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Trend of genetics learning media research: A bibliometric analysis (1968-2024)

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ABSTRACT

The use of learning media consisting solely of still images in genetics lectures presents several challenges. These include difficulty in comprehending complex material, the inability to effectively visualize microscopic objects that require specialized teaching aids or interactive media, and a tendency to foster misconceptions among students. This descriptive qualitative research, employing a bibliometric approach, aims to analyze research trends on learning media in genetics from 1964 to 2024. The analysis focuses on the volume and distribution of publications, the contributing countries, and the institutional affiliations, as well as key journals in the field. The research subject is learning media in genetics courses. Data collected through the Scopus website, using the keywords "genetic," "learning," and "media," yielded 1,135 results, which were analyzed using R and Biblioshiny software. The trend in research on genetics learning media has increased year by year, with a sharp increase from 2017 to 2023. This result indicating that the research trend reached its peak in that year. The USA and China are the countries that contribute the most to publishing articles, suggesting potential for collaboration with various countries. The most active affiliation, with a total of 72 articles, is the University of California. The journal that contributes the most to genetics learning media is the Journal of Behavior Genetics. This research can serve as a reference for future researchers interested in studying genetics learning media, with the recommendation to combine multiple applications, such as Biblioshiny with Vosviewer, to ensure more precise and more valid findings. Additionally, using more specific keywords, such as e-modules, virtual reality (VR), augmented reality (AR), or game-based learning, is advised.

ARTICLE INFO

Keywords
Bibliometric, Biblioshiny, Genetic, Learning media, Scopus

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INTRODUCTION

The development of Science, Technology, Engineering and Mathematics (STEM) can serve as a forum to enhance the learning process carried out by educators, one of which is by utilizing learning media in Genetics lectures. The Genetics course discusses hereditary factors, various types of genetic material, their applications in life, and emphasizes mastery of how the genes of living things are expressed (Adelana et al., 2021). The Genetics course aims to prepare students with the knowledge and skills needed to apply genetic concepts in research, industry, and technology development (Masrur et al., 2017; Mahrus et al., 2019; Khairani et al., 2024). Therefore, understanding the concepts in Genetics material is very important because the course is a prerequisite for taking other Biology courses such as Evolution, Cell and Molecular Biology, and Biotechnology (Prastyaningtias,

2022; Sukmawati & Permadani, 2022). However, Genetics is one of the courses considered difficult because it covers an extensive and complicated topic. Most of the material content is microscopic, comprising many terms that are difficult to understand, and it includes formulas and chemical reactions that are also challenging to comprehend, often leading to misconceptions (Sumampouw & Rengkuan, 2018; Wulandari et al., 2021; Daulay et al., 2020; Ginting & Gultom, 2021). Ideally, concepts in genetics should be presented comprehensively, with explicit clarification of the interrelationship among them (Roini & Sundari, 2019).

Based on the results of surveys and interviews with Genetics lecturers at Sebelas Maret University (UNS), the Genetics course is considered difficult, especially the material on protein synthesis and metabolism, because the subject matter is microscopic, requiring teaching materials and learning media that can make it easier for students to understand the material. In addition, the textbooks used only contain static images, which often lead to misconceptions (Rengkuan, 2020; Putri et al., 2024; Kadirhanogullari & Kose, 2024). The results of research conducted by Hariyadi (2018) and Smith & Knight (2012) show that students have misconceptions about DNA material, which are concepts inherited from junior high school and high school. A recent study conducted by Garofalo (2025) regarding the conceptual understanding of DNA molecules in the early stages of learning suggests that accurate and precise information is necessary at the beginning of learning to prevent misconceptions and errors that could have consequences later on. DNA is a crucial subject to study because it provides insight into how genetic material is stored and passed down from one generation to the next (Adrianto et al., 2025). These conditions make lectures less optimal.

