

Bibliometric Analysis of Digital Learning in Writing Skills

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ABSTRACT

The application of digital media in education has completely changed the way students develop writing skills. However, understanding of global research trends in this field is still limited. Therefore, this study aims to address the gap by mapping the scientific landscape of digital media use in improving writing skills. This study uses bibliometric analysis and visualization methods. Data were obtained from the Scopus database. Data analysis utilized VOSviewer, Publish or Perish, and Microsoft Excel software to identify publication trends, geographical distribution, relationships between countries, journal distribution, research focus, and citation trends. There are 116 publications from 2016 to 2025 that meet the criteria. The research results show the highest increase in publications in 2025 with 51 articles. The United States has the highest volume of publications and international collaborations. The most influential publication source is the work of M.M Naeuman (2018). The Journal of Education and Information Technology is one of the most frequently cited publications. The research focus indicates that the most frequently occurring keywords are "teacher," "education," "teaching," "digital tools," "professional development," "leadership," and "collaboration," which highlights the main focus of the research. Overall, this research provides a comprehensive overview of the development, influential contributors, and research directions in this field.

Keywords: *Anlyze, Digital, Skill, Technology, Writing.*

1. INTRODUCTION

The teaching and learning process is an interactive communication process carried out to achieve predetermined goals (Ansoriyah, 2020). One important goal of learning is to produce individuals who can convey their ideas, both orally and in writing, with good structure and logic. That ability is closely linked to language skills. According to Permendikbud No. 24 of 2016 regarding Core Competencies and Basic Competencies for 2013, there are four aspects of language skills: speaking, listening, reading, and writing (Situmorang, 2018). Although all four components have equal importance, most students experience difficulties in writing ability (Zulkarnaini, 2011) as cited in (Suprayogi et al., 2021). More than that, a survey of Indonesian language teachers showed that the least favorite Indonesian language lesson for both teachers and students is writing instruction. In fact, language skills are one of the essential requirements in today's industry (Suprayogi & Budi Eko, 2020)

Language is never separate from human social life. Language allows humans to communicate effectively and convey ideas, thoughts, and information (Hoerudin, 2023). As social beings, language skills are an important aspect that every individual needs to

possess. By mastering language skills, the quality of communication will improve, making social interactions more effective. According to (Sihombing et al., 2024) define language skills as the ability to use language effectively and accurately, both orally and in writing. Students' language skills can be improved thru various literacy activities integrated with subjects, as literacy provides opportunities for students to hone their language skills more deeply. Increased literacy activity has a positive impact on improving the four language skills: reading, speaking, listening, and writing (Sulatra et al., 2021). The literacy movement can be implemented in various subjects relevant to the curriculum (Najwa, 2018).

Writing has always been the most difficult part of classroom learning (Yunus et al., 2019). Previous research indicates that only 0.8% of the total respondents are interested in writing. However, in the current situation, it is important for every individual to be able to express their thoughts and feelings in writing. Additionally, having good writing skills will positively strengthen the character and potential of Indonesia's human resources. For this reason, writing instruction should be developed from primary education (Astutik et al., 2021; Munajah et al., 2022). Writing instruction needs to receive attention and directed guidance from an educator so that when students encounter difficulties, the educator can provide direction.

Learning media can help educators in the process of delivering material so that it is easier for students to understand (Ulfah et al., 2023). Educators can utilize various types of learning media as needed. One of the learning media widely used in the Merdeka Curriculum is technology-based learning media, including digital learning media. Digital learning media is learning media that uses digital devices because its utilization requires digital data to produce digital images that can be processed, accessed, and distributed. By utilizing digital learning media, learning objectives are expected to be achieved optimally with an effective and efficient process (Ulfah et al., 2023). The use of digital-based media is more effective than other media or traditional education channels because information can be seen, heard, and carried out. In this case, the researcher will develop language learning, specifically aspects of writing stories for lower-grade students in elementary schools (Munajah et al., 2022). Information and communication technology must be utilized as a tool for storing information and publishing various content that can be accessed by the international community. Every journal published must be responsible for the content and authenticity of its content. This indicates that writing skills and proficiency in using ICT (Information and Communication Technology) are closely interconnected in the 21st century. Writing is also a process of critical and creative thinking, as it involves analysis in choosing the right words and developing new ideas. Therefore, it is important for education to pay special attention to developing technology-supported writing skills (Saputra et al., 2021).

