

MATHEMATICS LEARNING IN THE SOUTHEAST ASIA REGION ON THE SCOPUS DATABASE: BIBLIOMETRIC ANALYSIS (1993-2024)

Resky Nuralisa Gunawan^{1*)}, Era Mutiara², Zafrullah³, Mohamed Hasan Mohamed Majid⁴, Muhammad Imran Nur⁵, James Leonard Mwakapemba⁶

¹Universitas Alma Ata Yogyakarta, Indonesia

^{2,3}Universitas Negeri Yogyakarta, Indonesia

⁴South Eastern University of Sri Lanka, Sri Lanka

⁵Universitas Indonesia, Indonesia

⁶Institute of Rural Development Planning, Tanzania

^{1*)}reskynuralisa074@gmail.com

Received: 18-06-2024 ; **Accepted:** 23-09-2024 ; **Published:** 30-10-2024

Abstract. This research aims to analyze research trends regarding mathematics learning in Southeast Asia on the Scopus Database. Using existing keywords, researchers selected using the PRISMA method and obtained 829 documents which were analyzed using VOSviewer and the R Program. From the results of the analysis, it can be concluded that research on mathematics learning in Southeast Asia began in 1993 and showed significant development until 2024, with a total of 829 documents published from 200 sources. Despite a decline in publications in 2013, the overall publication trend continues to show positive growth, especially after 2012. Indonesia occupies the top position in the number of publications and citations, followed by Malaysia, with Nanyang Technological University in Singapore being the leading institution. The various research focuses reflect efforts to improve the quality of mathematics learning in the region. Apart from that, the latest topics such as “online learning”, “ethnomathematics”, and “flipped classroom” are very relevant to be applied in facing educational challenges in the current digital era.

Keywords: *Mathematics Learning, Southeast Asia, Bibliometric*

1. INTRODUCTION

Education is a fundamental process in shaping individual character and intelligence [1]–[4]. In this digital era, the development of technology has had a significant impact on education methods and access [5], [6]. Students can now access various learning resources through the internet, which makes the teaching and learning process more interactive and interesting [7], [8]. However, although technology provides many conveniences, the role of schools remains very important in educating students holistically [9], [10]. Schools are not only a place to gain knowledge, but also a platform for students' social and emotional development.

School is an important place in the development of every individual, not only in the academic aspect, but also in character building [11]–[13]. At school, students learn about values such as responsibility, cooperation and discipline that will shape their personality [14], [15]. In addition, schools play a role in developing students' potential through various extracurricular activities that support their interests and talents [16]–[18]. Within the school environment, students also learn to interact and cooperate with their peers, which is an important provision for their future social life. This character and skill development is an important part of the learning experience that cannot be fully replaced by technology [19], [20]. Therefore, the existence of school as a place of learning outside the formal classroom is essential, because it is where students get real experiences that support learning in the classroom.

The classroom is the main environment where the formal learning process takes place and a place for students to develop their potential [21], [22]. In the classroom, students not only receive knowledge, but also learn to communicate, think critically and solve problems collaboratively [23]. The interaction between students and teachers in the classroom is very important, as teachers play a role in guiding and facilitating students' understanding of various materials [24], [25]. In addition, the classroom provides opportunities for students to exchange ideas, discuss ideas and inspire each other in a supportive environment [26]–[28]. Through various activities in the classroom, students learn to appreciate differences and build their confidence [29]. Thus, the role of the classroom is crucial in shaping meaningful learning experiences [30]. Therefore, the classroom should be optimally designed to support effective and holistic learning.

Learning is an important process that enables individuals to develop the knowledge, skills and attitudes needed in life [31], [32]. Through learning, students can explore their potential and deepen their understanding of various fields of knowledge [33]–[35]. A conducive environment plays a significant role in supporting this process, as a comfortable and organized atmosphere will motivate students to learn more effectively [36]. Teachers also play a vital role in creating an engaging learning experience by integrating relevant methods and media [37], [38]. In addition, interactive learning will encourage students to actively participate, discuss and think critically [39], [40]. This approach is very useful in increasing students' absorption of the material

taught. One learning that requires special attention is mathematics learning, which often requires a creative approach so that students can understand concepts more easily.

Mathematics is a basic science that has an important role in various aspects of life and the development of logical thinking skills [41], [42]. Learning mathematics helps students understand abstract concepts and hone their problem-solving skills systematically [43], [44]. In the process, mathematics trains accuracy, perseverance, and analytical skills that are very useful in everyday life and the world of work [45]. To support better understanding, math learning needs to be designed with a contextual and interactive approach, so that students not only understand formulas but also their application in real life [46], [47]. The use of props, technology and interesting learning methods can motivate students to be more interested in mathematics [48]. The implementation of effective math learning strategies across all levels of education will ensure that every student has a strong foundation in this field.

