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TRENDS AND MAPS OF RESEARCH COLLABORATION ON TEACHER DIGITAL LITERACY AND STUDENT DIGITAL CITIZENSHIP: BIBLIOMETRIC ANALYSIS

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ABSTRACT
This study aims to identify trends, main topics, and patterns of scientific collaboration in the study of teachers' digital literacy and students' digital citizenship. Using bibliometric methods, this study analyzed scientific publications obtained from the Scopus database during the period 2016–2025. The data collected includes information about titles, authors, year of publication, keywords, affiliations, and journal sources. The analysis was conducted using VOSviewer software to map collaboration networks between researchers and between countries, as well as identify keywords that frequently appear in related publications. The results of the study show that teachers' digital literacy is a topic that has experienced a significant increase, especially since 2020, in line with the increasing need for digital learning during the pandemic. Meanwhile, studies on student digital citizenship are still relatively few but show a steady upward trend. The most frequently appearing keywords include "digital literacy", "digital citizenship", "teachers", "students", and "digital competence". Collaboration between countries is dominated by the United States, followed by countries such as the United Kingdom, Canada, China, and Australia. Indonesia began to engage in collaborative networks, albeit on a limited scale. This study provides a comprehensive overview of the direction and development of research, as well as identifying opportunities for further study in the field of digital literacy and digital citizenship in the context of education.

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INTRODUCTIONS

In the midst of the development of the digital era, information and communication technology has become an essential element that is integrated in various lines of life, including the educational process (Arifin, 2025). These advances encourage all components of education to adapt, especially educators and students (M. Amalia et al., 2024; Hulu et al., 2025; R. E. Putri & Hadi, 2025). The role of teachers is no longer limited to delivering materials, but also includes assisting students in utilizing technology appropriately, safely, and responsibly (Sihombing et al., 2024). In this context, two interrelated ideas, namely digital literacy and digital citizenship, have an important position.

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Digital literacy refers to the ability of individuals to access, assess, manage, and produce information through the use of digital technology (Herlina & Purwanti, 2025). These capabilities span a broad spectrum, from operational skills to critical thinking capacity for information circulating in the digital space (Waroh et al., 2025). In the realm of education, teachers with good digital literacy are better able to utilize technology to improve the quality of learning and guide students to adapt to a dynamic and challenging digital environment (Rodhiyana, 2025).

On the other hand, digital citizenship refers to the ability to use technology responsibly, ethically, and safely (Madani et al., 2025). This concept includes an understanding of rights and obligations in the digital space, awareness of media ethics, protection of personal information, and the ability to communicate politely when interacting in an online environment (A. R. Amalia et al., 2025). As a generation that is familiar with technology, students need to receive adequate coaching so that they are not only skilled in technical aspects, but also have social and ethical sensitivity when doing activities in cyberspace (Luhukay et al., 2024).

The relationship between the digital literacy of teachers and the formation of digital citizenship in students is increasingly worthy of being the focus of the study. Teachers with good digital competence are not only able to utilize technology in the learning process, but also act as role models and facilitators in instilling digital citizenship values (Zaskia et al., 2025). Therefore, strengthening digital literacy in teachers has the potential to make an indirect contribution to the development of students' character in the digital space (Egok, 2024).

Although many studies on digital literacy and digital citizenship have been conducted, research that specifically maps the development and trends of research related to the relationship between the two in the global scope is still limited. This condition shows the need for an approach that is able to present a comprehensive picture of the direction of the development of scientific studies in this field.

This study applies bibliometric methods to examine trends, publication patterns, and scientific collaboration networks related to the topics of digital literacy in teachers and digital citizenship in students. The bibliometric method is a quantitative approach used to analyze scientific publications based on bibliographic data, such as the number of publications, citations, the use of keywords, and relationships between authors (A. R. Putri et al., 2025). Through this analysis, it is hoped that an overview of the direction of research development, potential study gaps (Research gap), as well as the basis for the development of advanced research in the field of digital education.

By conducting a bibliometric analysis of publications over the past ten years, this study aims to answer important questions such as: What is the trend of research publications regarding teachers' digital literacy from year to year? What are the key words or topics that often appear in research on teachers' digital literacy and students' digital citizenship? and What is the pattern of collaboration between countries in this study?