The rapid development of digital media in education has fundamentally changed how students develop their writing skills, even though digital technology has become widely used in various aspects. Understanding of research trends related to the use of digital tools in developing narrative writing skills is still limited.

Research related to digital media in writing instruction has been widely conducted. Consequently, a study that looks at these studies' findings is required. One technique that can be applied is bibliometric analysis. Research findings in particular domains, like education, can be examined using bibliometric analysis (Muhammad et al., 2022; Sanusi et al., n.d.; Triansyah & Supardi, 2023). The following are the goals of this study: 1) To document the state of research on digital tools for improving writing abilities between 2016 and 2025. 2) To determine the most recent publication and citation patterns pertaining to the use of digital technologies for improving writing abilities. 3) To ascertain patterns of relationships between nations and the geographic distribution of publications. 4) To determine the most cited papers and the area of study.

2. METHODOLOGY

2.1. Research Design

The methodical gathering, measurement, and analysis of data in accordance with the research topic is made possible by the bibliometric analysis strategy used in this study (Muhammad et al., 2022). Important techniques are used in bibliometric research to analyze publications on particular topics both statistically and qualitatively (Abouzid et al., 2021). The bibliometric visualization approach is used in this work. The structural overview of a particular topic of study is displayed using the bibliometric visualization method (Garfield, 2009) in (Sanusi et al., 2023). Both bibliometric analysis and bibliometric visualization are used in this study.

2.2. Participants of the Study

Identification, screening, eligibility, and inclusion are some of the steps in the data gathering process (Siregar et al., 2023). According to (Moher et al., 2009) in (Muhammad et al., 2023), a number of procedures must be completed in order to refine data collecting, including: 1) identification; 2) screening; 3) eligibility; and 4) inclusion. Entering the relevant keywords into the Scopus database allowed for identification. The study's keywords were "Digital tools" and "Writing skill development." The researcher found 259 papers that satisfied the requirements as a result of this procedure. After that, the researcher used the following standards to filter the publications: 1) Publications must be written in English; 2) They must be articles; 3) The researcher must have chosen publications from 2016 to 2025; 4) They must be of the document type; and 5) The source must be a journal. There were 116 publications that satisfied

these requirements. The documents' abstracts and titles were examined to see if they included digital learning in order to evaluate eligibility. Following this procedure, 116 papers that satisfied the predetermined standards were added to the subsequent phase.

The researcher employed a number of auxiliary programs, including Microsoft Excel, VOSviewer, and Harzing's Publish or Perish software, to analyze the data. The purpose of the analysis was to provide answers to the research questions. The resulting data was then saved in RIS and CSV format. RIS data was used to view publication trends and citation trends using Harzing's Publish or Perish software. CSV data was used to view the geographical distribution mapping, patterns of international collaboration, and research focus using the VOSviewer application. Publication trends were viewed based on the year of publication, displayed with the help of Microsoft Excel software. Citation trends were calculated from the highest number of citations. The geographical distribution mapping was displayed on a flat map to clearly show the distribution, with the help of Microsoft Excel software. The patterns of cooperation between countries are presented to show the relationships between them. The research focus was analyzed from the Network visualization and Overlay visualization displays. The novelty of the research can be seen from the interconnectedness of the keywords presented.

2.3. Research Subjects

The sample for this study consists of 116 publications obtained from digital data tools and writing skills.