Therefore, genetics lectures require enhancement, one effective approach being the integration of interactive learning media such as teaching aids and contextual examples—utilizing resources like NCBI databases or personal genome data analysis. These tools can help visualize microscopic and abstract concepts, thereby improving comprehension, fostering interest and motivation, and promoting greater student engagement in the learning process (Pendong et al., 2024; Alfionora et al., 2022; Rahmawati et al., 2022; Septiani et al., 2024; Rahmatika et al., 2017; Weber et al., 2015; Musdalifa, 2022). In addition, based on the interview results, it was also found that lecturers expect innovative digital-based teaching materials and learning media that can enhance critical thinking skills and other skills that support 21st-century learning. Examples of digital-based learning media include gamification, mobile learning, AR, VR, LMS, websites, digital game-based learning, and social media (Solihat et al., 2024; Safitri & Rakhmawati, 2024; Ristanto et al., 2022; Aladesusi et al., 2021; Mesra et al., 2022).

Research on technology-based learning media has been widely published in both national and international journals (Saputra et al., 2023). Research on bibliometric analysis on the topic of genetics has been conducted by Zhang and Fan (2022), Kumaragurupari and Mishra (2022), Tao *et* al. (2023), Frias-De-Diego et al. (2021), Klein et al. (2021), Zhou et al. (2018), and Zhang et al. (2021). However, some of these studies still have shortcomings including the period of research that only focuses on the years above 2000-2021, genetic studies that are more specific to retinal genetic diseases, the effect of the main genes on the level of meat tenderness, research on genetics and hot spots of sleep phenomena, genomes and genes, compounds related to Sialidase-1, genetic expression, and genetic damage.

Based on the background described, there has been no prior research specifically focused on a bibliometric analysis of the development of genetics learning media to date. The novelty of this research lies in its focus on genetics learning media, including the development of studies and recommendations for further research related to genetics learning media. A bibliometric analysis of learning media that supports genetics education is essential, as it relates to the benefits of teaching media as a means of conveying information (Manohar et al., 2015). The aim of this study is to analyze the trend of research on genetics learning media from 1968 to 2024, including the number and distribution of publications, countries and affiliations, and contributing journals.

METHOD

This research employs the Scientometrics approach, utilizing the R Bibliometrix (*Biblioshiny*) software and the Scopus database. This approach can produce an actual and specific mapping of the development of scientific studies based on a systematic literature review, evaluating the quality and significance of research documented in scientific journals (Rusliana et al., 2022; Sumara et al., 2024). *Biblioshiny* is "R" and "RStudio" programming software for interactive bibliometric analysis that presents data in the form of current trends in relevant literature, providing an overview of the development of the most words, word frequencies, and thematic maps that are not described in other analysis approaches (Evi et al., 2023; R. Wulandari & Lamopia, 2024; Fahruri, 2024). Data analysis is carried out by interpreting bibliometric data in the form of visualizations of images and diagrams to identify trends, patterns, and potential relevance to the research conducted by researchers (Kusmahardhika et al., 2024). On September 27, we determined the search keywords on the Scopus website. The literature search was performed using the keywords "genetic," "learning," and "media," which were then limited to articles only, resulting in a total of 1,135 articles. The results of the data search are then stored in CSV format, which contains all essential article details such as research title, author and co-author names, abstract, keywords, and references (Abdullah, 2022). The data was then imported into the bibliometric application, and data analysis was conducted.

RESULTS AND DISCUSSION

Main Information of Genetic Media Learning Research

The data obtained from the Scopus website were then analyzed using *Biblioshiny*, providing information about genetics learning media from 1968 to 2024. The main details, consisting of document type, average scientific publication, citation, and author, are shown in Figure 1.

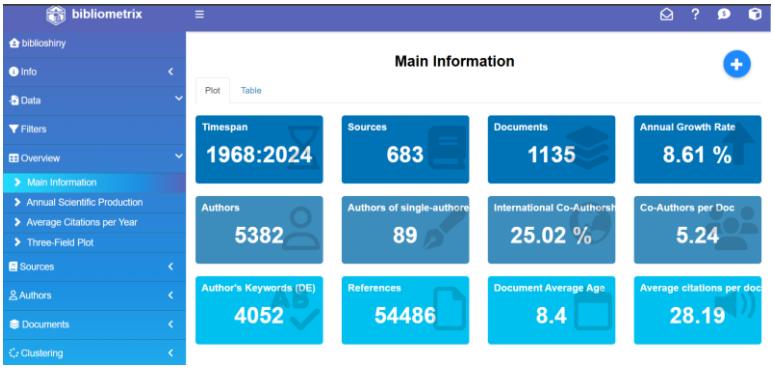

Figure 1. Main information related to genetics learning media research from 1968 to 2024