RESEARCH METHOD

This study is a quantitative study with a non-experimental approach that utilizes bibliometric methods. This study aims to examine the trends and developments of scientific studies on digital literacy in teachers and digital citizenship in students. Bibliometric methods, as described by Nurhudha & Safii (2024) is a quantitative approach used to analyze scientific publication data. In line with that, Yan & Zhiping (2023) states that bibliometrics processes bibliographic information, such as titles, author names, keywords, number of citations, and publication sources, in order to trace the development of a topic, identify parties who are actively researching, and see the connections between studies. This approach was chosen because according to Ananda et al. (2025) Bibliometrics can provide a comprehensive overview of scientific publication patterns, collaboration between authors, the distribution of the main themes of research, and the influence of a work through the number of citations and keyword linkage.

This research utilizes data sourced from Scopus, one of the scientific databases that is widely recognized for containing publications from various disciplines and has a strong reputation in the academic realm (Ariyatun et al., 2024; Takahashi et al., 2023; Tan, 2024). The search was carried out systematically on scientific articles published in the range of 2016 to 2025. The selection of the period is intended to describe the development and trends of research in the last ten years. This fairly long time span is considered adequate to trace the dynamics of changes in studies related to digital literacy in teachers and digital citizenship in students, both in terms of the number of publications,

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theme focus, and patterns of collaborative research. The determination of the criteria for the year also aims to capture the relevance of issues that develop in the context of digital education, especially those related to the role of teachers in shaping the character and digital competence of students in the midst of technological advances. Thus, the data collected is expected to be able to provide a comprehensive and up-to-date picture of the direction and trends of research in this field.

The keywords in this study were chosen to reflect two main focuses, namely digital literacy for teachers and digital citizenship for students. The selection was carefully made to include terms that were commonly used in previous research and were relevant to the topic. Some of the key keywords used include "Digital literacy", "Teacher", "Digital competence", "Digital Citizenship", "student"and "Education". These words represent important concepts related to teachers' digital abilities and the role of students in the digital environment. The search is done in the Scopus database by focusing on the title, abstract, and keyword sections (TITLE-ABS-KEY). In this process, keyword combinations with Boolean OR operators are used to expand the search results. The OR operator allows the system to display articles that contain one of several terms that have similar or interrelated meanings (Muhammad & Elmawati, 2023). In this case, a combination such as "digital literacy" OR "digital competence" OR "teacher" OR "student" OR "learner" OR "digital citizenship" OR "education" to capture as many articles as possible relevant to the topic of digital literacy for teachers and students' digital citizenship. This approach helps researchers obtain a wider range of data, which is then further analyzed using bibliometric methods.

The initial step in data analysis is to download metadata from Scopus in CSV format, which contains information such as article title, author name, institution affiliation, year of publication, keywords, number of citations, and journal name. This data was then analyzed using the VOSviewer software, which is used to map the network of collaboration between authors (co-authorship), the relationship between keywords (co-occurrence), as well as citation patterns between articles (Citation Analysis) (Setiawati et al., 2024). Through this analysis, it can be identified the research trends, authors and institutions that contribute the most, as well as the main themes that often appear in research related to digital literacy and digital citizenship in the field of education. The articles analyzed included journal articles, proceedings articles, and literature review articles written in English, relevant to the research topic, and having complete bibliographic data. Articles that are irrelevant, incomplete, or use languages other than English are excluded from the analysis.

RESULT AND DISCUSSIONS

1. Research Publication Trends on Teacher Digital Literacy and Digital Citizenship of Students from Year to Year

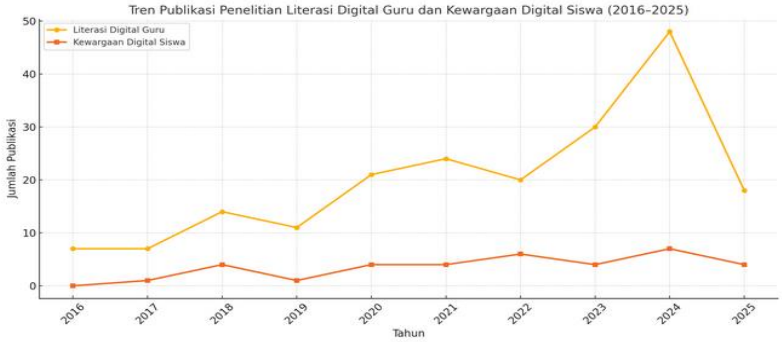

Figure 1. Publication Trends for Teacher Digital Literacy Research and Student Digital Citizenship (2016-2025)

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Based on a bibliometric analysis of publication data from 2016 to 2025, it can be seen that the number of studies focusing on teachers' digital literacy shows a significant increasing trend. In 2016 and 2017, only 7 publications were recorded each. However, the figure began to increase gradually from 2018 and peaked in 2024 with a total of 48 publications, before declining again to 18 publications in 2025. The sharp increase since 2020 is most likely influenced by the transition of the education system to the digital realm as a result of the COVID-19 pandemic. Teachers as the main actors in the learning process are required to master digital technology, thus encouraging many researchers to explore digital literacy issues in the context of teacher professionalism. This trend shows that teachers' digital literacy is becoming an increasingly strategic topic and receives wide attention in the field of digital education.

