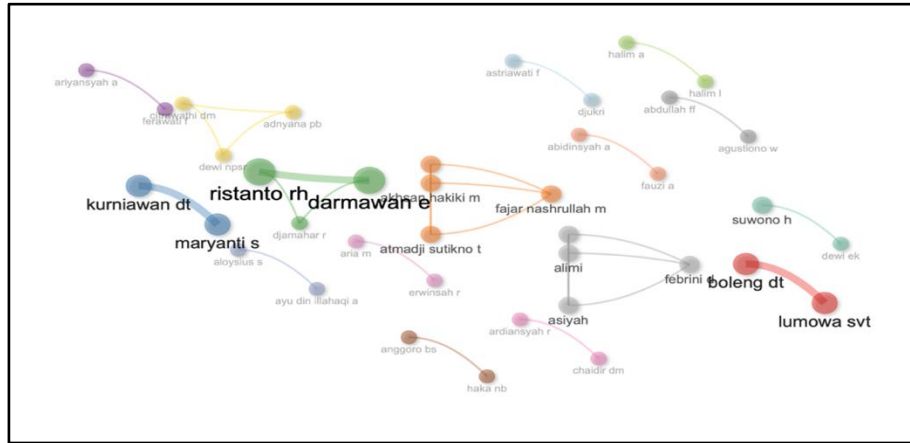


Figure 3. Co-Authorship Network Visualization Map

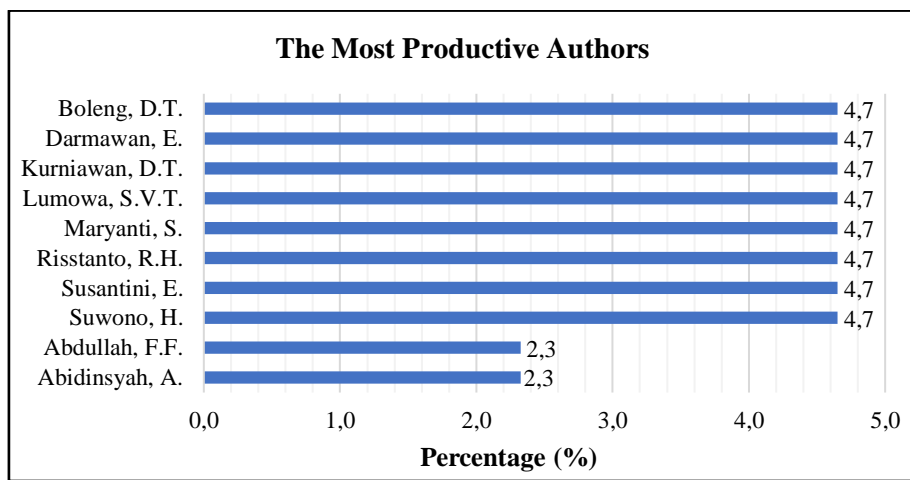


Figure 4. Top 10 Most Productive Authors

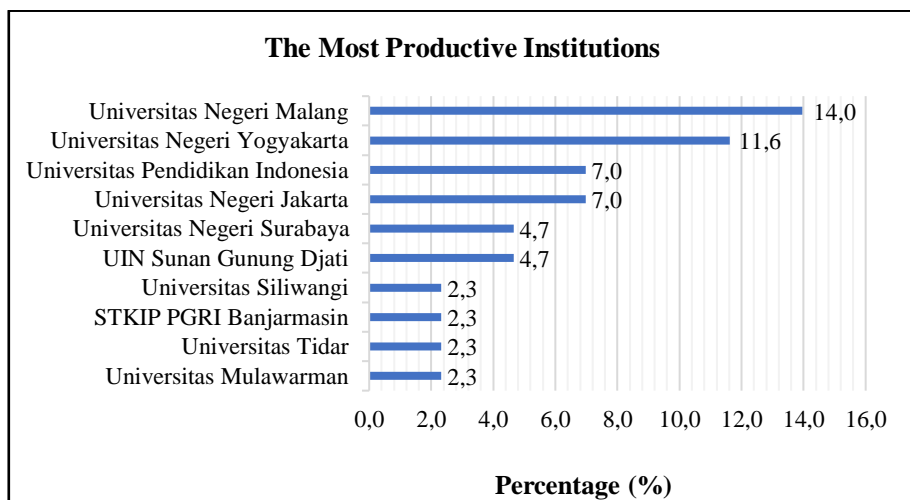


Figure 5. Top 10 Most Productive Institutions

Keyword Analysis

Research topics related to BLM

A total of 200 keywords were obtained from articles on the use of BLM in Indonesia. We categorized the keywords into two groups: research topics and learning topics related to the

