TEMATIK: Jurnal Konten Pendidikan Matematika
Volume 3, Number 1, Tahun 2025, pp. 84-95
ISSN: 2985-8844
Open Access: http://doi.org/10.55210/jkpm

Metacognitive Research in Mathematics Education: a Bibliometric Analysis from 2000 to 2024

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INFORMASI ARTIKEL
Tersedia Online pada:
April 30, 2025

Kata Kunci:
Metakognitif, Metakognisi, Pendidikan Matematika, Bibliometrik

Keywords:
Metacognitive, Metacognition, Mathematics Education, Bibliometric

Abstrak

Kemampuan pemecahan masalah merupakan salah satu dari empat keterampilan kunci dalam pembelajaran matematika. Salah satu faktor yang mempengaruhi kemampuan pemecahan masalah matematika adalah kemampuan metakognitif. Kemampuan metakognitif merupakan salah satu bentuk keterampilan berpikir tingkat lanjut yang meliputi langkah-langkah perencanaan, pemantauan, dan evaluasi dalam menyelesaikan suatu masalah. Penelitian ini bertujuan untuk: 1) menganalisis tren tahunan penelitian tentang metakognisi dalam konteks penelitian pendidikan matematika, 2) mengkaji kontribusi jumlah publikasi berdasarkan nama pengarang, 3) mengidentifikasi jurnal yang paling aktif menerbitkan artikel terkait studi metakognitif dalam pendidikan matematika, dan 4) menganalisis sebaran artikel studi metakognitif yang paling sering dikutip dalam penelitian pendidikan matematika. Penelitian ini merupakan penelitian analisis bibliometrik. Sebanyak 115 artikel dipilih menjadi 36 artikel dari tahun 2000 sampai dengan tahun 2024. Artikel penelitian tentang studi metakognitif dalam pendidikan matematika menunjukkan peningkatan yang stabil dari tahun 2000 sampai dengan saat ini, yang mencerminkan semakin besarnya minat dan pengakuan terhadap signifikansi bidang ini. Isu-isu mengenai penelitian ini setelah tahun 2022 banyak diangkat sebagai bahan kajian penelitian sehingga masih sangat relevan apabila ada penelitian lanjutan mengenai fokus penelitian ini. Penulis dan pengelola jurnal diharapkan mampu meningkatkan kualitas artikel yang dibuat atau dikelola sehingga memperoleh banyak sitasi dan berdampak pada fokus kajian metakognitif dalam pendidikan matematika.

Abstract

Problem-solving ability is one of the four key skills in learning mathematics. One of the factors that influences mathematical solving abilities is metacognitive ability. Metacognitive abilities are a form of advanced thinking skills that include planning, monitoring, and evaluating steps in solving a problem. This study aims to: 1) analyze the annual trend of studies on metacognition in the context of mathematics education research, 2) assess the contribution of the number of publications based on author names, 3) identify the journals that are most active in publishing articles related to metacognitive studies in mathematics education, and 4) analyzing the distribution of the most frequently cited articles in metacognitive studies in mathematics education research. This research is a bibliometric analysis research. There were 115 articles selected into 36 articles from 2000 to 2024. Research articles on metacognitive studies in mathematics education show a steady increase from 2000 to the present, reflecting the growing interest and recognition of the significance of this field. Issues regarding this study after 2022 have been widely raised as research study material so it is still very relevant if there is further research regarding the focus of this study. Writers and journal managers are expected to be able to improve the quality of articles created or managed so that they get lots of citations and have an impact on the focus of metacognitive studies in mathematics education.

INTRODUCTION

Mathematics is a discipline that students are required to learn and engage with at every level of education, from elementary to higher education. In fact, mathematics is often still a basic subject that is mandatory for students at higher education level. For example, calculus courses studied in the engineering department, statistics courses studied in the non-exact department, and so on. Students are expected to understand and comprehend mathematical content to facilitate the mathematics learning process. Students' experience of mathematics difficulties is due to the need to master concepts (Melinda & Margareta, 2019). The difficulty in mastering concepts to solve specific problems often arises from a lack of support in identifying strategies and articulating thought processes when tackling mathematical problems (Raymond, 2019).