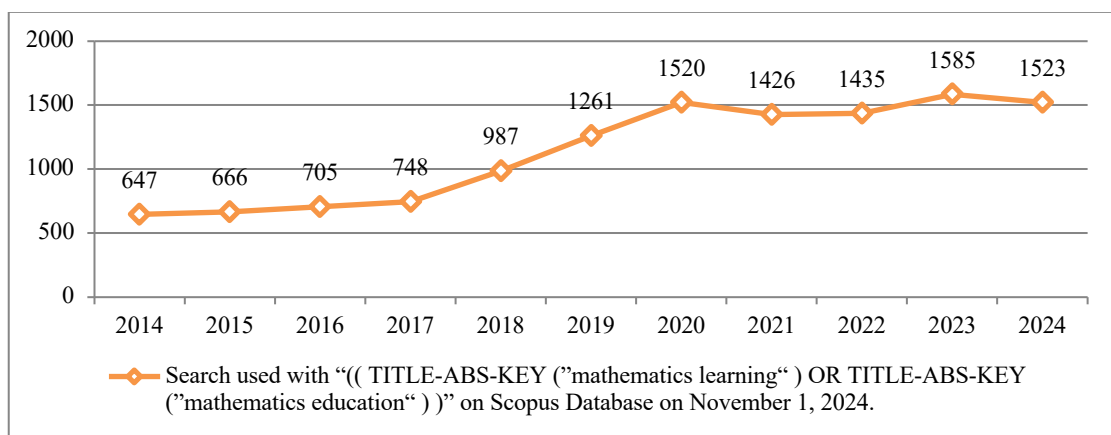


Figure 1. Trends in Mathematics Learning on Scopus Database

The rapid growth of mathematics learning encourages researchers to conduct research in this area. From the results of Figure 1, it can be seen that publications related to mathematics learning show a significant upward trend from 2014 to 2024, with a sharp spike especially after 2017. Although there was a slight decline in 2021 and 2024, the number of publications remained high, indicating consistent growth overall. Based on this phenomenon, the author is interested in conducting a bibliometric analysis of research trends in mathematics learning. However, in order to make this study more focused, the authors limited the scope of countries to the Southeast Asia region, so as to see more specific regional developments. Thus, this study is expected to provide a more

in-depth picture of the trends and contributions of mathematics learning research in Southeast Asia.

2. RESEARCH METHOD

This research aims to analyze research trends in mathematics learning in Southeast Asia using the Scopus database. Bibliometric analysis is a method used to measure and evaluate scientific publications, providing insight into publication patterns, collaborations, and developments in research topics within a scientific discipline [49]–[53]. Before carrying out further analysis, related documents will be analyzed using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method, which ensures that the study selection and selection process is carried out systematically and transparently. With this approach, it is hoped that this research can provide a clear picture of research trends and contributions in mathematics learning in the Southeast Asia region.

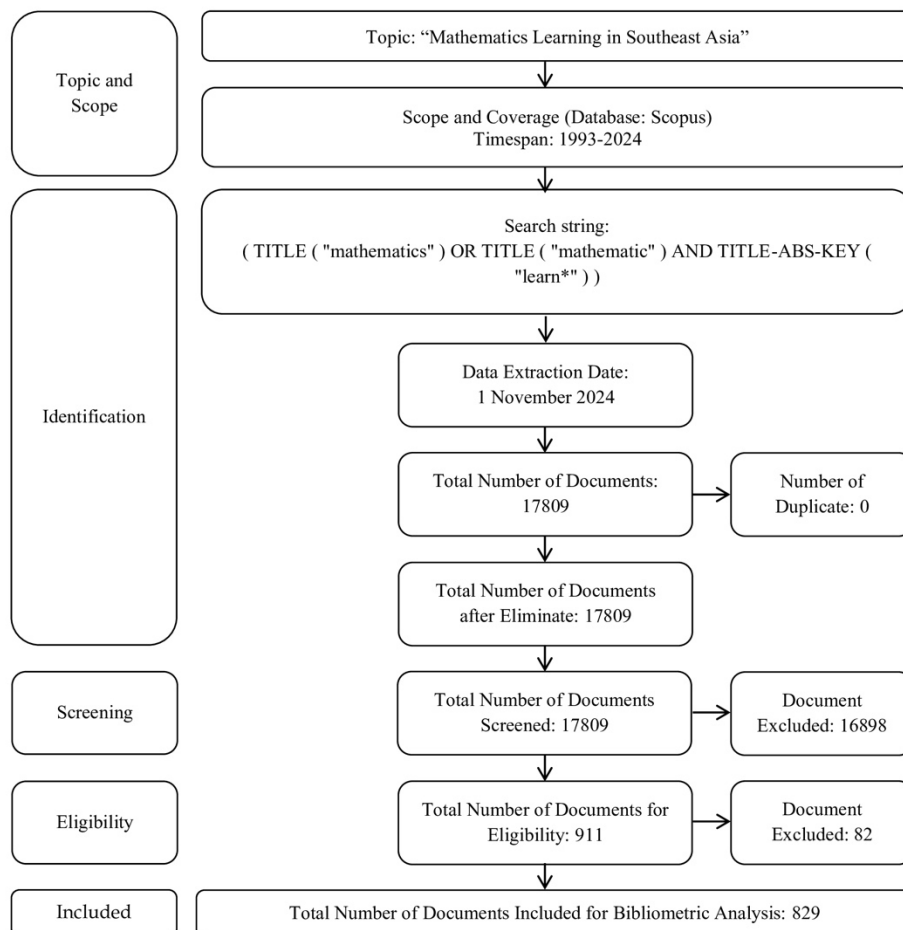


Figure 2. Document Selection using the PRISMA Method in Mathematics Learning in Southeast Asia in the Scopus Database

By using the specified keywords, 17,809 initial documents were obtained which were then selected. At the Screening stage, researchers selected the “Social Sciences” category, the document type was only articles, and the countries covered were only Southeast Asia, so 16,898 documents were eliminated, leaving 911 documents. Next, at the eligibility stage, the author carried out the manual selection of all articles and discarded documents that did not match the topic so that 82 documents were eliminated, leaving 829 documents, which were then analyzed using VOSviewer and the R Program.

