AKSIOMA: Jurnal Program Studi Pendidikan Matematika
Volume 14, No. 2, 2025, 637–649

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) RESEARCH TRENDS IN MATHEMATICS LEARNING

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Received 28 July 2023; Received in revised form 17 March 2024; Accepted 16 June 2025

Abstract

The emergence of ICT in teaching and learning has contributed to improving the quality of education, because teaching and learning is ultimately an active and interesting process linked to real-world situations. ICT can be integrated into all subjects outside of physical education, including language, comprehension, math, science, and environmental science. This research examines trends and identifies publications concerning ICT in Mathematics Learning by analyzing the most prolific document sources, rankings of institutions or universities, prominent journals and articles, as well as keyword usage. Utilizing data from the Dimensions database, a total of 390 documents were gathered through the Publish or Perish (PoP) application, consolidated into a single RIS file, and analyzed using the VOSviewer application to generate network and overlay visualizations.The findings reveal an increasing trend in publications on ICT in Mathematics Learning over the past five years, with Indonesia leading in the number of documents (66), "Guangxi Normal University" as the top institution, "Journal of Physics: Conference Series" as the most prominent journal, and the article by Lo et al. (2018) as a key reference. The keyword "ICT" is not commonly associated with other variables such as case studies or stems, presenting a gap that offers opportunities for future research in this area.

***Keywords**:* Bibliometrics, Mathematics, ICT

Abstrak

Penggunaan Teknologi Informasi dan Komunikasi (TIK) dalam pembelajaran telah berperan dalam meningkatkan kualitas pendidikan, menjadikan proses pembelajaran lebih aktif, menarik, dan relevan dengan situasi dunia nyata. TIK dapat diintegrasikan ke dalam berbagai mata pelajaran, seperti bahasa, pemahaman, matematika, sains, dan ilmu lingkungan, kecuali pendidikan jasmani. Penelitian ini mengeksplorasi tren dan mengidentifikasi publikasi terkait TIK dalam Pembelajaran Matematika melalui analisis jumlah dokumen terbanyak, peringkat institusi atau universitas, jurnal, dokumen, serta penggunaan kata kunci berdasarkan data dari basis data Dimensions. Dengan menggunakan analisis bibliometrik, 390 dokumen dikumpulkan melalui aplikasi Publish or Perish (PoP), dikompilasi ke dalam satu file RIS, dan dianalisis menggunakan aplikasi VOSviewer untuk menghasilkan visualisasi jaringan dan hamparan. Temuan menunjukkan adanya tren peningkatan publikasi tentang TIK dalam Pembelajaran Matematika selama lima tahun terakhir, dengan Indonesia memimpin dalam jumlah dokumen (66), "Guangxi Normal University" sebagai institusi teratas, "Journal of Physics: Conference Series" sebagai jurnal yang paling menonjol, dan artikel oleh Lo dkk. (2018) sebagai referensi utama. Kata kunci "TIK" tidak umum dikaitkan dengan variabel lain seperti studi kasus atau batang tubuh, menghadirkan celah yang menawarkan peluang untuk penelitian di masa depan di bidang ini.

Kata kunci: Bibliometrik, Matematika, TIK

ISSN 2089-8703 (Print)
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INTRODUCTION

ICT is one of the most advanced technologies used by millions of people around the world (Engelbrecht & Borba, 2024; Sharma, 2021). ICT has become a part of our lives over the past few decades, influencing both society and our personal lives (Alabdulaziz, 2021; Bhattacharjee & Deb, 2016; Drijvers & Sinclair, 2024; Har et al., 2019). ICT includes any electronic device or communication device, such as radio, television, cell phone, video camera, calculator, computer network, software and hardware, satellite system, service application, including video conferencing, online lectures, and education long distance (Egoeze et al., 2018; Muhammad et al., 2020; Singhavi et al., 2019). ICT is described as a technological center that facilitates the storage, processing, transmission and dissemination of data and information (Kaput et al., 2020).

The integration of ICT in education enhances its quality by making teaching and learning more engaging, active, and connected to real-world contexts (Cirneanu & Moldoveanu, 2024; Dahal et al., 2022; Kumbar et al., 2018). The benefits of ICT are demonstrated from various perspectives and have facilitated the learning process, as well as providing access to learning to anyone which creates a conducive environment, encourages the delivery of appropriate knowledge, and provides quick answers to a number of questions that teachers and students often have (Peace et al., 2020). By using ICT, teaching materials can be made in such a way as to facilitate students' understanding of the subject matter in a timely manner and allow for repetition (Supianti et al., 2019). ICT can be integrated into mathematics learning. ICT can be integrated into all subjects outside of physical education, including language, comprehension, mathematics, science and environmental science (Hassan, 2020; Verschaffel et al., 2019). ICT changes the process of teaching and learning mathematics by incorporating aspects of life into the educational environment in the classroom, including virtual ones (Das, 2019). ICT can be used in mathematics learning which can increase teaching effectiveness and offer new ways of thinking about mathematics (Radović et al., 2019; Sandi & Fernandy, 2022).