2.4. Data Analysis Techniques

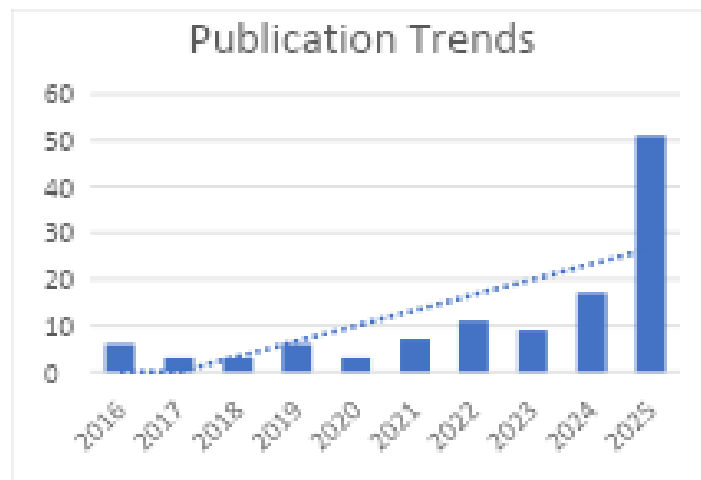
The data analysis technique used is deductive, starting from general findings and moving toward more specific ones, such as: publication trends, geographical distribution of publications, distribution of publication collaboration patterns, distribution of publication journals, citation trends of bibliographic pairs in publications, and co-occurrence of author keywords, so that readers follow the information provided from general to more specific (Ersozlu & Karakus, 2019).

3. RESULT AND DISCUSSION

3.1. Publication Trends

The review of publication years in bibliometric studies aims to understand the development of research related to a specific topic year by year. A search on Scopus using the keywords "digital learning" and "writing skills development" over the past 10 years found 116 articles. Based on Figure 1, the data trend for scientific publications

related to digital learning in writing skills indexed in Scopus shows a fairly fluctuating development.



Source: Data processing 2025

Figure 1. Development of Scopus Data Source Publication

In the early period of 2016 to 2025, the number of publications was still relatively low and stable, averaging only about 4-6 articles per year. From 2021 to 2023, there was a noticeable increase, with the number of articles reaching 7-9 publications per year. A significant increase was seen in 2024 with 17 articles or (14.29%), and this continued to increase in early 2025 with a total of 51 publications, equivalent to 47.62% of the total publications. This proves that research on technology-based learning in writing materials remains a topic of interest to many researchers to this day. The publication trend from year to year shows that research and publication activities have experienced very rapid development in the last two years. This increase is due to the growing interest in research, supported by institutional or academic encouragement in related fields.

3.2. Geographic Distribution

Figure 2 shows the trend in research productivity across 74 countries. Data shows that over the period from 2016 to 2025, the United States dominates in terms of the number of publications, with a total of 15 publications in 2025, followed by Saudi Arabia with 14 publications and Spain with 12 publications. Turkey had 11 publications and China had 10 publications. Countries with strong educational infrastructure, significant research funding, and a thriving academic tradition will produce more publications in reputable international journals. At the intermediate level, countries like Malaysia with 8 publications, Thailand, Indonesia, and Australia with 7 publications each, demonstrate active research. Indonesia is included in the productive group in Southeast Asia. Other countries with fewer publications, such as Zambia, Uzbekistan,

Moldova, Slovenia, and others, each produced 1 publication. Here are some public publications related to the keywords that have been set in several countries.

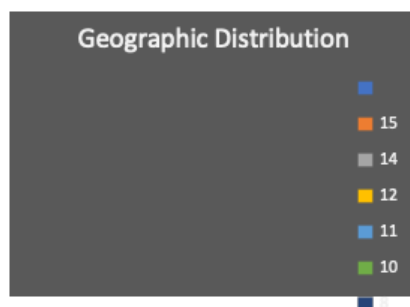


Figure 2. Geographic Distribution

The image above illustrates that the publications are distributed across the Americas, Asia, Europe, Africa, Australia, and almost all continents contribute to publications related to digital tools in writing skill development.

3.3. Relations in International Cooperation Patterns

The relationships between countries in this publication are shown in several color clusters, representing closely connected collaboration groups. Each color illustrates a different pattern of cooperation based on the intensity of the relationships between countries within a cluster. Here is an image of the relationship between countries in Figure 3.



Figure 3. Relations in International Cooperation Patterns

The red color cluster, centered on the American countries, illustrates the strong collaborative network between the United States, Canada, the United Kingdom, Turkey, Switzerland, and Australia. Thus, these countries have an intensive relationship with the United States as the main link for other countries. The yellow-green cluster is located around Middle Eastern and Western Asian countries, such as Saudi Arabia and the United Arab Emirates, both of which have strong collaborative relationships with countries like Australia and Hong Kong. Saudi Arabia's position as a network center in Western Asia and a component of a cross-continental network that connects to East Asia and Australia is highlighted by this pattern of collaboration. The green and blue

clusters, which include nations like Indonesia, Malaysia, and Spain, constitute an alliance between Asia, Europe, and Southeast Asia.