3. RESULTS AND DISCUSSION

3.1 Results

Main Information

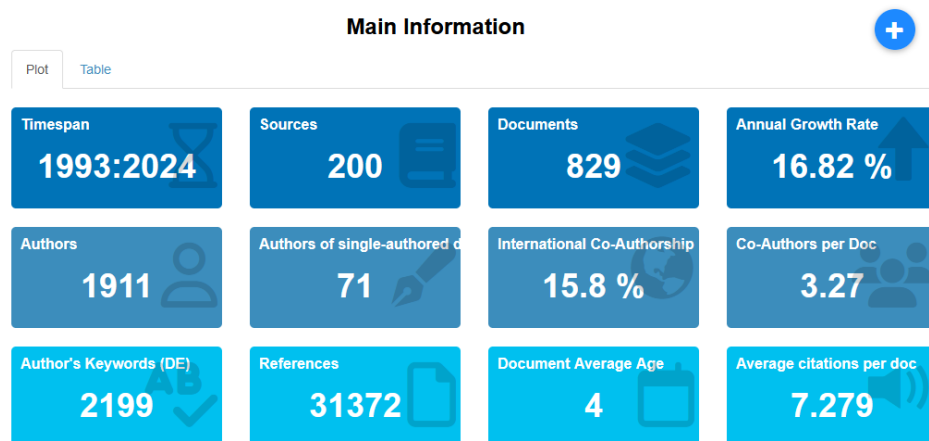


Figure 3. Main Information About Mathematics Learning in Southeast Asia in the Scopus Database

Research on mathematics learning in Southeast Asia shows quite significant developments in the period 1993 to 2024. With a total of 829 documents from 200 sources, there is a trend of increasing research in this field with an annual growth rate of 16.82%. There were 1,911 researchers involved, of whom 71 wrote articles independently. International collaboration reached 15.8%, which reflects the openness of research to global contributions. There were an average of 3.27 authors per document, indicating that collaborative research is quite common. Each document was referenced on average around 7,279 times, with the average age of the documents being 4 years, indicating the high relevance of existing research in the development of mathematics learning in this region.

Publication Trends

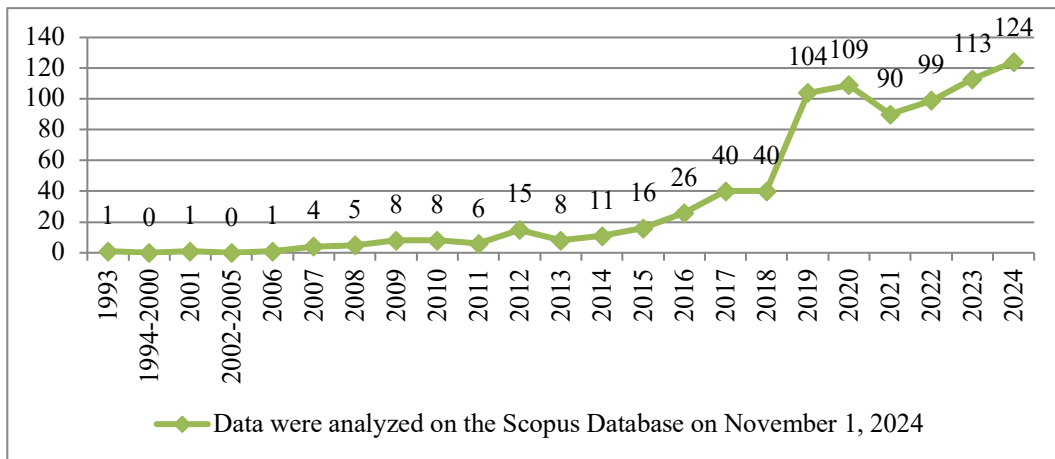


Figure 4. Analysis of Publication Trends from 1993-2024 About Mathematics Learning in Southeast Asia in the Scopus Database

Research on mathematics learning in Southeast Asia began to show a marked increase in 2012, when the number of publications rose to 15 documents, after a period of slow growth in previous years. 2013 saw a slight decrease to 8 documents, but this did not stop the overall upward trend. The following years showed a more steady development, with the number of publications continuing to increase. From 2015 to 2018, the number of published documents was in the range of 16 to 40 per year, indicating that interest in this topic is growing among researchers.

The peak of growth occurred in 2024, with a total of 124 documents, making it the year with the most publications during this period. A sharp increase has been seen since 2019, when publications reached 104 documents and will continue to increase consistently until 2024. This trend shows that there is increasing attention from the academic community to issues related to mathematics learning in Southeast Asia. This increase can be caused by factors such as developments in educational technology, encouragement of educational policies, or increased international collaboration observed in recent years.

The Most Highest Country

Table 1. The Top 5 Most Highest Publication by Country About Mathematics Learning in Southeast Asia in the Scopus Database

Rank	Country	Total of Publication	%	Total of Citations	%
1 st	Indonesia	277	33.41%	2114	50.13%
2 nd	Malaysia	94	11.34%	821	19.47%
3 rd	Philippines	61	7.36%	250	5.93%
4 th	Singapore	28	3.38%	305	7.23%
5 th	Thailand	24	2.90%	132	3.13%

Source: Scopus Database (Data analyzed on November 1, 2024)

Indonesia ranks first in the number of publications related to mathematics learning in Southeast Asia, with a total of 277 publications or around 33.41% of the total regional contribution. This shows the active role of Indonesian researchers in the development and dissemination of research results in this field. In addition to the large number of publications, Indonesia also recorded a total of 2,114 citations, which accounted for more than half (50.13%) of all citations received from the region. This figure indicates that research

conducted by researchers in Indonesia is not only productive but also has a significant impact, is widely recognized and referred to by the academic community.

In second place, Malaysia showed a strong contribution with 94 publications (11.34%) and 821 citations (19.47%). This indicates that Malaysia, although the number of publications is lower than Indonesia, still plays an important role in mathematics research in Southeast Asia, with a fairly high citation impact. The Philippines, Singapore and Thailand follow in the next position with a lower number of publications and citations. Even though these three countries contributed less than 10% of the number of publications, they still had significant contributions, especially Singapore which recorded a total of 305 citations even though it only produced 28 publications, showing the fairly good quality or impact of the research produced.

Overall, these five countries demonstrate collaboration and significant contributions in advancing mathematics research in Southeast Asia. Each country brings different contributions in terms of both number of publications and citation impact, demonstrating diverse perspectives and approaches to this topic. This collective contribution is important to enrich understanding and development of mathematics education strategies that suit regional needs. Differences in the number of publications and citations also indicate the potential for collaboration between countries, where countries with higher publications can collaborate with countries that have good citation quality, thereby strengthening the impact of mathematics research regionally and internationally.