use of BLM. Keywords that occurred at least twice were chosen and a total of 51 words on research topics and 12 words on learning topics satisfied this threshold. The findings are depicted in the keyword network visualizations presented in Figure 6 and Figure 8.

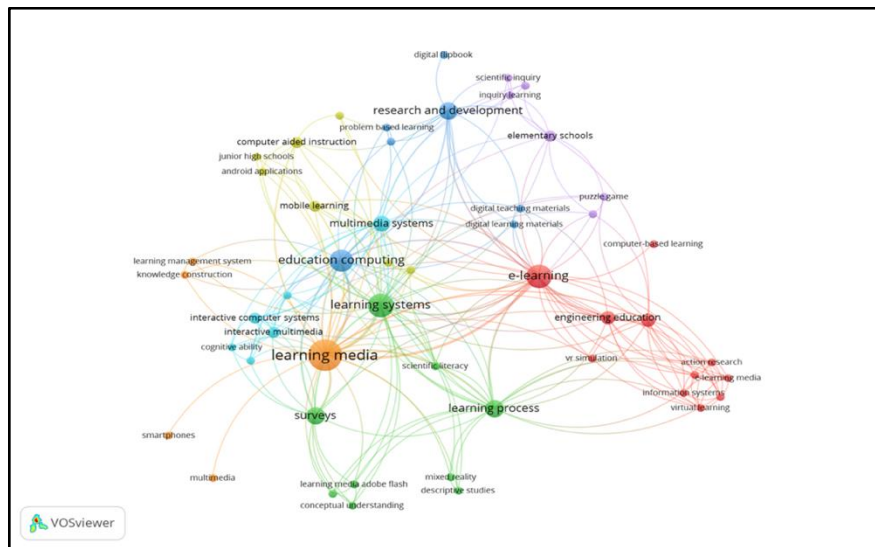


Figure 6. Research Topic Visualization Map

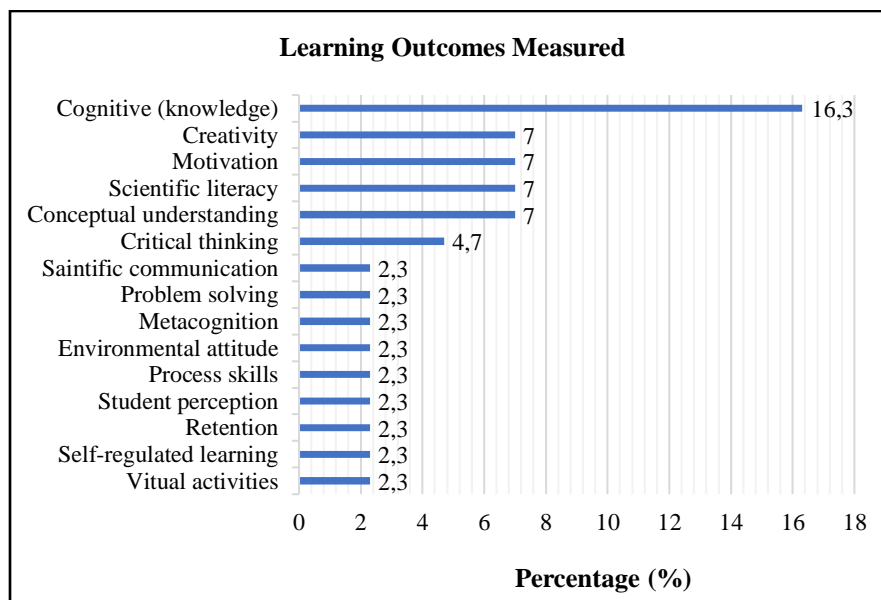


Figure 7. Learning Outcomes Measured

Figure 6 shows the network visualization map closely related to the use of BLM. This map is clustered into 7 clusters. Cluster 1 (red) has 11 keywords such as "action research", "computer-based learning", "e-learning", "engineering education", "information systems", "innovative learning", "virtual communication", "virtual learning", "virtual reality", "vr simulation". Cluster 2 (green) has 9 keywords such as "conceptual understanding", "descriptive study", "secondary school", "adobe flash", "learning process", "learning system", "mixed reality", "scientific literacy", "survey". Cluster 3 (dark blue) has 7 keywords such as "digital flipbook", "digital learning", "digital teaching", "education computing", "problem-based learning", "problem solving", "research and development". Cluster 4 (yellow) has 7 keywords

such as "android application", "computer aided instruction", "junior high school", "mobile learning", "mobile technology", "process-oriented", "visualization technique". Cluster 5 (purple) has 6 keywords such as "elementary school", "inquiry learning", "learning difficulties", "puzzle game", "scientific inquiry", "virtual doll". Cluster 6 (light blue) has 6 keywords such as "operating system", "cognitive ability", "interactive computer system", "interactive multimedia", "learning outcomes", "multimedia system". Cluster 7 (orange) has 5 keywords such as "knowledge construction", "learning management".