ICT research topics have gained popularity in recent years, this is in line with Batanero et al. (2020) that there is an increasing amount of literature related to ICT which has aroused interest in the subject matter. Figure 1 shows, according to the search results on the web dimensions database, the growing popularity of ICT-related research. There is a growth in interest in ICT-related research by 61 percent from 2017 to 2022. This research uses bibliometric analysis to examine ICT in mathematics learning and its research trends.

Bibliometrics is a methodology for identifying the most popular and influential publications on a particular topic (Zyoud et al., 2015). In bibliometric research, qualitative and quantitative indices such as publication year, affiliation, document type, country name, topic category, journal name, publisher language, collaboration, and citation patterns are used for data analysis (Zyoud et al., 2017). Over the years, bibliometrics has developed and become widespread in many domains to assess and map published ideas and information (Rana & Pragati, 2022; Zupic & Čater, 2015). Bibliometrics in education has not worked as well as

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ISSN 2442-5419 (Online)

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expected in terms of data collection and individualization (Marín et al., 2019). Thus, there is a need for research on education, particularly bibliometric studies on ICT in mathematics learning.

There are still many data sources other than Scopus that can be used in finding data sources. According to Moral-muñoz et al. (2020) and Singh et al. (2021) the main bibliographic databases used in bibliometric analysis are: Web of Science (WoS), Scopus, Google Scholar (GS), Microsoft Academic (MA) and Dimensions. Researchers use database dimensions in finding data sources. Dimensions is a new scholarly search database that focuses on the greater range of use cases that academics are now confronted with (Hook et al., 2018; Isaksson & Hakulinen, 2022).

Research related to this research, namely, research conducted by Hernández et al. (2017) which is about research trends related to ICT in the learning community using bibliometric analysis. Research results show steady growth since ICT studies were applied to teaching and learning models starting in the nineties, presenting a significant increase in interest in the subject in 2005 and the highest publication productivity in 2010 and 2011. Countries with the largest contributions to studies ICT in the context of learning is China, the US and Taiwan, leading the research process in the area. Furthermore, research conducted by Trinh Thi Phuong et al. (2022) shows that publications that appear mainly in the 1999–2020s range have been published in Scopus sources with a low citation index; Indonesia, Malaysia and Australia are the most influential countries in studies on this topic. From the results of these studies, there are already discussions about ICT trends in mathematics learning, only there are differences in the use of databases in searching for ICT-related publications, researchers use databases other than Scopus in searching for data sources, such as dimensions. The researcher also narrowed the range of publications related to ICT in mathematics learning, starting from 2017 – 2022. The purpose of this study was to identify public-cations related to ICT in mathematics learning and visualize them.

METHOD

This study analyzed research publications on ICT in mathematics learning from the Dimensions database over the past five years (2017–2022) using bibliometric analysis and visualization techniques with an evaluative and descriptive approach. The aim was to identify and describe publications related to ICT in mathematics learning. VOSviewer software was utilized to visualize and analyze collected publication data, including author names, publication years, and keywords. VOSviewer is a tool designed for creating network visualizations of frequently used terms in specific fields (Oyewola & Dada, 2022). There are five stages of research in bibliometric analysis, these five stages can be seen in Figure 2 (Dewi et al. 2021).

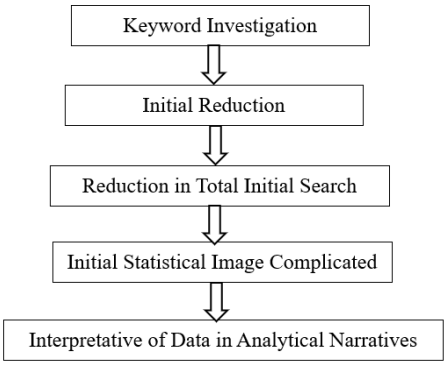

Figure 1. Stages of bibliometric analysis

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

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The bibliometric analysis process involves several stages. First, researchers conduct a keyword investigation by setting "ICT" and "mathematics learning" as the focus. Next, an initial reduction is performed, where these keywords are searched using the Google Scholar database through the Publish or Perish (PoP) application. This is followed by reducing the total initial search results by refining the data in the VOSviewer application to select relevant public-cations. The subsequent stage involves compiling initial statistical visuali-zations, where data is grouped into topic descriptions such as bibliographic pairs of institutions, journals, documents, and occurrences of author keywords. Finally, researchers interpret the data from the visualizations generated by VOSviewer, providing analytical narratives that can be further developed.