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Problem-solving ability is one of the four core skills outlined by the National Education Association (NEA), which include: 1) critical thinking and problem solving, 2) creativity and innovation, 3) communication, and 4) collaboration (Erdoğan, 2019). Problem solving is also the main skill needed in learning mathematics (Wangi et al., 2018). Problem solving is a fundamental aspect of mathematics, as it involves the ability to gather, organize, and apply information across various contexts (Hariadi et al., 2022). Problem solving is frequently associated with higher-order thinking skills (HOTS), this is due to the fact that students are generally still in the stage of developing effective and applicable strategies to solve problems (Sa'diyah et al., 2019).

Several factors influence students' problem-solving abilities, including working memory capacity, cognitive and metacognitive awareness, self-confidence, and anxiety related to mathematics (Fatmanissa & Qomaria, 2021; Juniati & Budayasa, 2020; Suliani et al., 2024). Another main factor in learning mathematics is metacognitive abilities (Laksana et al., 2024). UNESCO has stated that metacognition is one of the essential skills for the 21st century. OECD also states that metacognitive is one of the key competencies that students need to develop in 2030. Metacognition is closely linked to problem-solving abilities, academic performance, and success in the life sciences (Halmo et al., 2024). In research by Fernie et al. (2018), there is a significant relationship between students' level of metacognition in mathematics and their mathematics learning achievement.

Various studies on metacognition have been conducted. Adiansyah (2022) found that the metacognitive skills of Biology Education students in South Sulawesi showed that 8% were classified as well developed, 28% were in the category of starting to develop, around 48% were in the developing category, and around 16% were classified as very risky. Meanwhile, Dewi et al. (2023) identified learning difficulties of students in the Computer Systems and Information Technology Study Program in Bali, with a percentage of 51.61% in the aspect of determining learning objectives, 64.52% in the aspect of process monitoring, 51.61% in the clarity of monitoring, and 48.39% in the accuracy of monitoring. Research by Soeharto et al. (2024) showed that the metacognitive awareness of PGSD students in various regions such as Kalimantan, Java, Sumatra, and Sulawesi was generally at a moderate level. Based on these findings, it can be concluded that most students in Indonesian universities still have metacognitive skills in the moderate category.

Based on previous research, it shows that there are still many problems regarding metacognitive, especially in mathematics education. Therefore, it is still necessary to carry out further research related to metacognitive in mathematics education. So far, there has never been a bibliometric analysis research conducted from the beginning when this metacognitive problem emerged until 2024 which focused on mathematics education. This study aims to: 1) analyze the annual trend of studies on metacognition in the context of mathematics education research, 2) assess the contribution of the number of publications based on author names, 3) identify the journals that are most active in publishing articles related to metacognitive studies in mathematics education, and 4) analyzing the distribution of the most frequently cited articles in metacognitive studies in mathematics education research.

METHOD

This research is a bibliometric analysis research. Metadata was obtained from the Scopus database using the keyword "metacognitive" OR "metacognition" using subject area filters, namely social sciences and mathematics, document type filters in the form of articles, source type filters in the form of journals, language filters in the form of English, and open access filters in the form of all open access. The search was carried out on March 13 2024. It found 115 journal articles between 2000 and 2024 that focused on metacognitive topics in mathematics learning. The main information can be found in Table 1.

Table 1. Main information.

Description	Results
Main Information about Data	
Timespan	2000:2024
Sources (Journals, Books, etc)	46
Documents	115
Annual Growth Rate %	5.95
Document Average Age	5.88
Average citations per doc	14.3
References	6084
Document Contents	
Keywords Plus (ID)	388
Author's Keywords (DE)	439
Authors	
Authors	292
Authors of single-authored docs	17
Authors Collaboration	
Single-authored docs	18
Co-Authors per Doc	2.81
International co-authorships %	21.74
Document Types	
Article	115

The screening stage was carried out through the title and abstract of the 115 articles. There were 72 articles that passed the screening stage and there were 43 articles that did not pass the screening stage. Of the 72 articles, they continued to the next stage, namely full text review. There were 36 articles that passed and 36 articles that did not pass this stage. Of the 36 articles that did not pass, some were due to 15 articles due to wrong outcomes, 14 articles due to wrong study design, six articles due to wrong patient population, and one article due to wrong route of administration. The PRISMA of the stages of this selection can be seen in Figure 1.