After determining the keywords, we analyzed various research topics related to student learning outcomes in the use of BLM. As a result, there are 15 research topics that are most frequently measured, including: cognitive (knowledge) (16.3%), creative thinking (7.0%), motivation (7.0%), scientific literacy (7.0%), conceptual understanding (7.0%), critical thinking (4.7%), science communication (2.3%), problem solving (2.3%), metacognitive (2.3%), environmental attitudes (2.3%), process skills (2.3%), student perception (2.3%), retention (2.3%), self-regulated learning (2.3%), and virtual activities (2.3%). The distribution of student learning outcomes can be seen in Figure 7.

Learning topics related to BLM

Figure 8 is a network visualization map showing the most frequently used biological topics in BLM. This map is clustered into 2 clusters. Cluster 1 (red) contains 7 keywords such as "environmental changes", "environmental materials", "human body's systems", "human reproduction", "reproductive systems", "human physiology", "immune systems". Cluster 2 (green) has 5 keywords such as "plants (botany)", "plant identification", "plant anatomy", "histology", "cell".

After determining the network of learning topics, we clustered the topics into the most taught areas of biology (Figure 9). The results showed that Ecology was the most taught topic (20.9%) followed by Botany (16.3%), Reproductive system (7.0%), Digestive system (7.0%), Excretory system (4.7%), Cell (2.3%), Evolution (2.3%), Respiratory system (2.3%), Virus (2.3%), and Zoology (2.3%).