The Most Higher Affiliations

Table 2. The Top 5 Highest Publications About Mathematics Learning in Southeast Asia in the Scopus Database

Rank	Affiliation	City	Country	Total Publications
1 st	Nanyang Technological University	Singapore	Singapore	68(8.20%)
2 nd	Universitas Pendidikan Indonesia	Bandung	Indonesia	61(7.35%)
3 rd	Universitas Negeri Yogyakarta	Yogyakarta	Indonesia	60(7.23%)
4 th	Universiti Putra Malaysia	Serdang	Malaysia	50(6.03%)
5 th	Universitas Negeri Semarang	Semarang	Indonesia	44(5.30%)

Source: Scopus Database (Data analyzed on November 1, 2024)

The institution with the largest number of publications related to mathematics learning research in Southeast Asia is Nanyang Technological University (NTU) in Singapore, with a total of 68 publications. NTU is known as one of the leading universities in Asia and consistently supports education and STEM (Science, Technology, Engineering, and Mathematics) research. NTU's dominance in this contribution shows the high quality and academic competitiveness of Singapore, which continues to prioritize education as one of its main focuses. NTU's achievements in this regard also reflect Singapore's commitment to becoming a center for educational research in the region, especially in strategic areas such as mathematics.

Indonesia shows significant dominance in this affiliate list, with three of the top five institutions originating from the country. The Universitas Pendidikan Indonesia (UPI), Universitas Negeri Yogyakarta (UNY), and Universitas Negeri Semarang (UNNES) each contributed 61, 60, and 44 publications. The involvement of these three universities reflects

Indonesia's active role in mathematics education research at the regional level. In addition, the involvement of many Indonesian institutions may reflect national education policies that focus on increasing the quality and quantity of educational research, especially at universities that have a strong mandate in the field of education. This shows that mathematics research is a major concern, especially in improving the quality of learning and educational curriculum in Indonesia.

The Most Highest Source

Table 3. The Top 5 Highest Source About Mathematics Learning in Southeast Asia in the Scopus Database

Rank	Source Name	h-index	Total Citations	Total Publications
1 st	Journal on Mathematics Education	17	747(17.71%)	66(8.08%)
2 nd	International Journal of Instruction	12	369(8.75%)	34(4.16%)
3 rd	Eurasia Journal of Mathematics, Science and Technology Education	10	676(16.03%)	22(2.69%)
4 th	International Journal of Scientific and Technology Research	9	195(4.62%)	44(5.39%)
5 th	European Journal of Educational Research	8	127(3.01%)	22(2.69%)

Source: Scopus Database (Data analyzed on November 1, 2024)

From the Table 3, the Journal on Mathematics Education is ranked first with the highest h-index, namely 17, indicating a significant influence in the field of mathematics education. This high H-index reflects that many publications from this journal have been widely cited, indicating the quality and relevance of the research it publishes. Followed by the International Journal of Instruction with an h-index of 12, and the Eurasia Journal of Mathematics, Science and Technology Education in third position with an h-index of 10. These journals are important references for researchers and educators who want to explore and deepen research in the field education.

When considering total citations, the Journal on Mathematics Education also dominates with a total of 747 citations, which covers 17.71% of the total citations. This figure shows that the works published in this journal are often referred to by other researchers, confirming its extensive contribution to the development of mathematics education science. Furthermore, the Eurasia Journal of Mathematics, Science and Technology Education has a total of 676 citations, covering 16.03%, indicating that the research it publishes also receives significant attention from the academic community. Other journals, even though they have a lower number of citations, still contribute to a more specific scope of research.

Overall, all journals listed in this table demonstrate important contributions to research in the field of education. The journal with the highest total publications is the International Journal of Scientific and Technology Research with 44 publications, but has lower citations (195). This shows that although this journal is active in publishing articles, its impact on citations may still need to be improved. In contrast, the Journal on Mathematics Education

and the Eurasia Journal of Mathematics, Science and Technology Education not only have a good number of publications but also demonstrate high relevance in citations, so both serve as valuable resources for researchers and academics who wish to explore education and teaching methods in science and mathematics.

The Most Productive Authors

Table 4. The Top 5 Productive Authors About Mathematics Learning in Southeast Asia in the Scopus Database

Rank	Author	Affiliation	Country	h-index	TC	TP
1 st	Putri Ratu Ilma Indra	Universitas Sriwijaya	Indonesia	8	177	18
2 nd	Prahmana Rully Charitas Indra	Universitas Ahmad Dahlan	Indonesia	7	246	16
3 rd	Suparman	Universitas Bengkulu	Indonesia	7	109	19
4 th	Zulkardi	Universitas Sriwijaya	Indonesia	7	146	17
5 th	Kaur Berinderjeet	National Institute of Education Singapore	Singapore	6	70	11

Description: TC= Total Citations, TP=Total of Publications. Source: Scopus Database (Data analyzed on November 1, 2024)

From the table presented, Putri Ratu Ilma Indra from Sriwijaya University is in the top ranking with an h-index of 8. This shows that she has a significant influence in her research field, with a total of 177 citations (TC) from 18 publications (TP). Following in second place is Prahmana Rully Charitas Indra from Ahmad Dahlan University with an h-index of 7, total citations of 246, and 16 publications. Suparman, also with an h-index of 7, has the highest number of publications, namely 19, indicating that although his citations are lower, he is active in producing scientific work. This ranking emphasizes the importance of the contribution of these researchers to the development of science in Indonesia.

In this table, Indonesia dominates the list of top researchers, with four of the five authors coming from universities in Indonesia. This reflects the strength and research potential that exists in this country, as well as the significant contribution of higher education institutions in producing quality researchers. Kaur Berinderjeet from the National Institute of Education Singapore was the only representative from outside Indonesia who recorded an h-index of 6 and a total of 70 citations. The dominance of Indonesian researchers shows that there is an academic environment that supports and facilitates research development in various fields.