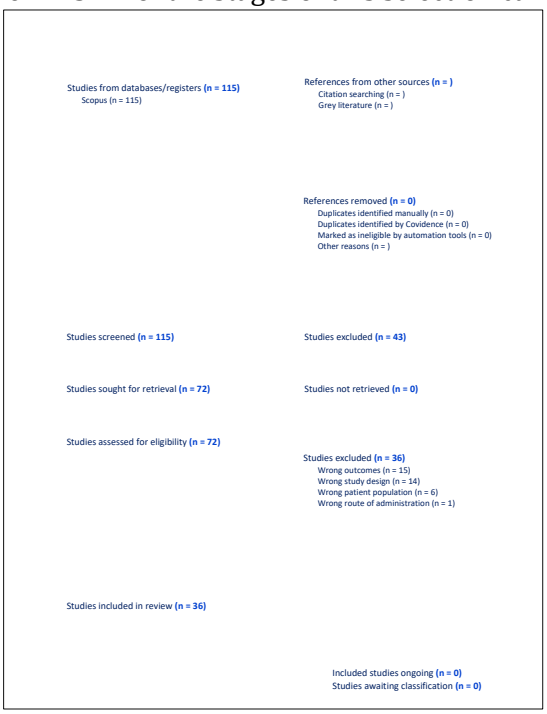

Figure 1. Flowchart according to the PRISMA declaration.

RESULT AND DISCUSSION

The results of annual scientific production are shown in Figure 2.

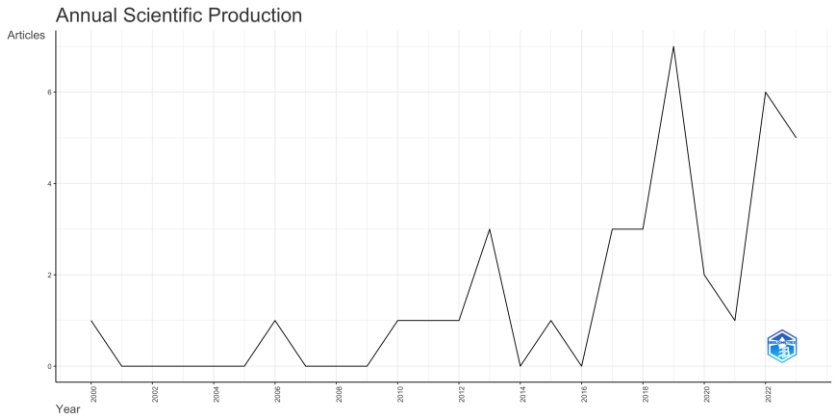

Figure 2. Annual scientific production.

The annual report of this publication can be found in Figure 2. There are a large number of articles discussing metacognitive studies in mathematics education, with the largest number of articles published in 2019, namely 7 articles. The most recent publications occurred in 2023, with a total of 5 articles. This analysis shows a steady rise in research articles on metacognition in mathematics education from 2000 to 2024, starting with only one publication in 2000 and gaining momentum as a regular research topic from 2017 onwards. However, there were no similar studies conducted between 2001 to 2005, 2007 to 2009, 2014, and 2016. The number of publications has varied over time, with periods of rapid growth followed by slower expansion. The growth rate fluctuates between decline and increase. These publications reflect the growing interest and acknowledgment of the importance of these studies in scientific educational research, as advancements in research techniques and resources enable researchers to explore these topics more extensively.

The results of average citations per year are shown in Figure 3.

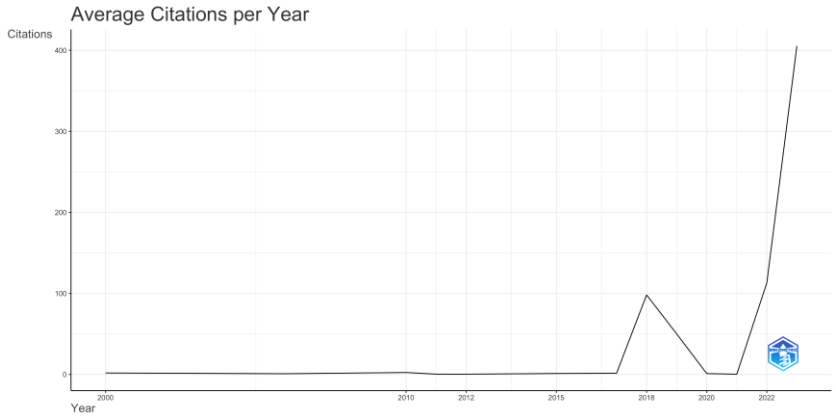

Figure 3. Average citations per year.