Search using web dimensions on October 22, 2022. The dimensions database was queried using the terms "ICT" and "mathematics learning" and the publication name and year of publication were "journal" and "2017-2022" respectively. The results data search yielded 390 journal articles, which were utilized as a sample of study based on research criteria; these papers were published in journals and linked to ICT in mathematics learning. The data is stored as CSV for usage in the VOSviewer application. VOSviewer is used to map scientific publishing trends based on bibliographic pairings of organizations, journals, authors, and keywords linked to ICT in mathematics learning using the dimensions database.

RESULT AND DISCUSSION

The bibliometric analysis findings are presented by highlighting the number of citations, countries, organizations, journals, authors, and keywords (Donthu et al., 2021; Ellili, 2022). The researchers utilized VOS-viewer to visualize the data through Network Visualization and Overlay Visuali-zation. Initially, the Dimensions database identified 3,697 publications related to ICT and education. However, narrowing the keywords to focus on ICT in mathematics learning reduced the number of relevant papers to 390, as illustrated in the graph below. The search was further refined to include only open-access articles, as detailed in Table 1.

Table 1. The frequency and proportion of publications concerning ICT in mathematics learning (2017-2022)

No	Year publications	Number of publications	%
1	2022	61	15,64 %
2	2021	84	21,54 %
3	2020	95	24,36 %
4	2019	76	19,49 %
5	2018	41	10,51 %
6	2017	33	8,46 %
	Total	**390**	**100 %**

Source: Modification by Authors

According to Table 1, 2020 recorded the highest number of public-cations, totaling 95, which accounts for 24.36%. There was a significant increase in publications from 2017, with only 33 publications, to 2020, reaching 95. Articles in the Dimensions database are frequently cited or referenced in other studies, indicating that the more citations an article receives, the more widely it is used as a reference in subsequent research (Supinah & Soebagyo, 2022). Therefore, the researcher uses the number of docu-ments and the number of citations in sorting out organizations, journals, and authors.

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Institute Bibliography Partner

Various institutions and universities have contributed publications on ICT in mathematics learning. Table 2 highlights the ten institutions or universities with the highest citation counts, along with their number of publications and total link strength.

Table 2. Top five universities citations related to ICT in mathematics learning (2017-2022)

No	Institution / University	Country	NP	NC	TLS
1	Guangxi Normal University	China	3	25	90
2	Indonesia University of Education	Indonesia	2	20	70
3	Sultan Ageng Tirtayasa University	Indonesia	2	10	370
4	Kryvyi Rih National University	Ukraine	2	10	30
5	Sriwijaya University	Indonesia	2	5	15

NP: Number of Publications, NC: Number of Citations, TLS: Total Link Strength

Table 2 presents the trend of institutions or universities with the highest citations in ICT in mathematics learning. Guangxi Normal University ranks first with 8 publications, 58 citations, and a total link strength of 108. Following in second place is the Siliwangi Institute of Teacher Training and Education, with 7 publications, 50 citations, and a total link strength of 29. Among the top 10 institutions, 6 are based in Indonesia, namely the Siliwangi Teaching and Education Institute, Indonesia University of Education, State University of Padang, Sultan Ageng Tirtayasa University, Sriwijaya University, and State University of Semarang, while 4 other institutions namely, Kryvyi Rih National University (Ukraine), Kryvyi Rih State Pedagogical University (Ukraine), Autonomous University Of Madrid (Spain), and Guangxi Normal University (China). This shows that research interest in ICT is unevenly distributed, with six of the ten institutions with the highest number of publications come from a single country. It highlights the limited research on ICT in mathematics learning conducted by institutions or universities outside Europe and Asia.

State Bibliographical Partners

Publications on ICT in Mathematics Learning appear in a variety of journals. From the 390 collected documents, researchers utilized the VOSviewer application to analyze country bibliographic pairings, as depicted in Figure 2.