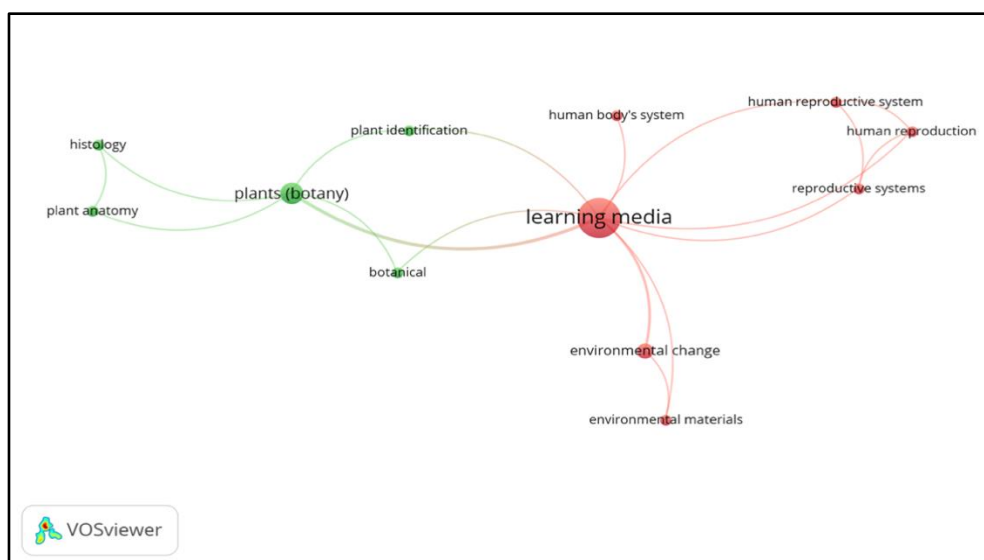


Figure 8. Learning Topics Network Visualization Map

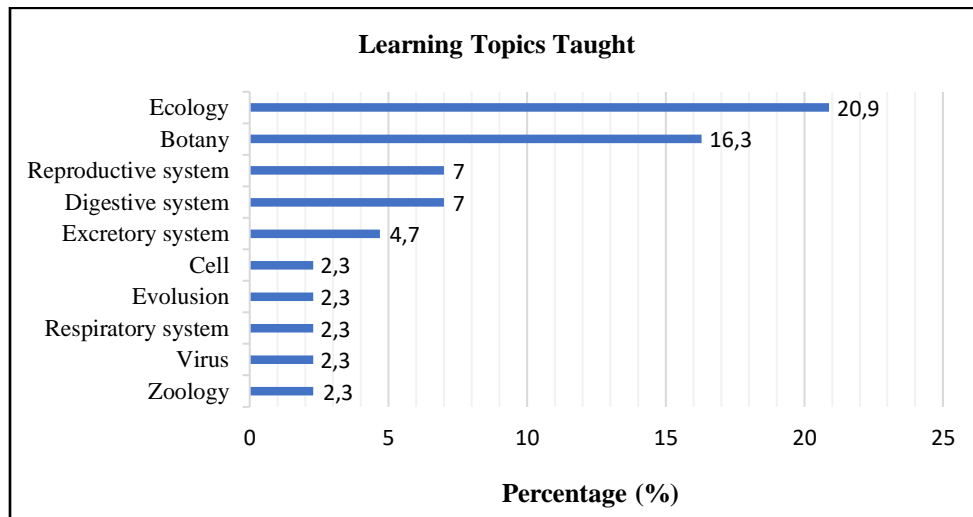


Figure 9. Learning Topics Taught

How the learning topics are displayed

Figure 10 is the most widely used BLM. As a result, android-based media, interactive multimedia, and website-based media are the most widely used (14.0%), followed by e-modules (11.6%), local wisdom-based media (11.6%), augmented reality (7.0%), virtual reality (7.0%), 3D software (2.3%), realia (2.3%), and video-based games (2.3%).