The average citation report per year from 2000 to 2017 looks very low, in the range of 0.5 to 2.5. There was an increase in the average citations in 2018, namely 98.1, although after that it experienced a decline. In 2022, the average will increase again by 113 and continue to increase until 2023, amounting to 405.4. This shows that issues regarding metacognitive after 2022 have begun to be widely raised as material for research studies so that it is still very relevant if there is further research on metacognitive studies in mathematics education research.

The results of the most relevant sources are shown in Table 2.

Tabel 2. Most relevant sources.

Sources	Articles
EURASIA - Journal of Mathematics, Science and Technology Education	9
ZDM - Mathematics Education	6
Journal on Mathematics Education	4
BOLEMA - Mathematics Education Bulletin	3
Mathematics	3
Infinity Journal	2
ZDM - International Journal on Mathematics Education	2
International Journal of Mathematical Education in Science and Technology	1
International Journal of Science and Mathematics Education	1
Journal for Research in Mathematics Education	1
Journal of Numerical Cognition	1
PRIMUS	1
PYTHAGORAS	1
Research In Mathematics Education	1

This academic journals play an important role in deepening our understanding of how metacognition influences the process of teaching and learning mathematics. Table 2 provides evidence that EURASIA - Journal of Mathematics, Science and Technology Education, ZDM - Mathematics Education, and Journal on Mathematics Education are the three journals most relevant to this study. This can make journal managers more selective in seeing their relevance to the focus of metacognitive studies in mathematics education.

The source impact results are shown in Table 3.

Tabel 3. Source impact.

Source	h index	g index	m index	TC	NP	PY start
EURASIA - Journal of Mathematics, Science and Technology Education	4	9	0.333	2064	9	2013
Journal on Mathematics Education	4	4	0.286	17	4	2011
ZDM - Mathematics Education	4	6	0.667	76	6	2019
BOLEMA - Mathematics Education Bulletin	3	3	0.375	2054	3	2017
Mathematics	2	3	0.333	2033	3	2019
ZDM - International Journal on Mathematics Education	2	2	0.105	53	2	2006
Infinity Journal	1	1	0.167	3	2	2019
International Journal of Mathematical Education in Science and Technology	1	1	0.5	2024	1	2023
International Journal of Science and Mathematics Education	1	1	0.5	3	1	2023
Journal for Research in Mathematics Education	1	1	0.04	46	1	2000
Journal of Numerical Cognition	1	1	0.2	3	1	2020
PRIMUS	1	1	0.333	3	1	2022
PYTHAGORAS	1	1	0.143	2024	1	2018
Research in Mathematics Education	1	1	0.143	35	1	2018

Based on Table 3, it is evident there are three journals that have had the greatest impact related to this study. That journals are ZDM - Mathematics Education, Journal on Mathematics

Education, and EURASIA - Journal of Mathematics, Science and Technology Education. Through their published works, these journals significantly contribute to shaping theoretical frameworks and advancing research methodologies. This influence can encourage journal managers to be more selective when reviewing prospective articles, ensuring that they have a greater impact on metacognitive issues in mathematics education.

The results of sources' production over time are shown in Figure 4.

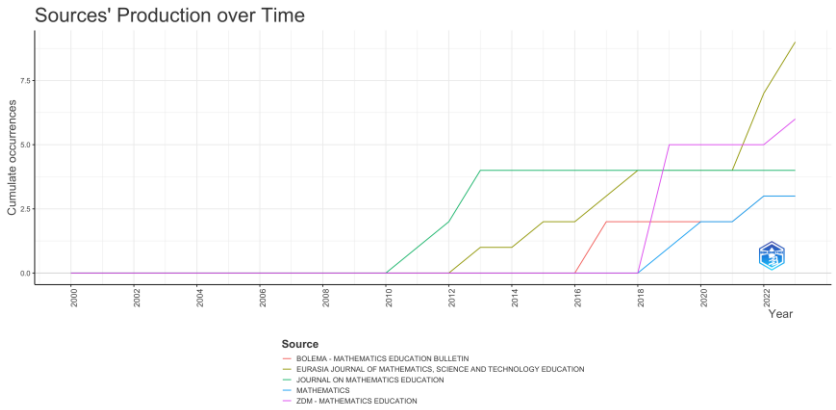

Figure 4. Sources' production over time.