This indicates significant transregional collaboration. Overall, Figure 3 above shows that the pattern of international publication collaboration is not only centered on one continent or region, but forms a cross-continental network involving the Americas, Europe, the Middle East, Asia, and Australia. However, based on the network of international cooperation shown in this publication, it can be seen that the United States emerges as the largest and most connected hub. The United States is the most central country on the collaboration map, indicating the highest frequency and diversity of cooperation compared to other countries in the network presented.

3.4. Journal Distribution

Based on the search results using the keywords "digital tools" and "writing skill development" with the categories of article title, abstract, and keywords within the period of 2016 – 2025 on Scopus, 116 publications were obtained. The distribution results of the journals can be seen in Table 2 below.

Table 1. Distribution of Journals

Name of Journal	Document	Citation
Arab Word English Journal	3	0
Fronties in psychology	3	95
International journal of learning, teaching	2	0
Plos one	2	42
Reading and writing	3	8
Word journal of english language	3	4
Computer assisted language learning	4	120
Computers and education	4	355
Education and information tecnology	5	8
Educational process: international journal	2	28
Journal of computer assited learning	2	44
Medical writing	2	3
Sustainability (Switzerland)	2	4
Theory and practice in language	2	6

The articles included as part of the analyzed data and widely cited by other scientific articles are those published in the Journal Computers and Education and the journal Computer Assisted Language Learning, receiving 355 and 120 citations respectively. Meanwhile, journals that publish many articles related to digital learning in other writing skills include the Arab Word English Journal (3 documents, 0 citations), the journal Frontiers in Psychology (3 documents, 95 citations), the International Journal of Learning, Teaching (3 documents, 0 citations), Plos One (2 documents, 42 citations),

Reading and Writing (3 documents, 8 citations), Word Journal of English Language (3 documents, 4 citations), Education and Information Technology (3 documents, 4 citations), Education and Information Technology (5 documents, 8 citations), Educational Process: International Journal (2 documents, 8 citations), Journal of Computer Assisted Learning (2 documents, 44 citations), Medical Writing (2 documents, 3 citations), Sustainability (Switzerland) (2 documents, 4 citations), and Theory and Practice in Language (2 documents, 6 citations).

3.5. Research Focus

In the process of reviewing research trends on digital tools and writing skills development, the division of clusters in the diagram is crucial for identifying them (Mazov et al., 2021) in (Muharram et al., 2025). In network visualization, each keyword is represented by a colored circle. The size of the circle for a keyword is determined by the weight of each keyword. The higher the weight of an item, the larger the circle for that item (Pesta et al., 2018). By detecting phrases that exhibit notable shifts in their frequency over time, they can even reveal which study topics in a field are popular (or less so). The findings of keyword mapping employed by researchers in scientific papers about the growth of writing skills and digital technologies between 2016 and 2025 are displayed in Figure 4. Seven cluster sections are used out of the 116 articles that Scopus has indexed.

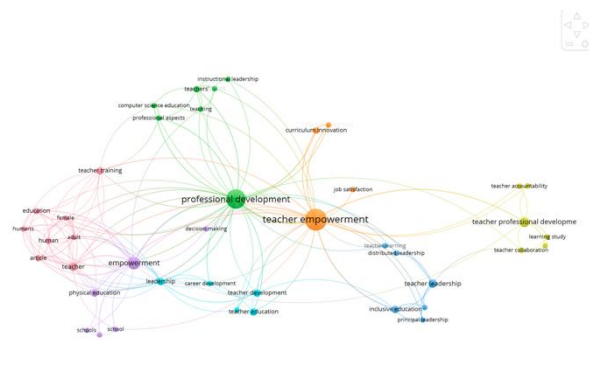


Figure 4. Research Focus

The connections between terms that exist in the literature pertaining to "digital tools" and "writing skills development" from scientific databases are depicted in the network visualization in Figure 5. Keywords are represented by nodes (circles) in the network visualization diagram, while connections to other scientific articles are shown by the lines that connect the nodes. 42 keywords in all are shown, divided into seven groups according to topic and research relationship.