Article Distribution Based on Year of Publication

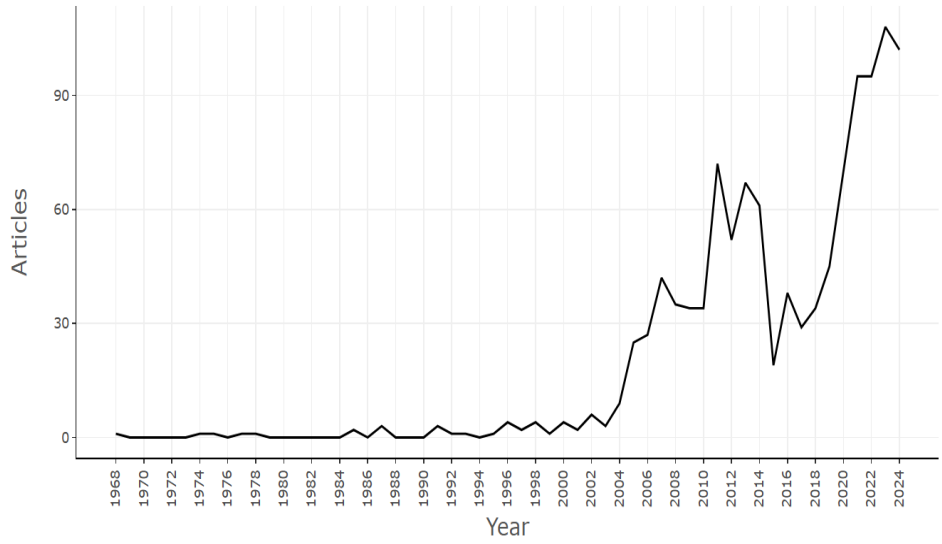

Figure 2. Publication trends related to genetics learning media from 1968 to 2024

Based on Figure 2, the trend of publications related to genetics learning media from year to year shows an increasing trend, with a sharp increase from 2017 to 2023. As of 2024, the data collection process in this study was carried out in September 2024, and therefore, the current year is not yet reflected in the data. This increasing publication trend suggests that research on genetics learning media remains a topic of interest for discussion, particularly concerning the COVID-19 pandemic, which is also closely tied to genetics. The large number of publications is partly due to the influence of the COVID-19 pandemic, where people started working from home (WFH) and began conducting various research, especially those related to genes. The COVID-19 pandemic has increased the creativity of lecturers in teaching lecture material, supporting lectures by utilizing technology or e-learning media (Pranata, 2022). This trend is in line with Kristanti (2022), who found that productivity performance related to scientific publications and citations during WFH increased significantly, namely by 290%. With the implementation of WFH, various activities and work are carried out online through video conferences. WFH also facilitates schools to conduct distance learning that utilizes technology (Lestari et al., 2023; Ali, 2022; Pratama et al., 2020). WFH is more effective for reading literature, analyzing data, and working on manuscripts (Aczel et al., 2021). WFH is also effective in improving teachers' performance in writing scientific papers (Arianto et al., 2021). It turns out that WFH is not a new concept, as it was first introduced in the 1970s and has many positive aspects, such as flexibility, greater effectiveness, cost savings, and reduced stress and fatigue levels (Jonathan & Dewi, 2023; Febrita & Prasojo, 2023).

Country Analysis

Based on Figure 3, research collaboration on genetics learning media involves various countries, which are divided into two types of articles: MCP and SCP. A Multiple Country Publication (MCP) occurs when authors from different countries collaborate, whereas a Single Country Publication (SCP) involves authors from the same country. According to Yuliyanto et al. (2023), an MCP can represent collaboration between countries, (Yuliyanto et al., 2023). The most collaborative publications between authors come from the United States, followed by China, the United Kingdom,

and India. The dominance of scientific publications by the United States and China is not surprising, as both countries are home to numerous leading institution that heavily invest in research infrastructure and digital technology development. Their prominent role in generating scholarly output presents significant opportunities for international collaboration with institutions across the globe (Judijanto et al., 2024).