Overall, all researchers listed in this table have made significant contributions to the world of academia and research. With varying citation totals, they demonstrate different levels of influence in their respective fields. Researchers such as Prahmana Rully Charitas Indra, even though he has the same h-index as Suparman and Zulkardi, have the highest total citations, namely 246, indicating that his works are more often referred to by other researchers. This confirms that the quality and relevance of research is very important in

		Education, Motivation, Problem Solving, Teaching	
4.	Yellow	Attitude, Conceptual Understanding, Flipped Classroom, Mathematics Learning, Online Learning, Technology	Innovative Mindsets in Mathematics
5.	Purple	Elementary School, Learning Outcomes, Mathematical Literacy, Realistic Mathematics Education	Foundations of Mathematical Literacy

Source: VOSviewer

The cluster with the title Mathematics “Mindset and Innovation” includes keywords such as cooperative learning, critical thinking, ethnomathematics, and problem-based learning. This shows a focus on the importance of developing a positive mindset towards mathematics through innovative approaches. Cooperative learning and problem solving provide opportunities for students to collaborate and think critically, which can reduce math anxiety and improve their performance. In addition, the concept of ethnomathematics reflects the importance of cultural context in learning, making mathematics more relevant and interesting for students. By paying attention to learning styles and increasing students' self-efficacy, mathematics teaching can be more effective and empowering.

The cluster entitled “Digital Empowerment and Student Success” highlights the use of technology in mathematics education through keywords such as e-learning, mobile learning, and self-regulated learning. The use of technology, especially at the junior high school level, is very important in increasing mathematics learning achievement. E-learning and mobile-based learning enable broader access to educational resources, giving students flexibility in learning. In addition, regular study skills help students to become more independent and responsible for their learning process. This in turn contributes to students' success in understanding complex mathematical concepts.

The cluster entitled “Mathematics Motivation and Mastery” focuses on student achievement and motivation in the context of mathematics learning. With keywords such as collaboration, geogebra, and mathematics learning, this cluster shows the importance of tools and strategies that encourage active student engagement. Geogebra, as a mathematical visualization tool, can improve understanding of concepts and provide a more interesting learning experience. In addition, collaboration in learning helps students support and motivate each other, which can improve learning outcomes. Therefore, integrating motivation and collaboration in mathematics learning is very important to achieve comprehensive mastery of the material.

The cluster entitled “Innovative Mindsets in Mathematics” emphasizes the importance of attitudes and conceptual understanding in learning mathematics. Keywords such as flipped classroom and technology indicate modern approaches that can enhance students' learning experiences. By implementing the flipped classroom model, students can learn the material first through videos or online sources, and then apply it in class discussions. This

3.2 Discussion

Education shapes individual character and intelligence, and technological developments in the digital era make accessing more interactive learning easier [54]. Even though technology makes things easier, the role of schools is still important in educating students holistically, developing the values of responsibility, cooperation and discipline, and supporting talents through extracurricular activities [55], [56]. The learning process at school is also strengthened by the role of teachers who encourage understanding of material and critical thinking. Learning mathematics, which is important in practicing logical thinking skills, requires a creative and contextual approach. In Southeast Asia, research on mathematics learning continues to increase, and bibliometric analysis can provide insight into research trends and contributions in this region.

Research on mathematics learning in Southeast Asia shows quite significant developments in the period 1993 to 2024, with a total of 829 documents from 200 sources. An increase in publications began to be seen in 2012 with 15 documents, although there was a slight decline in 2013. However, this trend still shows positive growth, where the number of publications continues to increase from year to year. In the period 2015 to 2018, publications ranged from 16 to 40 documents per year, indicating growing interest among researchers. The peak of growth occurred in 2024 with a total of 124 documents, the highest figure in that period, after a sharp increase that began in 2019 with 104 documents. This trend reflects the academic community's increasing attention to mathematics learning issues in Southeast Asia, which may be influenced by developments in educational technology, educational policy drives, and increased international collaboration in recent years.

Indonesia ranks first in publications related to mathematics learning in Southeast Asia, with 277 publications or around 33.41% of regional contributions, and recorded 2,114 citations which represent more than half of the region's total citations. This figure shows the active role of Indonesian researchers in contributing research results that are productive and influential in the academic community. Malaysia is in second place with 94 publications and 821 citations, indicating a strong contribution even though the number of publications is lower, but still has a high citation impact. Among the five countries with the largest contributions, including the Philippines, Singapore, and Thailand, each shows differences in the number of publications and quality of citations. This diversity shows opportunities for collaboration between countries that can strengthen the impact of mathematics research regionally and internationally, by combining a high number of publications from one country and good quality citations from other countries.

Research related to mathematics learning in Southeast Asia shows significant contributions, especially from Indonesia which leads in the number of publications and citations. Nanyang Technological University in Singapore stands out with 68 publications, demonstrating a commitment to educational research, particularly in STEM. In Indonesia, the Universitas Pendidikan Indonesia, Universitas Negeri Yogyakarta, and Universitas Negeri Semarang also dominate publications, illustrating serious attention to improving the

quality of education. At the journal level, the Journal on Mathematics Education is the most influential with the highest h-index (17) and 747 citations. In terms of researchers, Indonesia's dominance can be seen in four of the top five researchers, with Putri Ratu Ilma Indra ranked first. This shows the great potential for research in Indonesia and the importance of collaboration to improve the academic image at the international level.