Meanwhile, the number of publications highlighting the topic of student digital citizenship has tended to be relatively low over the past decade. From 2016 to 2025, publications in this field have never exceeded 7 per year. The peak was recorded in 2024 with 7 publications. Although this number is relatively small compared to teachers' digital literacy, the emerging trend indicates a slow but steady growth in research interest. This shows that the issue of student digital citizenship is still not the main focus in academic discourse, although the importance of students' understanding of digital rights, responsibilities, and ethics is increasingly relevant in the midst of technological developments and social media. Thus, students' digital citizenship is an area that still has great opportunities for further research.

2. Keywords or Main Topics that Often Appear in Research on Teacher Digital Literacy and Digital Citizenship Students

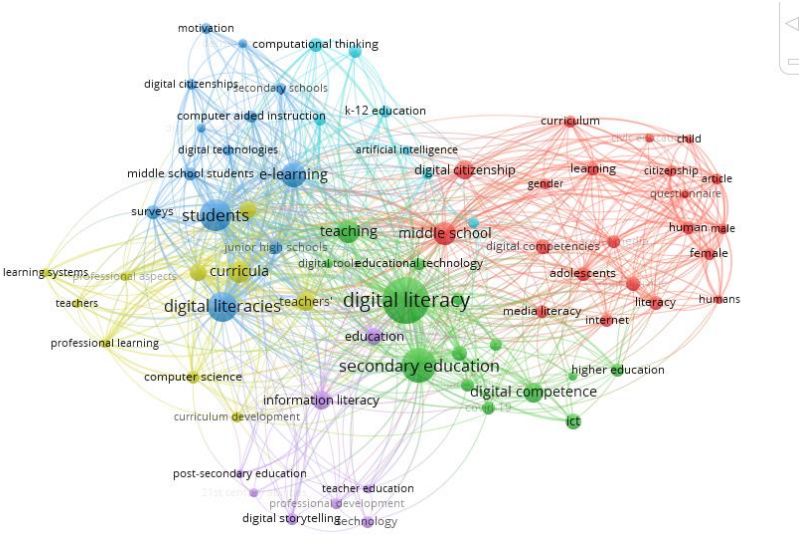

Figure 2. Frequently Appearing Keyword Relationship Patterns

Based on the results of visual mapping using VOSviewer (Figure 2), a number of dominant keywords were found that often appeared and were interrelated in the studies analyzed. High-frequency keywords include: "digital literacy," "digital citizenship," "students," "teachers," "digital competence," "secondary education," and "media literacy." These keywords are the core of academic discourse on digital literacy and digital citizenship in the context of education.

The visualization of the keyword network forms four main clusters that each represent adjacent research topics:

1. Cluster 1 (Red): Digital citizenship and Student Online Behavior
   The cluster is centered around the keyword "digital citizenship" and includes terms such as "media literacy," "adolescents," "gender," "internet," and "learning." Topics in this cluster focus on the formation of students' character and ethics in using digital media, as well as social issues such as gender differences and media literacy.

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2. Cluster 2 (Green): Teacher Digital Literacy and Competency
   The cluster centers on "digital literacy," "digital competence," and "ICT." These topics are closely related to teachers' competence in integrating technology in the learning process as well as teachers' professional development to meet the demands of the 21st century.
3. Cluster 3 (Blue): Implementation of ICT in Student Learning
   This cluster consists of keywords such as "students," "e-learning," "computational thinking," and "K-12 education." The main focus is on the utilization of technology by students and its role in digital learning in secondary schools.
4. Cluster 4 (Yellow): Curriculum and Digital Learning System
   Topics in this cluster include "curricula," "learning systems," "professional learning," and "curriculum development." This shows the importance of developing a curriculum and learning system that supports digital literacy.