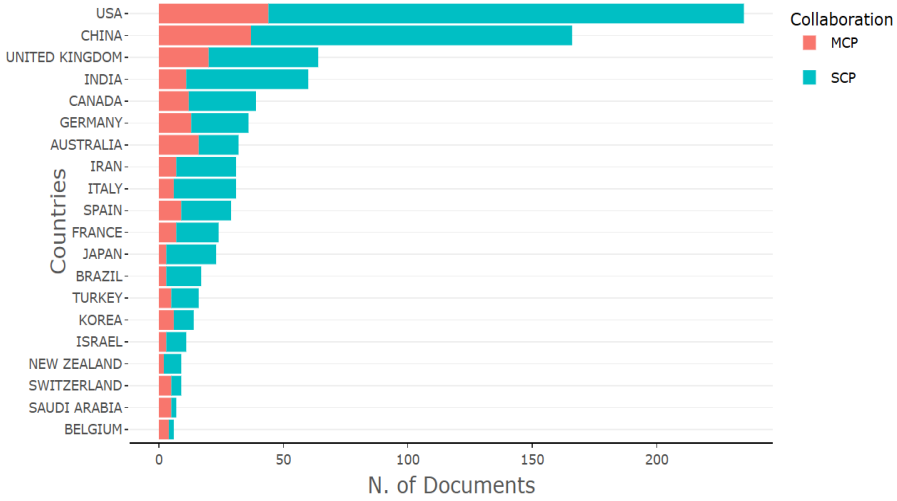

Figure 3. Top 20 correspondence author collaborations by country

Affiliations Analysis

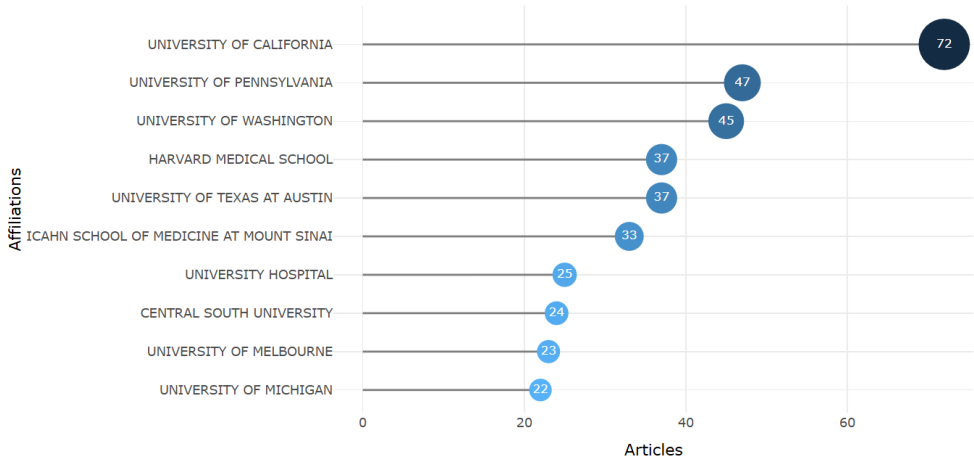

Figure 4. Top 10 affiliations of authors of articles related to genetics learning media

Figure 4 indicates that the top 10 affiliations are most active in publications on genetic learning media. The most active affiliation, with a total of 72 articles, is the University of California. Then followed the University of Pennsylvania with 47 articles and the University of Washington with 45 articles. The university that produces the fewest publications is the University of Michigan, with a total of 22 articles. The involvement indicates a significant contribution from these 10 affiliates (Zafrullah et al., 2024). In addition, among the top 10 affiliates, there are two universities that hold the most significant endowment funds as of the end of 2020, namely the University of Pennsylvania and the University of Michigan. Endowment funds are one of the strategies in managing assets in advanced world-class universities. The endowment fund at the University of Michigan ranks ninth among all American universities and third among public universities, with a focus on providing

financial support for university operations on: (1) scholarships (22%); (2) dedicated to Michigan Medicine (20%); and (3) the rest for educational programs, research, and professor performance support (Slamet et al., 2022). This result shows that although the University of Michigan occupies the 10th position, it does not close the opportunity to establish research collaboration with the university. Analysis of the author's publication affiliation can serve as a reference for other researchers when writing further articles, facilitating cooperation between authors and other collaborations (Amin et al., 2023).