The grouping of keywords in this research shows the various focuses in mathematics learning in Southeast Asia, which include innovation, technology, motivation, modern approaches, and basic mathematical literacy. The “Mathematics Mindset and Innovation” cluster highlights the importance of innovative approaches such as cooperative learning and problem solving to increase a positive mindset towards mathematics. “Digital Empowerment and Student Success” highlights the role of technology, such as e-learning and mobile learning, in supporting student learning achievement and independence. Next, the “Mathematics Motivation and Mastery” cluster focuses on using tools such as Geogebra and collaboration to increase motivation and understanding of mathematics. “Innovative Mindsets in Mathematics” features approaches such as the flipped classroom and technology to enrich the learning experience, while the “Foundations of Mathematical Literacy” cluster emphasizes the importance of early mathematical literacy through realistic mathematics education in elementary schools. This grouping illustrates the diversity of approaches that can strengthen the effectiveness of mathematics learning in this region.

The keywords “Online Learning”, “Ethnomathematics”, and “Flipped Classroom” reflect recent emerging topics in mathematics learning research. These three concepts are very relevant to be applied in the context of mathematics learning in Southeast Asia, especially in facing educational challenges in the current digital era. Online learning allows wider access to learning resources and flexibility in the learning process, while ethnomathematics links mathematical concepts to local culture, thus making learning more contextual and interesting for students. On the other hand, the flipped classroom model encourages students to study material independently before discussing in class, increasing their active involvement and understanding of mathematical concepts. By researching and implementing these three approaches, it is hoped that the quality of mathematics learning in this region can improve significantly.

4. CONCLUSION

From the results of the analysis, it can be concluded that research on mathematics learning in Southeast Asia began in 1993 and showed significant development until 2024, with a total of 829 documents published from 200 sources. Despite a decline in publications in 2013, the overall publication trend continues to show positive growth, especially after 2012. Indonesia occupies the top position in the number of publications and citations, followed by Malaysia, with Nanyang Technological University in Singapore being the leading institution. The various research focuses reflect efforts to improve the quality of mathematics learning in the region. Apart from that, the latest topics such as “online learning”, “ethnomathematics”, and “flipped classroom” are very relevant to be applied in facing educational challenges in the current digital era.

REFERENCES

- [1] D. Andrian, A. Wahyuni, S. Ramadhan, F. R. E. Novilanti, and Zafrullah, "Pengaruh Pembelajaran Kooperatif Tipe STAD Terhadap Peningkatan Hasil Belajar, Sikap Sosial, dan Motivasi Belajar," *Inomatika*, vol. 2, no. 1, pp. 65–75, 2020, doi: 10.35438/inomatika.v2i1.163.
- [2] Muhamad Yunus, Mizan Abrory, Zafrullah, Dedek Andrian, and David Maclinton, "The Effectiveness of Macromedia Flash Digital Media in Improving Students' Mathematics Reasoning," *Math. Res. Educ. J.*, vol. 6, no. 1, pp. 14–20, 2022, doi: 10.25299/mrej.2022.vol6(1).9013.
- [3] B. D. Izzulhaq, R. N. Gunawan, Z. Zafrullah, R. T. Ayuni, A. M. Ramadhani, and R. L. Fitria, "Research Trends on Leadership in Indonesian Schools: Bibliometric Analysis (2008-2024)," *Elem. J. Educ. Res.*, vol. 2, no. 1, pp. 19–38, 2024.
- [4] S. Hamdi, N. M. Murdiyani, M. Fauzan, H. Djidu, E. Chrisdiyanto, and Z. Zafrullah, "Developing an assessment instrument for strengthening the Pancasila student profile in web-based middle school mathematics teaching," *J. Elem.*, vol. 10, no. 3, pp. 479–500, 2024.
- [5] S. Grassini, "Shaping the future of education: exploring the potential and consequences of AI and ChatGPT in educational settings," *Educ. Sci.*, vol. 13, no. 7, p. 692, 2023.
- [6] J. Code, R. Ralph, and K. Forde, "Pandemic designs for the future: perspectives of technology education teachers during COVID-19," *Inf. Learn. Sci.*, vol. 121, no. 5/6, pp. 419–431, 2020.
- [7] A. Riyanti, U. Sagena, N. C. Lestari, S. A. Pramono, and G. Al Haddar, "Internet-based learning in improving student digital literacy," *Cendikia Media J. Ilm. Pendidik.*, vol. 13, no. 4, pp. 585–594, 2023.
- [8] M. Arifin, I. Eryani, and G. Farahtika, "Students' Perception of Using Moodle as a Learning Management System in Tertiary Education," *AL-ISHLAH J. Pendidik.*, vol. 15, no. 4, pp. 5140–5152, 2023.
- [9] Y. Zhao, M. Zhao, and F. Shi, "Integrating moral education and educational information technology: A strategic approach to enhance rural teacher training in universities," *J. Knowl. Econ.*, pp. 1–41, 2023.
- [10] R. Zhou, S. M. Rashid, and S. Cheng, "Entrepreneurship education in Chinese higher institutions: Challenges and strategies for vocational colleges," *Cogent Educ.*, vol. 11, no. 1, p. 2375080, 2024.
- [11] M. Mohzana, "The Impact of the New Student Orientation Program on the Adaptation Process and Academic Performance," *Int. J. Educ. Narrat.*, vol. 2, no. 2, pp. 169–178, 2024.
- [12] A. M. Ramadhani, N. Y. B. Yakob, R. T. Ayuni, Z. Zafrullah, and A. A. Bakti, "TRENDS IN IMPLEMENTATION OF GAME USE AS LEARNING AT PRIMARY SCHOOLS LEVEL IN SCOPUS DATABASE: A BIBLIOMETRIC ANALYSIS," *J. Penyelid. Sains Sos.*, vol. 7, no. 23, 2024.
- [13] A. M. Ramadhani and H. Retnawati, "Computational Thinking and its Application in School: A Bibliometric Analysis (2008-2023)," in *International Conference on Current Issues in Education (ICCIE 2023)*, 2024, pp. 329–338, [Online]. Available: https://doi.org/10.2991/978-2-38476-245-3_35.
- [14] S. Saryanto, R. Retnaningsih, N. Nofirman, and I. Yuniwati, "Analysis The Role of School Culture in Shaping The Personality and Character of Students," *Mudir J. Manaj. Pendidik.*, vol. 5, no. 2, pp. 477–482, 2023.