Different colors are used to identify these clusters, which represent various yet related research areas. The first cluster, which has eight items and is red, highlights the elements of "adult, article, education, female, human, humans, teacher, teacher

training," suggesting that this subject is a major priority when it comes to using digital tools to improve writing abilities. The second cluster, which has seven components and focuses on "computer science education, professional aspects, teaching, teachers, teaching, and instructional leadership," shows how technology and teacher professional development are related. The third cluster, which has six items and is blue, focuses on the elements of "distributed leadership, inclusive education, principal leadership, relationship between leadership attributes, teacher leadership, teaching learning," suggesting that one of the key elements in the development of writing skills is a leadership approach. A collaborative and evaluative learning approach is highly relevant to the context of digital learning, as evidenced by the fourth cluster, which is yellow (6 items) and focuses on the elements of "learning study, teacher accountability, teacher collaboration, teacher evaluation, teacher professional development, and variation theory". The fifth cluster is purple (6 items) and focuses on the aspects of "decision making, empowerment, physical education, school, schools, teachers." This indicates that the school context and teacher empowerment are a major focus in developing writing skills. The sixth cluster is light blue (5 items), with the main focus on the aspects of "career development, challenges, leadership, teacher development, and teacher education." This indicates that teacher development is an important issue in the context of digital learning tools. The seventh cluster is orange (4 items), emphasizing the aspects of "chemistry teachers, curriculum innovation, job satisfaction, and teacher empowerment." This shows that innovation and teacher satisfaction are supporting factors in developing writing skills.

3.6. Quotation Trend

Table 2. Quotation Trend

Cites	Authors	Title	Year	Source
157	M.M. Neumann	Using tablets and apps to enhance emergent literacy skills in young children	2018	Early Childhood Research Quarterly
131	C. Williams, S. Beam	Technology and writing: Review of research	2019	Computers and Education
124	T. Asselborn, T. Gargot, Å. Kidzinski, W. Johal, D. Cohen, C. Jolly, P. Dillenbourg	Automated human-level diagnosis of dysgraphia using a consumer tablet	2018	npj Digital Medicine
111	S. Wollscheid, J. Sjaastad, T. T. mte	The impact of digital devices vs. Pen(cil) and paper on primary school students' writing skills - A research review	2016	Computers and Education

Cites	Authors	Title	Year	Source
105	K. Hava	Exploring the role of digital storytelling in student motivation and satisfaction in EFL education	2021	Computer Assisted Language Learning
105	M.M. Neumann, G. Finger, D.L. Neumann	A Conceptual Framework for Emergent Digital Literacy	2017	Early Childhood Education Journal
100	M.M. Neumann	Young children's use of touch screen tablets for writing and reading at home: Relationships with emergent literacy	2016	Computers and Education
73	K. Alexander, C. Savvidou, C. Alexander	Who Wrote This Essay? Detecting Ai-Generated Writing In Second Language Education In Higher Education	2023	Teaching English with Technology
60	J. Guilbert, D. Alamargot, M.-F. Morin	Handwriting on a tablet screen: Role of visual and proprioceptive feedback in the control of movement by children and adults	2019	Human Movement Science
57	C. Mayer, S. Wallner, N. Budde-Spengler, S. Braunert, P.A. Arndt, M. Kiefer	Literacy Training of Kindergarten Children With Pencil, Keyboard or Tablet Stylus: The Influence of the Writing Tool on Reading and Writing Performance at the Letter and Word Level	2020	Frontiers in Psychology

Articles with the keywords “digital tools” and “writing skill development” from 2016 to 2025 contain seven references that have been cited at least 100 times. The publication with the most citations is Neumann (2018) with the title “Using tablets and apps to enhance emergent literacy skills in young children,” which has been cited 157 times. Next, the second most cited publication is from (Williams & Beam, 2019) with the title “Technology and writing: Review of research,” which has been cited 131 times. The article "Automated human-level diagnosis of dysgraphia using a consumer tablet" by Asselborn et al. (2018) is the third most cited. With 111 citations, "The impact of digital devices vs. Pen(cil) and paper on primary school students' writing skills – A research review" by Wollscheid et al. (2016) is the fourth most cited publication. With 105 citations, Hava's (2021) paper "Exploring the role of digital storytelling in student motivation and satisfaction in EFL education" is the fifth most cited. With 105 citations, Neumann et al. (2017)'s "A Conceptual Framework for Emergent Digital Literacy" is the sixth most cited article. Neumann (2016), "Young children's use of touch screen tablets

for writing and reading at home: Relationships with emergent literacy," has received 100 citations, making it the seventh most referenced publication.