Journal Analysis

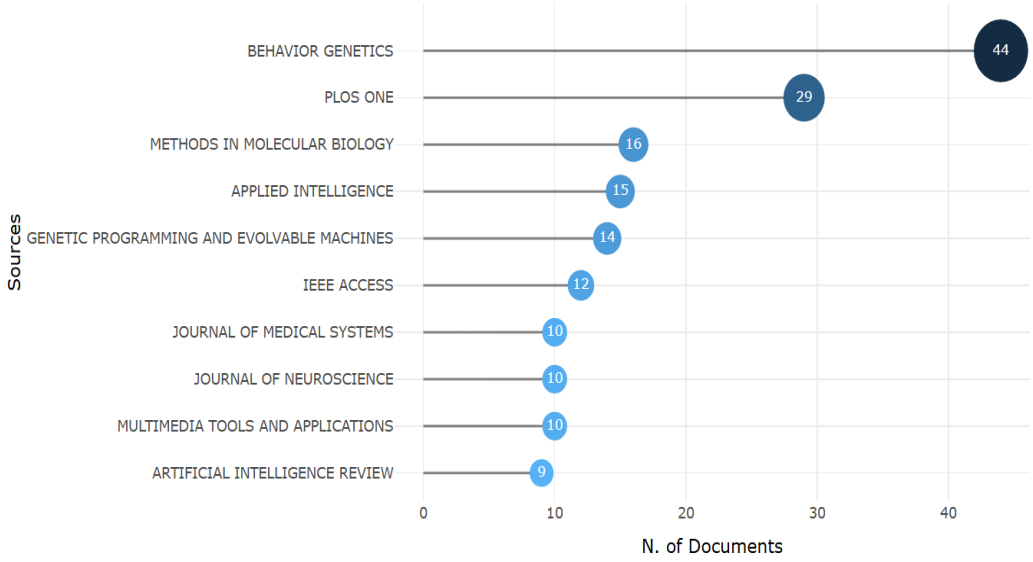

Figure 5. 10 Journals with the highest number of publications relevant to the topic of genetic learning media

Figure 5 shows the 10 journals that produced the most publications on genetics learning media and are relevant to the topic of genetics learning media during 1968-2024. The first rank is occupied by the Behavior Genetics journal, with 44 publications. The Behavior Genetics Journal is a journal that focuses on the genetics and evolution of behavioral characteristics, with a Scopus index of Q1. This journal serves as a reference for submitting articles in the future. The second rank is occupied by PLOS ONE, with the number of publications produced, namely 29 documents. PLOS ONE is known for its multidisciplinary research and is indexed by Q1 Scopus (Wardhana & Lawanda, 2024). The third rank is occupied by "Method in Molecular Biology," with 16 publications. Additionally, in the 6th rank is the IEEE Access journal, a multidisciplinary journal with a Scopus-indexed topic scope, classified as Q1. The 9th rank is occupied by the Multimedia Tools and Applications journal, which is the first international journal in the field of multimedia. This journal can be used as a reference for submitting articles related to multimedia.

CONCLUSION

The trend in research on genetics learning media has increased year by year, with a sharp increase from 2017 to 2023, indicating that the research trend reached its peak in that year. The USA and China are the countries that contribute the most to publishing articles, which suggests potential

for collaboration with various countries. The most active affiliation, with a total of 72 articles, is the University of California. The journal that contributes the most to genetics learning media is the Journal of Behavioral Genetics. This research can serve as a reference for future researchers interested in studying genetics learning media, with the recommendation to combine multiple applications, such as *Biblioshiny* with *Vosviewer*, to ensure more precise and more valid findings. Additionally, using more specific keywords, such as e-modules, virtual reality (VR), augmented reality (AR), or game-based learning, is advised.

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