- [15] N. Komariah and I. Nihayah, "Improving the personality character of students through learning Islamic religious education," *At-Tadzkir Islam. Educ. J.*, vol. 2, no. 1, pp. 65–77, 2023.
- [16] A. P. Rahayu and Y. Dong, "The relationship of extracurricular activities with students' character education and influencing factors: a systematic literature review," *AL-ISHLAH J. Pendidik.*, vol. 15, no. 1, pp. 459–474, 2023.
- [17] H. Setyawan *et al.*, "Implementation of Archery Class Management at the Pre-Extracurricular Program Stage To Improve Archery Skills of Elementary School Students," *Retos nuevas tendencias en Educ. física, Deport. y recreación*, no. 55, pp. 867–873, 2024.
- [18] J. Aliu and C. Aigbavboa, "Reviewing the roles of extracurricular activities in developing employability skills: a bibliometric review," *Int. J. Constr. Manag.*, vol. 23, no. 10, pp. 1623–1632, 2023.
- [19] M. B. Purwanto, R. Hartono, and S. Wahyuni, "Essential skills challenges for the 21st century graduates: Creating a generation of high-level competence in the industrial revolution 4.0 era," *Asian J. Appl. Educ.*, vol. 2, no. 3, pp. 279–292, 2023.
- [20] N. Ghamrawi, T. Shal, and N. A. R. Ghamrawi, "Exploring the impact of AI on teacher leadership: regressing or expanding?," *Educ. Inf. Technol.*, vol. 29, no. 7, pp. 8415–8433, 2024.
- [21] S. Walan and N. Gericke, "Transferring makerspace activities to the classroom: a tension between two learning cultures," *Int. J. Technol. Des. Educ.*, vol. 33, no. 5, pp. 1755–1772, 2023.
- [22] A. Alam and A. Mohanty, "Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics," *Int. J. Adolesc. Youth*, vol. 28, no. 1, p. 2270662, 2023.
- [23] P. Karuru, A. F. Setiawan, and S. Junaida, "Improving Students' Higher Order Thinking Skills Through a Question and Answer Method," *RETORIKA J. Ilmu Bhs.*, vol. 9, no. 3, pp. 340–349, 2023.
- [24] J. Jeon and S. Lee, "Large language models in education: A focus on the complementary relationship between human teachers and ChatGPT," *Educ. Inf. Technol.*, vol. 28, no. 12, pp. 15873–15892, 2023.
- [25] T. Doyle, *Helping students learn in a learner-centered environment: A guide to facilitating learning in higher education*. Taylor & Francis, 2023.
- [26] K. Guo, Y. Zhong, D. Li, and S. K. W. Chu, "Investigating students' engagement in chatbot-supported classroom debates," *Interact. Learn. Environ.*, pp. 1–17, 2023.
- [27] A. Wahyuni, Y. S. Kusumah, B. A. P. Martadiputra, and Z. Zafrullah, "Tren penelitian kemampuan pemecahan masalah pada pendidikan matematika: Analisis bibliometrik," *JPMI (Jurnal Pembelajaran Mat. Inov.)*, vol. 7, no. 2, pp. 337–356, 2024, doi: 10.22460/jpmi.v7i2.22329.
- [28] Z. Zafrullah, A. Meisya, and R. T. Ayuni, "ARTIFICIAL INTELLIGENCE AS A LEARNING MEDIA IN ENGLISH EDUCATION: BIBLIOMETRIC USING BIBLIOSHINY ANALYSIS (2009-2023)," *ELTR J.*, vol. 8, no. 1, pp. 71–81, 2024.
- [29] Q. Yang, Q. Chen, J. Wang, and R. Ou, "The effect of student self-efficacy on learning outcomes in a business simulation mobile game: a quasi-experimental study," *Libr. Hi Tech*, vol. 42, no. 2, pp. 547–563, 2024.
- [30] Y. Wu, "Integrating generative AI in education: how ChatGPT brings challenges for future learning and teaching," *J. Adv. Res. Educ.*, vol. 2, no. 4, pp. 6–10, 2023.
- [31] I. Asal, D. R. M. I. Yousuf, and D. R. M. Imran, "Parents and Teachers Attitudes