Based on Figure 4, it can be seen that EURASIA - Journal of Mathematics, Science and Technology Education, ZDM - Mathematics Education, Journal on Mathematics Education, Mathematics, BOLEMA - Mathematics Education Bulletin are the five most productive articles producing articles related to metacognitive studies in education mathematics. These five journals did not start producing articles related to the study in 2020. Such as the Journal on Mathematics Education which only produced this study article in 2011, EURASIA - Journal of Mathematics, Science and Technology Education which only produced this study article in 2013, BOLEMA - Mathematics Education Bulletin which only produced this study article in 2017, ZDM - Mathematics Education and Mathematics which only produced this study article in 2019. These journals consistently produce metacognitive studies in mathematics education every year even though the number of articles published fluctuates.

The most relevant author results are shown in Figure 5.

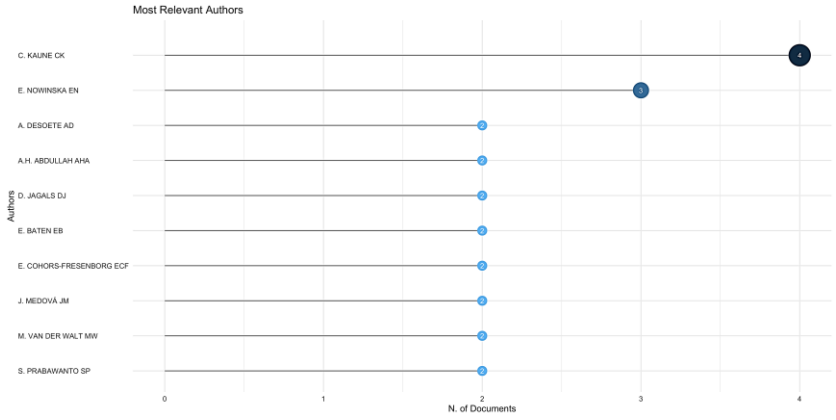

Figure 5. Most relevant author.

Based on Figure 5, it is evident that the distribution of articles authored on metacognitive studies in mathematics education has shifted over time, spanning the period from 2000 to 2024. It can be seen that two authors have more than two articles relevant to metacognitive studies in mathematics education. Other authors have only two or one relevant article. This can encourage researchers to study more metacognitive issues in mathematics education because there is still not much relevance of articles written by previous authors.

The results of the authors' local impact by H index are shown in Figure 6.

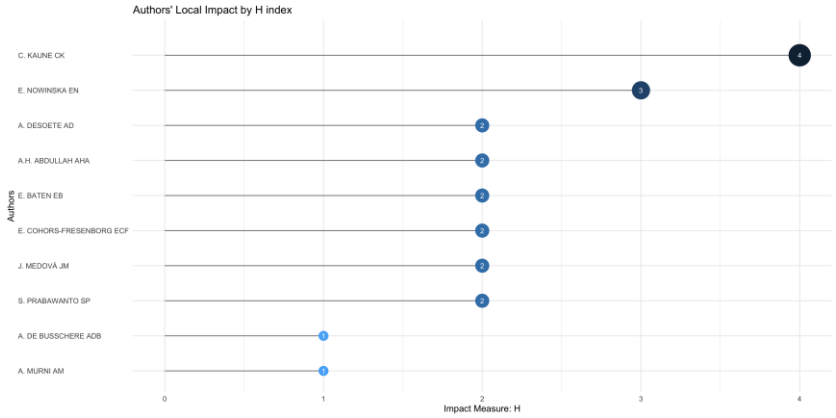

Figure 6. Authors' local impact by h index.

Based on Figure 6, it provides evidence that one author is the author who has had the greatest impact related to metacognitive studies in mathematics education. Through their publications, these authors contribute to the development of theoretical frameworks and research methodologies. This can make researchers better at conducting research so that they can have more impact on metacognitive issues in mathematics education.

The results of most global cited documents are shown in Figure 7.