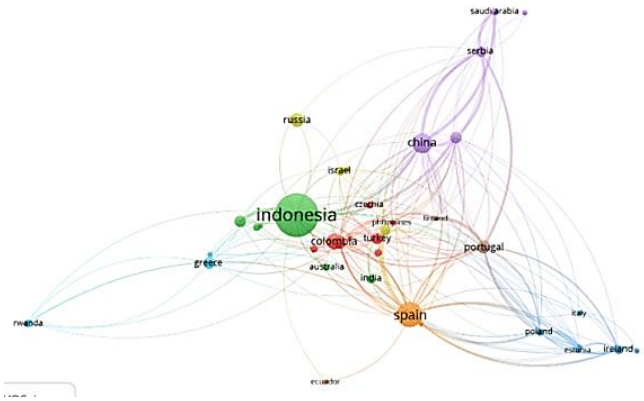

Figure 2. Network visualization of country bibliographic pairs

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

In the picture above it can be seen that the country of Indonesia ranks first. Judging from the size of the circle, Indonesia is the largest of the others. The countries with the most publications on ICT in mathematics learning are listed consecutively, Indonesia with 66 documents, Spain with 22 documents, China 14 documents, Ukraine with 11 documents, Colombia with 9 documents, Russia with 7 documents, Portugal with 6 documents, Greece with 5 documents, Malaysia with 5 documents, South Africa with 5 documents, and Turkey with 5 documents. This means that in the top 10 when viewed from the continents of these countries, Europe and Asia dominate, and there is only one country from each of the Americas and Africa.

Journal Bibliography Pair

Publications on ICT in Mathematics Learning are distributed across various journals. From the 390 documents collected, the researcher used the VOSviewer application to analyze journal bibliographic pairings and then ranked the journals by the number of documents published. The ten journals with the highest number of documents are shown in Figure 3.

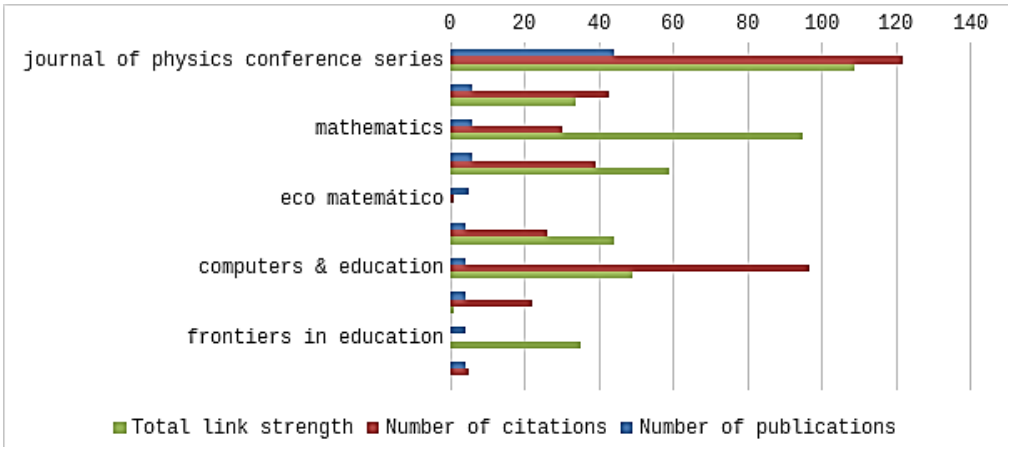

Figure 3. Number of citations to journals related to ICT in mathematics learning (2017-2022)

Figure 3 shows the trend of journals with the highest number of documents regarding ICT in Mathematics Learning, it can be seen that the Journal of Physics Conference Series is in the top rank with 44 documents, 122 citations, and 109 total link strength, followed by Education And Information Technologies in order second with 6 document counts, 43 citations, and 34 total link strength. In the top 10 journals above, 5 of them are indexed by SCOPUS namely, journal of physics conference series (Q4) , education and information technologies (Q1), sustainability (Q1), cogent education (Q2), and computers & education (Q1) and 5 journals others that have not been indexed by SCOPUS are only indexed by Google Scholar. This means that the results of research on ICT are in accordance with the focus and scope of the journals above, so they are useful for researchers who want to publish documents related to ICT research results.