- toward Life Skills-based Education at Elementary Level,” *Int. J. Acad. Res. Humanit.*, vol. 4, no. 1, pp. 64–76, 2024.
- [32] S. J. H. Yang, H. Ogata, T. Matsui, and N.-S. Chen, “Human-centered artificial intelligence in education: Seeing the invisible through the visible,” *Comput. Educ. Artif. Intell.*, vol. 2, p. 100008, 2021.
- [33] J. H. L. Koh, “Three approaches for supporting faculty technological pedagogical content knowledge (TPACK) creation through instructional consultation,” *Br. J. Educ. Technol.*, vol. 51, no. 6, pp. 2529–2543, 2020.
- [34] T. Wang *et al.*, “Exploring the potential impact of artificial intelligence (AI) on international students in higher education: Generative AI, chatbots, analytics, and international student success,” *Appl. Sci.*, vol. 13, no. 11, p. 6716, 2023.
- [35] D. T. K. Ng, W. Luo, H. M. Y. Chan, and S. K. W. Chu, “Using digital story writing as a pedagogy to develop AI literacy among primary students,” *Comput. Educ. Artif. Intell.*, vol. 3, p. 100054, 2022.
- [36] R. F. O. Cayubit, “Why learning environment matters? An analysis on how the learning environment influences the academic motivation, learning strategies and engagement of college students,” *Learn. Environ. Res.*, vol. 25, no. 2, pp. 581–599, 2022.
- [37] M. M. Asad, N. Hussain, M. Wadho, Z. H. Khand, and P. P. Churi, “Integration of e-learning technologies for interactive teaching and learning process: an empirical study on higher education institutes of Pakistan,” *J. Appl. Res. High. Educ.*, vol. 13, no. 3, pp. 649–663, 2021.
- [38] P. Onu, A. Pradhan, and C. Mbohwa, “Potential to use metaverse for future teaching and learning,” *Educ. Inf. Technol.*, vol. 29, no. 7, pp. 8893–8924, 2024.
- [39] D. A. S. Widolaksono, L. Harun, L. Ariyanto, and A. Supriyanto, “Implementation of discovery learning model to improve student learning outcomes,” *Union J. Ilm. Pendidik. Mat.*, vol. 11, no. 2, pp. 294–304, 2023.
- [40] T. Rasul *et al.*, “The role of ChatGPT in higher education: Benefits, challenges, and future research directions,” *J. Appl. Learn. Teach.*, vol. 6, no. 1, pp. 41–56, 2023.
- [41] F. Farida, A. Rotama, D. Dharmawan, and A. Pahrudin, “How relevance of philosophy, science and science philosophy through the study of mathematical logic?,” *Al-Jabar J. Pendidik. Mat.*, vol. 15, no. 1, 2024.
- [42] W. Purwandari, I. M. B. Tarigan, N. Sinuhaji, P. Ramles, and P. A. Chusna, “DELVING INTO THE WORLD OF NUMBERS: INNOVATIVE APPROACHES IN ELEMENTARY MATHEMATICS EDUCATION,” *Int. J. Teach. Learn.*, vol. 2, no. 2, pp. 522–529, 2024.
- [43] S. R. Powell, E. N. Mason, S. E. Bos, S. Hirt, L. R. Ketterlin-Geller, and E. S. Lembke, “A Systematic Review of Mathematics Interventions for Middle-School Students Experiencing Mathematics Difficulty,” *Learn. Disabil. Res. Pract.*, vol. 36, no. 4, pp. 295–329, 2021.
- [44] É. Fülöp, “Developing problem-solving abilities by learning problem-solving strategies: an exploration of teaching intervention in authentic mathematics classes,” *Scand. J. Educ. Res.*, vol. 65, no. 7, pp. 1309–1326, 2021.
- [45] T. Zhang, *Mathematical analysis of machine learning algorithms*. Cambridge University Press, 2023.
- [46] J. Nilimaa, “New Examination Approach for Real-World Creativity and Problem-Solving Skills in Mathematics,” *Trends High. Educ.*, vol. 2, no. 3, pp. 477–495, 2023.
- [47] Ü. Çakıroğlu, M. Güler, M. Dündar, and F. Coşkun, “Virtual reality in realistic

- mathematics education to develop mathematical literacy skills,” *Int. J. Human–Computer Interact.*, vol. 40, no. 17, pp. 4661–4673, 2024.
- [48] S. Poçan, B. Altay, and C. Yaşaroğlu, “The effects of mobile technology on learning performance and motivation in mathematics education,” *Educ. Inf. Technol.*, vol. 28, no. 1, pp. 683–712, 2023.
- [49] N. Donthu, S. Kumar, D. Mukherjee, N. Pandey, and W. M. Lim, “How to conduct a bibliometric analysis: An overview and guidelines,” *J. Bus. Res.*, vol. 133, no. 3, pp. 285–296, 2021.
- [50] S. M. Hanaa and A. P. Abdul, “A holistic approach to augmented reality-related research in tourism: through bibliometric analysis,” *J. Hosp. Tour. Insights*, vol. 7, no. 1, pp. 76–94, 2024.
- [51] Z. Zafrullah, A. Fitriani, A. M. Ramadhani, and S. M. N. Hidayah, “Transformasi Adobe Flash dalam Dunia Pendidikan: Analisis Bibliometrik (2006-2023),” *Indo-MathEdu Intellectuals J.*, vol. 4, no. 3, pp. 1652–1666, 2023, [Online]. Available: <https://doi.org/10.54373/imeij.v4i3.387>.
- [52] Z. Zafrullah, Y. K. Sembiring, N. Ramadana, R. N. Gunawan, and K. Kusumawardhani, “Research Trends on the Use of Artificial Intelligence in Educational Environments in Southeast Asia on Scopus Database: A Bibliometric Analysis (2014-2024),” *Innov. J. Soc. Sci. Res.*, vol. 4, no. 5, pp. 8972–8989, 2024.
- [53] Z. Zafrullah, R. N. Gunawan, H. Haidir, and A. M. Ramadhani, “IMPLEMENTASI PENGGUNAAN KEMAMPUAN COMPUTATIONAL THINKING PADA SEKOLAH ANAK-ANAK: ANALISIS BIBLIOMETRIK (2014-2024),” *J. Binagogik*, vol. 11, no. 2, pp. 201–225, 2024.
- [54] Z. Zafrullah, A. M. Ramadhani, R. T. Ayuni, N. T. Fadhilla, and R. Safitri, “The Using Confirmatory Factor Analysis as Construct Validity in Education Research: A Analysis with Biblioshiny,” *DIROSAT J. Educ. Soc. Sci. Humanit.*, vol. 2, no. 3, pp. 206–220, 2024.
- [55] Z. Zafrullah and Z. Zetriuslita, “Learning interest of seventh grade students towards mathematics learning media assisted by Adobe Flash CS6,” *Math Didact. J. Pendidik. Mat.*, vol. 7, no. 2, pp. 114–123, Aug. 2021, doi: 10.33654/math.v7i2.1272.
- [56] M. L. Hakim and M. Angga, “ChatGPT Open AI: Analysis of Mathematics Education Students Learning Interest,” *J. Technol. Glob.*, vol. 1, no. 01, pp. 1–10, 2023, [Online]. Available: <https://penaeducentre.com/index.php/JTeG/article/view/35>.