   In addition to these four clusters, the keyword "digital literacy" appears to be at the center of the network, showing its role as the main hub (link) between various research themes, both related to teachers and students. This shows that digital literacy is an umbrella topic that covers various aspects in digital education.

3. Patterns of Collaboration Between Countries in Research

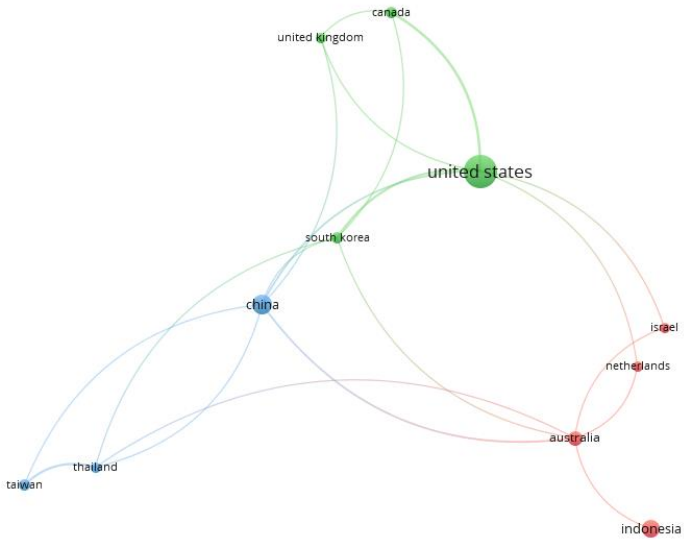

Figure 3. Patterns of Collaboration Between Countries in Research

Visualization of collaboration networks between countries indicates the formation of several interconnected collaborative clusters, based on the intensity and frequency of joint publications. In the resulting visualization, the United States emerged as the dominant actor with the largest nodes and the most number of connections compared to any other country. The central position of the United States reflects its role as a center for the production and dissemination of global knowledge in this field. The country has close collaborative relationships with countries such as Canada, the United Kingdom, South Korea, and Australia, which are also among the countries with significant contributions to digital education research. In addition, it was found that there is a regional cluster consisting of China, Thailand, and Taiwan, with China as the center of collaboration. This cluster illustrates the tendency of intra-regional collaboration in the East and Southeast Asia regions. China appears to be actively cooperating with its neighbors, which supports strengthening research in the Asian region.

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Australia occupies a strategic position as a link between countries from various clusters. The country is connected not only with the United States and European countries such as the Netherlands and Israel, but also collaborates with Indonesia, which in this context is the only developing country in the Southeast Asian region that appears in the visualization. Although the scale of Indonesia's collaboration is still limited, its emergence in this collaborative network is a positive indicator of the participation of developing countries in global research in the field of digital literacy.

Other countries such as Israel and the Netherlands are also seen in the network, although their contribution is not as large as that of major countries. Their presence is more selective and specific in a specific topic, adding color to the map of global collaboration.

Overall, this visualization shows that the pattern of collaboration in digital literacy and digital citizenship research is still dominated by developed countries, both in the number of publications and the intensity of cooperation. However, there are positive indications that developing countries such as Indonesia are starting to actively build international collaboration, especially with countries that have similar concerns about digital transformation in education

CONCLUSION

Based on the results of bibliometric analysis of publications in the period 2016 to 2025, it can be concluded that teachers' digital literacy has become the main focus in academic discourse in the field of digital education. The significant increase in the number of publications, especially since 2020, shows that this issue is getting more and more attention, along with the change in the educational paradigm towards digitalization. In contrast, the topic of student digital citizenship still shows a limited number of publications, although it is starting to grow slowly.

Keyword analysis revealed that "digital literacy" is the most dominant term and is central to the mapping of research themes. Other topics such as "digital competence", "media literacy", and "digital citizenship" also frequently appear and form four major clusters, each of which describes the focus of the study on teacher competence, students' digital behavior, learning curriculum, and the use of technology in education.

In terms of scientific collaboration, the United States emerged as the country with the most extensive contributions and collaborative networks. Collaboration also appears to be strong among other developed countries such as the UK, Canada, and Australia, while developing countries such as Indonesia are starting to show their involvement, particularly in cooperation with Australia.

In general, this study shows that the topic of teachers' digital literacy and students' digital citizenship has high relevance in the current educational context. However, more research is needed, especially in the aspect of student digital citizenship, as well as increased collaboration from developing countries so that the study of digital education becomes more inclusive globally.

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