Document Bibliography Pair

Documents on ICT in Mathematics Learning are published in various journals, documents with more than 25 citations are presented in Table 3.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

Table 3. The most publication citations ICT in mathematics education

No	Author	Article Title	Year	Citations
1	Chung Kwan Lo	Applying "First Principles of Instruction" as a design theory of the flipped classroom: Findings from a collective study of four secondary school subjects	2018	85
2	Azhari	Distance learning during the COVID-19 pandemic: School closure in Indonesia	2021	44
3	Barakabitze	Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities	2019	32
4	Costa	The data scientist profile and its representativeness in the European e-Competence framework and the skills framework for the information age	2017	32
5	Dockendorff	ICT integration in mathematics initial teacher training and its impact on visualization: the case of GeoGebra	2017	28

In the Table 3, it can be seen that the document with the title Applying by (Lo et al., 2018) with 85 total citations. The second order of documents by (Azhari & Fajri, 2022) with 44 total citations. The third order is a document by (Barakabitze et al., 2019). Fourth and fifth respectively are documents from (Costa & Santos, 2017) & (Dockendorff & Solar, 2018). The documents above can be used as references for further research that takes the theme of ICT in learning mathematics.

Data collected through the PoP software is compiled into a single RIS format file and analyzed using the VOSviewer software to generate bibliometric analysis results. Researchers applied a threshold for co-occurrence of keywords, requiring each keyword to appear in at least two different documents to be included in the visualization generated by VOS-viewer. This is illustrated in Figure 6.

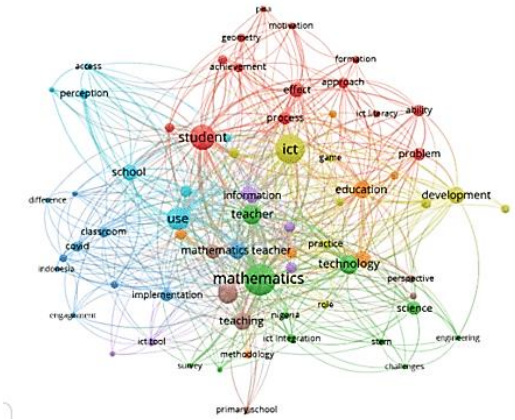

Figure 4. Network visualization of the keyword occurrence

Figure 4 shows a network visualization of the use of shared keywords (at least 2), it can be seen that "Mathematics" is the most commonly found keyword, namely 73 shared uses, this can be seen by the size of the circle in the keyword "Mathematics", the bigger the circle, the These keywords have been widely used by researchers related to ICT in Mathematics Learning.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

Table 4. The most common keyword occurrences

No	Keyword	Occurrence
1	Mathematics	73
2	ICT	67
3	Student	41
4	Use	38
5	Teacher	30
6	Learning	25
7	Teaching	23
8	Development	21
9	Education	21
10	Technology	21
11	Effect	18
12	Information	17
13	Model	17
14	Study	17
15	Communication Technology	16

Table 3 highlights that mathematics is a key area of interest for researchers, reflected in the use of shared keywords across 73 articles. ICT follows closely with 67 occurrences, while "students" ranks third with 41. "Teacher" also appears frequently. The network visualization in Figure 3 shows eight clusters with a total of 73 items related to ICT in mathematics learning. Cluster 1 (red) includes 15 items such as ability, achievement, competence, effect, geometry, ICT literacy, influence, instruction, motivation, and student. Cluster 2 (green) has 11 items, Cluster 3 (dark blue) features 9 items, and Cluster 4 (yellow) also includes 9 items. Cluster 5 (purple) consists of 8 items, while Clusters 6 (light blue), 7 (orange), and 8 (brown) each contain 7 items.

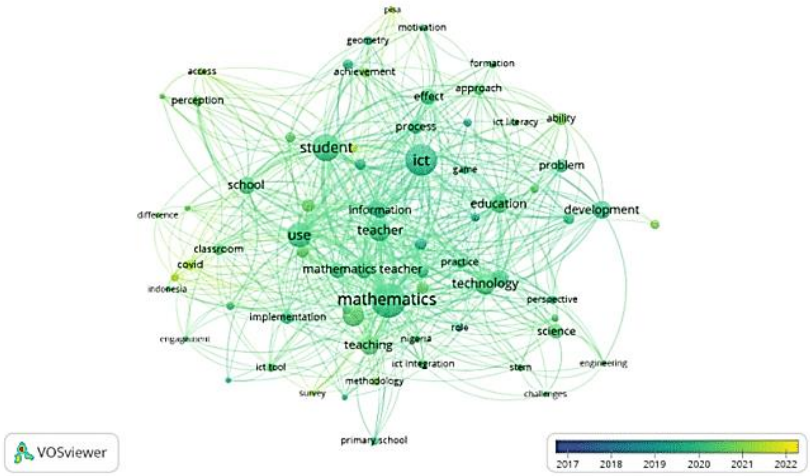

Figure 5. Overlay visualization

The Figure 5 shows three distinct colors: yellow, blue, and green. The yellow color indicates keywords that were used together around 2022, the blue color represents keywords used together around 2017, and the green color reflects the use of keywords around 2019-2020. This demonstrates a shift in terminology over time. New themes include "covid", "pandemic", and "experience", while older themes such as "teaching mathematics", "roles", and "higher education" are no longer as prominent. This suggests a transition from older themes to those focused on covid and the pandemic.