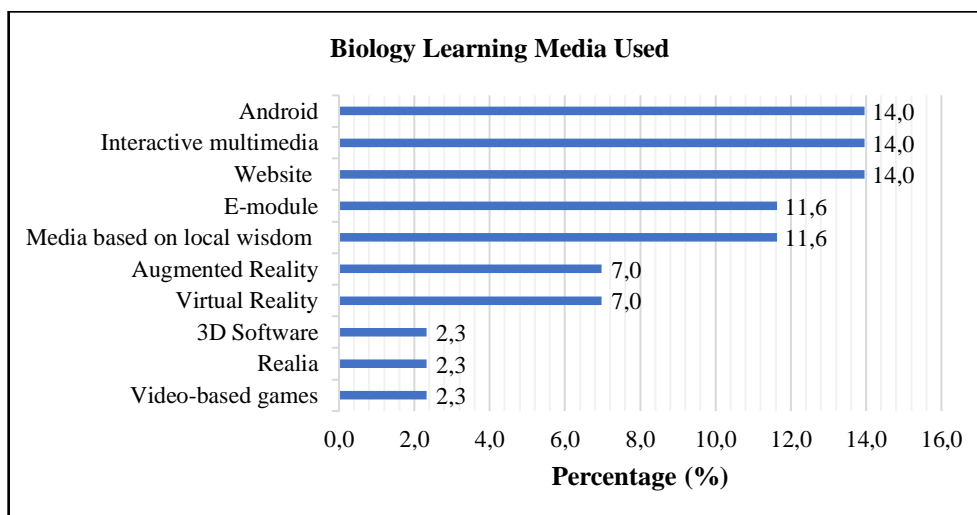


Figure 10. BLM Used

Discussion

The bibliometric analysis used in this review provides a unique perspective on the development of BLM. In the last 5 years, the growth of publications related to the trend of using BLM in the Scopus database tends to be stable with an average increase of ≤ 1 article each year. The data indicates that research related to BLM is still not widely conducted, especially on the Scopus database. We argue that the lack of BLM research on the Scopus database can be due to various factors such as funding limitations, the narrowness of the niche nature of BLM, or a lack of new methodologies emerging in the field. In addition, the relatively low increase in the number of publications may reflect a consolidation phase in which existing

technologies and methodologies are optimized rather than newly introduced ones.

In line with that, our findings also illustrate the low number of BLM-related publications on the Scopus database. As a result, there are 8 main authors who have the same number of publications with 2 documents each (4.7%), while the institution with the most publications is Universitas Negeri Malang with 6 documents (14%). This proves that BLM research is still not optimized in biology learning. We argue that there is a need for wider collaboration and a more integrated research network. Interdisciplinary research that combines researchers, educators, and various experts is crucial (Newman, 2024) especially in supporting the advancement of BLM. On the other hand, we see collaborative research is a step in enriching the existing literature and providing new insights in biology teaching and learning.

In bibliometric analysis, examining keywords is pivotal as it reflects trends, areas of interest, and advancements within a discipline (Kusmahardhika et al., 2024). In our research, we divided keyword analysis into three, namely research topics, learning topics, and media used. On the research topic, we found that 16.3% of BLM was used to improve cognitive learning outcomes (knowledge) (Irwansyah et al., 2020; Kusmahardhika et al., 2023; Prasetyo et al., 2021; Topano et al., 2021). These results are also in line with Munyemana et al., (2023) who revealed that academic achievement (cognitive learning outcomes) is a research topic often studied.

A total of 20.9% of BLM explored ecological learning topics (Astriawati, 2019; Badria et al., 2021; Ramdiah et al., 2020; Sagita & Aminatun, 2019). This result contrasts with Munyemana et al. (2023) who found biochemistry to be much more studied than ecology. We argue that this difference is influenced by different student needs. Several studies reveal that the use of BLM in Ecology is conducted because of the need for students to solve various environmental problems. Therefore, its use is considered effective to present various natural phenomena directly (Astriawati, 2019; Sagita & Aminatun, 2019).

The evolution of BLM reflects a broader trend in education toward a more interactive, personalized, and technologically integrated learning environment. This not only helps in keeping students motivated, but also in cultivating a deeper understanding of the biological sciences. In the development of technology, BLM has a significant contribution to the process of providing information to students. Our findings found that the use of android-based media (Perdana et al., 2023; Puspa et al., 2021), interactive multimedia (Anjani & Yustim, 2019; Topano et al., 2021), and website-based media (Salmah et al., 2023; Suwono & Dewi, 2019) are the most widely used in biology learning. The research revealed that BLM creates dynamic learning spaces, facilitating the transfer of information in a way that is more engaging and understandable to students. This shows that BLM plays an important role in biology learning.

Overall, the results of the bibliometric analysis provided a comprehensive view of BLM development trends in recent years. However, we still find gaps or areas that have not been explored. Many BLMs have been used, but they only facilitate certain topics and learning outcomes. The wide scope of topics in biology learning and the various learning outcomes provide opportunities for similar research with different topics, such as literacy empowerment in protists, genetics, or microbiology.

CONCLUSION

The bibliometric analysis conducted in this study provides a unique perspective on the development of BLM in Indonesia. For the last five years, publications peaked in 2019 with 19 articles. Universitas Negeri Malang is a foremost institution in BLM development. The most widely used BLMs are android-based media, interactive multimedia, and website-based media.

Ecology is the most taught learning topic while cognitive (knowledge) is the most frequently measured learning outcome. Based on this analysis, we highlight various paradigm changes in BLM development research centering more on the use of technology. In addition, we also suggest examining various research topics in biology learning such as protists, genetics, or microbiology that can empower literacy as a primary topic in more innovative and dynamic learning

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