4. CONCLUSION

Based on the results of a bibliometric analysis conducted on the development of research and scientific publications related to digital tools in writing skills development, it was found that there was a significant increase in the number of publications examining this theory during the period 2016 to 2025. The year 2025 saw the highest number of publications, with 51. The study shows that authors from the United States are among those with the highest number of publications. Although the United States remains the country with the highest number of publications, researchers from Saudi Arabia experienced a sharp increase in their research productivity in 2023. The most frequently cited references in research and scientific publications related to digital tools and writing skill development are the works of Neumann (2018) and Williams & Beam (2019). Both are considered the main foundation in the development of digital tools in writing skills development, with many researchers referring to these works to build a further understanding of how the use of digital tools can improve writing skills development. In this case, these two articles are very important sources in the context of digital tools and writing skill development used in various disciplines. In addition, the journals that publish the most articles related to attribution theory are the journals Education and Information Technology, Computer Assisted Language Learning, and Computers and Education, which are the most cited journals among researchers writing about digital tools and writing skill development. This shows that digital tools are widely applied in educational research contexts.

From the keyword mapping, seven main clusters were identified that reflect various topics frequently discussed in research and publications related to digital tools and writing skill development. The first cluster consists of 8 items marked in red with the keywords "adult, article, education, female, human, humans, teacher, teacher training." The second cluster consists of seven items marked with green circles with the keywords "computer science education, professional aspects, teaching, teachers, teaching, and instructional leadership." The third cluster consists of six items marked with blue circles with the keywords "distributed leadership, inclusive education, principal leadership, relationship between leadership attributes, teacher leadership, teaching learning." The fourth cluster is marked with a yellow circle with the keywords "learning study, teacher accountability, teacher collaboration, teacher evaluation, teacher professional development, and variation theory." The fifth cluster consists of 6 items marked with a purple circle with the keywords "decision making, empowerment, physical education, school, schools, teachers." The sixth cluster consists of five items marked with a light blue circle with the keywords "career development, challenges,

leadership, teacher development, teacher education.” The sixth cluster consists of five items marked with bright blue circles with the keywords “career development, challenges, leadership, teacher development, teacher education.” The seventh cluster consists of four items marked with orange circles with the keywords “chemistry teachers, curriculum innovation, job satisfaction, and teacher empowerment.” Overall, the results of this analysis show that research in this area contributes to and broadens our understanding of effective ways to encourage the development of writing skills through technology. This encourages practical implications in strengthening teachers' digital competencies, adjusting the curriculum, and developing creative and inclusive writing learning strategies in line with the direction of global digital-based education development.

The practical implications of this article provide a broad overview of research trends and developments in scientific publications related to digital tools and writing skills in the period from 2016 to 2025. The main findings show, first, that the use of digital tools in the development of writing skills must be supported by comprehensive teacher training, especially in the context of inclusive education and instructional leadership. second, collaborative and evaluative approaches to learning are very important for improving students' writing skills, especially in a digital context. Third, curriculum innovation and teacher empowerment are key supporting factors in the development of writing skills, especially in the context of digital tools. However, there are several limitations that should be noted. First, this analysis only covers publications indexed in Scopus, which means that not all relevant journals are included in this study. This may limit the scope of the research, given the possibility that important publications are not listed in the database. Second, although bibliometric methods provide a useful quantitative overview, this study does not investigate in depth the methodological quality of each publication analyzed. Thus, despite the apparent trend, the quality and substantive impact of the research cannot yet be fully understood. Future studies should conduct longitudinal experiments testing digital tools' impact on diverse learner demographics, particularly in non-Western contexts beyond the U.S. and Saudi Arabia. Comparative analyses across clusters, such as integrating teacher leadership (Cluster 3) with professional development (Cluster 6), could explore causal mechanisms. Additionally, investigate underrepresented areas like AI-driven tools or inclusive strategies for neurodiverse students to address gaps in current keyword mappings and advance evidence-based curriculum reforms.

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