The link provided illustrates the relationships between keywords. In Figure 4, it is evident that the keyword "ICT" the second most cited keyword,

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

is not directly connected to other variables such as case study or STEM. Recent themes, like "covid" are not closely related to "achievement" or "motivation". Additionally, "geometry material" is not directly linked to STEM. These relationships reveal gaps that could be valuable for future research on ICT in mathematics learning.

The discussion above reveals a yearly increase in publications related to ICT in Mathematics Learning. Several factors contribute to this growth. First, the rising integration of technology in education, particularly in mathematics learning, has attracted significant attention from researchers and educators. Second, the COVID-19 pandemic has expedited the adoption of technology in educational settings, leading to a surge in studies addressing ICT in mathematics learning. Lastly, support and investment from educational institutions and governments have played a key role in promoting the use of ICT to enhance learning quality.

The benefit of this analysis is that it offers a thorough overview of research trends and advancements in ICT in mathematics learning. Through bibliometric analysis, this study successfully identified the most influential factors in this field, including citations, countries, organizations, journals, authors, and keywords. For instance, the discovery that Indonesia leads with 66 publications highlights the country's strong interest in integrating ICT into mathematics education. Additionally, the "Journal of Physics Conference Series" with 44 publications, emerges as a key platform for related research, underscoring the significance of scientific forums in disseminating knowledge.

However, this research also has several shortcomings. One weakness is the use of the Dimensions database as the main data source, not Scopus or WoS. Dimensions may not have the same data coverage and quality as Scopus or WoS, which could affect the accuracy and completeness of analysis results. Additionally, this study found that the keyword "ICT" does not directly involve other variables such as case studies and stems, indicating a research gap that can be further explored. Another shortcoming is the lack of focus on in-depth analysis of how ICT is used specifically in the context of mathematics learning, which could be an important area for future research.

CONCLUSION AND SUGGESTION

From the results of the analysis, it can be concluded that the trend of publications in journals related to ICT in Mathematics Learning over the last five years (2017–2022) shows an increase, although not yet significant. Indonesia recorded the highest number of documents with 66 documents, followed by "Guangxi Normal University" with 8 documents, and the journal "Journal of Physics Conference Series" with 44 documents. The article by Lo et al. (2018) is the article with the highest citations and also contributed. The keyword "Math" was the most used with 73 events, while new keywords such as covid, pandemic and experience started to emerge. The keyword "ICT" does not directly involve other variables such as case studies and stems, indicating a gap for further research in ICT in Mathematics Learning. For future research, it is recommended to expand the keywords used and use more reputable databases, namely Scopus and WoS.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

REFERENCES

Alabdulaziz, M. S. (2021). COVID-19 and the use of digital technology in mathematics education. *Education and Information Technologies*, *26*(6), 7609–7633. https://doi.org/10.1007/s10639-021-10602-3

Azhari, B., & Fajri, I. (2022). Distance learning during the COVID-19 pandemic: School closure in Indonesia. *International Journal of Mathematical Education in Science and Technology*, *53*(7), 1934–1954. https://doi.org/10.1080/0020739X.2021.1875072

Barakabitze, A. A., William-Andey Lazaro, A., Ainea, N., Mkwizu, M. H., Maziku, H., Matofali, A. X., Iddi, A., & Sanga, C. (2019). Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities. *Education Research International*, *2019*. https://doi.org/10.1155/2019/6946809

Batanero, J. M. F., Rueda, M. M., Cerero, J. F., & Martinez, I. G. (2020). Impact of the information and communication technologies on the education of students with down syndrome: A bibliometric study (2008-2018). *European Journal of Educational Research*, *9*(1), 79–89. https://doi.org/10.12973/eu-jer.9.1.79

Bhattacharjee, B., & Deb, K. (2016). Role of ICT in 21st Century's Teachers Education. *International Journal of Educational and Information Studies*, *6*(1), 1–6.

Cirneanu, A.-L., & Moldoveanu, C.-E. (2024). Use of Digital Technology in Integrated Mathematics Education. *Applied System Innovation*, *7*(4), 66. https://doi.org/10.3390/asi7040066

Costa, C., & Santos, M. Y. (2017). The data scientist profile and its representativeness in the European e-Competence framework and the skills framework for the information age. *International Journal of Information Management*, *37*(6), 726–734. https://doi.org/10.1016/j.ijinfomgt.2017.07.010

Dahal, N., Manandhar, N. K., Luitel, L., Luitel, B. C., Pant, B. P., & Shrestha, I. M. (2022). ICT tools for remote teaching and learning mathematics: A proposal for autonomy and engagements. *Online Submission*, *2*(1), 289–296. https://doi.org/10.25082/AMLER.2022.01.013

Das, K. (2019). Role of ICT for better Mathematics Teaching. *Shanlax International Journal of Education*, *7*(4), 19–28. https://doi.org/10.34293/education.v7i4.641

Dewi, P. S., Widodo, A., Rochintaniawati, D., & Prima, E. C. (2021). Web-Based Inquiry in Science Learning: Bibliometric Analysis. *Indonesian Journal of Science and Mathematics Education*, *4*(2), 191–203.

Dockendorff, M., & Solar, H. (2018). ICT integration in mathematics initial teacher training and its impact on visualization: the case of GeoGebra. *International Journal of Mathematical*

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

Education in Science and Technology, *49*(1), 66–84. https://doi.org/10.1080/0020739X.2017.1341060

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*(3), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Drijvers, P., & Sinclair, N. (2024). The role of digital technologies in mathematics education: purposes and perspectives. *ZDM–Mathematics Education*, *56*(2), 239–248. https://doi.org/10.1007/s11858-023-01535-x

Egoeze, F., Misra, S., Maskeliūnas, R., & Damaševičius, R. (2018). Impact of ICT on universities administrative services and management of students' records: ICT in university administration. *International Journal of Human Capital and Information Technology Professionals*, *9*(2), 1–15. https://doi.org/10.4018/IJHCITP.2018040101

Ellili, N. O. D. (2022). Bibliometric analysis on corporate governance topics published in the journal of Corporate Governance: The International Journal of Business in Society. *Corporate Governance (Bingley)*, *1*(6). https://doi.org/10.1108/CG-03-2022-0135

Engelbrecht, J., & Borba, M. C. (2024). Recent developments in using digital technology in mathematics education. *ZDM–Mathematics Education*, *56*(2), 281–292. https://doi.org/10.1007/s11858-023-01530-2

Har, E., Khairi, A., & Roza, W. (2019). Teachers' skills and ICT facilities for science learning at senior high school in Padang city. *Australian Educational Computing*, *34*(1).

Hassan, M. M. (2020). Exploring Benefits of Information and Communication Technology (ICT) in the Primary Education. *Journal of Xidian University*, *14*(7). https://doi.org/10.37896/jxu14.7/211

Hernández, J. B., Chalela, S., Arias, J. V., & Arias, A. V. (2017). Research trends in the study of ICT based learning communities: A bibliometric analysis. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(5), 1539–1562. https://doi.org/10.12973/eurasia.2017.00684a

Hook, D. W., Porter, S. J., & Herzog, C. (2018). Dimensions: Building Context for Search and Evaluation. *Frontiers in Research Metrics and Analytics*, *3*(August), 1–11. https://doi.org/10.3389/frma.2018.00023

Isaksson, E., & Hakulinen, R. (2022). Responsible Metrics for Astronomy: Comparing ADS to Other Citation Databases. *Bulletin of the AAS*. https://doi.org/10.3847/25c2cfeb.774afe59

Kaput, J., Hegedus, S., & Lesh, R. (2020). Technology becoming infrastructural in mathematics education. In *Foundations for the future in mathematics education* (pp. 173–191). Routledge.

Kumbar, S. S., Bidnurkar, A. A., Tamhane, K. N., & Kumbar, R. B.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

(2018). Case study on need of ICT in teaching learning process. *Journal of Engineering Education Transformations*, *32*(1), 1–5. https://doi.org/10.16920/jeet/2018/v32i1/130801

Lo, C. K., Lie, C. W., & Hew, K. F. (2018). Applying "First Principles of Instruction" as a design theory of the flipped classroom: Findings from a collective study of four secondary school subjects. *Computers and Education*, *118*, 150–165. https://doi.org/10.1016/j.compedu.2017.12.003

Marín, J. A., Belmonte, J. L., Campoy, J. M. F., & Rodríguez, J. M. R. (2019). Big Data in Education. A Bibliometric Review. *Social Sciences Article*, *8*(8), 223–234.

Moral-muñoz, J. A., Herrera-viedma, E., Santisteban-espejo, A., Cobo, M. J., Herrera-viedma, E., Santisteban-espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up- to-date review. *El Profesional de La Informa-Ción*, 1–20. https://doi.org/10.3145/epi.2020.ene.03

Muhammad, S., Zubairu, S. A., Jamilu, M., & Muhammed, K. (2020). ICT Is An Integral Strategy For Crimes Prevention And Detection. *Academic Leadership (Online Journal)*, *21*(06), 249–257.

Oyewola, D. O., & Dada, E. G. (2022). Exploring machine learning: a scientometrics approach using bibliometrix and VOSviewer. *SN Applied Sciences*, *4*(5), 1–18. https://doi.org/10.1007/s42452-022-05027-7

Peace, E., Suleiman, M. M., Yahya, A. T., & Tukur, M. (2020). Effective Utilization of ICT Tools in Higher Education. *Journal of Xidian University*, *14*(9). https://doi.org/10.37896/jxu14.9/061

Radović, S., Marić, M., & Passey, D. (2019). Technology enhancing mathematics learning behaviours: Shifting learning goals from "producing the right answer" to "understanding how to address current and future mathematical challenges." *Education and Information Technologies*, *24*(1), 103–126. https://doi.org/10.1007/s10639-018-9763-x

Rana, S., & Pragati. (2022). A Bibliometric and Visualization Analysis of Human Capital and Sustainability. *Vision: The Journal of Business Perspective*, *9*(7), 1–10. https://doi.org/10.1177/09722629221105773

Sandi, A. P., & Fernandy, H. (2022). The effect of ICT learning media and discipline on the effectiveness of learning mathematics. *International Journal of Trends in Mathematics Education Research*, *5*(1), 61–68. https://doi.org/10.33122/ijtmer.v5i1.91

Sharma, M. (2021). Influence of ICT and Its Dynamic Change in Daily Life of Human Being. *Journal of Contemporary Issues in Business and Government*, *27*(3), 1–5. https://doi.org/10.47750/cibg.2021.27.03.085

Singh, V. K., Singh, P., Karmakar, M., Leta, J., & Mayr, P. (2021). The journal coverage of Web of Science, Scopus and Dimensions: A comparative analysis. *Scientometrics*, *126*(6), 5113–

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v14i2.8461

5142. https://doi.org/10.1007/s11192-021-03948-5

Singhavi, C., Basargekar, P., & Somaiya, K. J. (2019). Barriers Perceived by Teachers for use of Information and Communication Technology (ICT) in the Classroom in Maharashtra, India. *International Journal of Education and Development Using Information and Communication Technology (IJEDICT)*, *15*(2), 62–78.

Supianti, I. I., Wahyudin, Kartasasmita, B. G., & Nurlaelah, E. (2019). Teachers' perspective on the application of information and communication technology (ICT) in mathematics learning. *Journal of Physics: Conference Series*, *1321*(2). https://doi.org/10.1088/1742-6596/1321/2/022107

Supinah, R., & Soebagyo, J. (2022). Analisis Bibliometrik Terhadap Tren Penggunaan ICT Pada Pembelajaran Matematika. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *6*(2), 276–290. https://doi.org/10.33603/jnpm.v6i2.6153

Trinh Thi Phuong, T., Nguyen Danh, N., Tuyet Thi Le, T., Nguyen Phuong, T., Nguyen Thi Thanh, T., & Le Minh, C. (2022). Research on the application of ICT in Mathematics education: Bibliometric analysis of scientific bibliography from the Scopus database. *Cogent Education*, *9*(1). https://doi.org/10.1080/2331186X.2022.2084956

Verschaffel, L., Depaepe, F., & Mevarech, Z. (2019). Learning Mathematics in Metacognitively Oriented ICT-Based Learning Environments: A Systematic Review of the Literature. *Education Research International*, *2019*. https://doi.org/10.1155/2019/3402035

Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629

Zyoud, S. H., Al-Jabi, S. W., & Sweileh, W. M. (2015). Worldwide research productivity of paracetamol (acetaminophen) poisoning: A bibliometric analysis (2003-2012). *Human and Experimental Toxicology*, *34*(1), 12–23.

Zyoud, Waring, W. S., Al-Jabi, S. W., & Sweileh, W. M. (2017). Global research production in glyphosate intoxication from 1978 to 2015: A bibliometric analysis. *Human and Experimental Toxicology*, *36*(10), 997–1006. https://doi.org/10.1177/0960327114531993