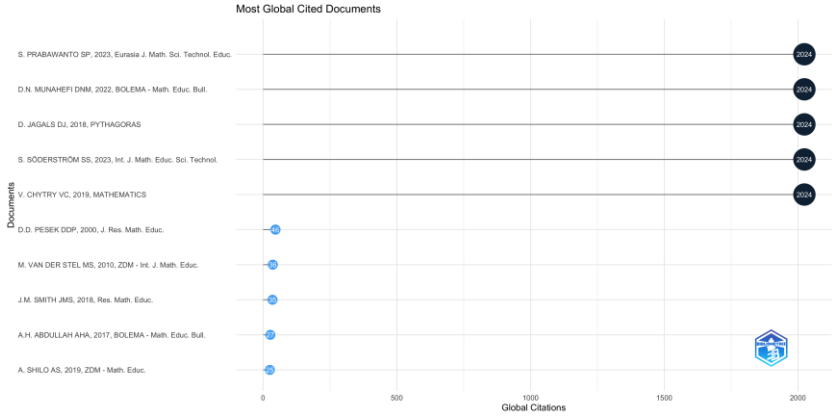

Figure 7. Most global cited documents.

According to Figure 7, the distribution of the most frequently cited articles shows that five authors received the highest number of citations in 2024. The next five authors received citations ranging from 25 to 50. Meanwhile, the other authors only received a number of citations below 25. It can be seen that of the five authors who received the most citations, only one author entered the top 10 authors who had a big impact related to metacognitive studies in mathematics education. The other nine authors who received the most citations were not included in the top 10 authors who had a big impact on this study.

Metacognitive abilities stem from cognitive psychology and significantly impact students' understanding of given problems, problem-solving, planning, self-confidence, and behavior regulation related to problem solving. These factors are crucial components of learning achievement (Saparbaikyzy et al., 2023). Although there is some criticism suggesting that metacognition closely resembles the concept of the problem-solving process as outlined by Polya (Anupan & Chimmalee, 2024). Metacognitive abilities influence the thinking process when solving problems and are an important factor for students to carry out and monitor behavior, achieve academic goals, and also improve student achievement (Nguyen, 2023). Metacognitive abilities contribute to the development of meaningful mathematics learning for students (Ahmad & Febryanti, 2018). Metacognitive abilities should be developed in students to assist

them in solving mathematical problems accurately and effectively (Aituganova et al., 2023). Metacognitive abilities refer to the processes and stages of an individual's thinking when solving problems, which play a significant role in the development of cognitive maturity (Purwati et al., 2024).

Metacognitive can also improve decision-making abilities (Wess et al., 2021). Metacognitive is understanding and analyzing ways of thinking so that you can make the right decisions in solving problems (Zendrato & Harefa, 2023). Metacognition enhances an individual's awareness of their thought processes during specific tasks, and this awareness is subsequently used to guide and adjust the steps taken to reach the desired outcome (Fitri, 2017). Students' metacognitive development can evolve in a complex way, supported by meaningful interactions with peers or peer tutors, each contributing in line with their specific roles (Dindar et al., 2020). Metacognitive ability is one of the higher-order thinking skills in Bloom's Taxonomy, which encompasses activities such as analyzing, evaluating, and creating (Anggraini & Pratiwi, 2019). These metacognitive activities can encourage students to collaborate skills that form learning strategies in solving problems (Baten et al., 2017). The components or aspects of metacognitive abilities can also predict a person's problem-solving abilities (Arum et al., 2019). Most students cannot plan, monitor, and evaluate solving mathematical problems or problems that are being solved (Amir, 2018).

A person's learning achievement is shaped by their metacognitive abilities. Thus, if every learning activity includes indicators on how to learn, optimal results are certainly achievable (Widodo et al., 2023). A person with a high level of cognitive regulation is more likely to achieve better outcomes in the problem-solving process compared to someone with a medium level of cognitive regulation (Hidayat et al., 2021). Someone who lacks metacognitive knowledge tends to perform worse and has difficulty understanding problems, choosing appropriate strategies, and finding the right answers (Güner & Erbay, 2021). An individual with strong metacognitive skills tends to excel at assessing learning strategies and identifying mistakes in their work (Mishra, 2019). Students with a higher academic level are generally more aware of metacognitive strategies and tend to demonstrate stronger mathematical abilities (Hidayat et al., 2018). Students with poor metacognitive skills often struggle to achieve good learning outcomes.

There are several opinions about the aspects and indicators that exist in metacognitive abilities. According to Safitri & Suryani (2024), metacognitive awareness consists of eight indicators: declarative knowledge, procedural knowledge, conditional knowledge, planning, information management, monitoring, the process of finding and correcting errors, and evaluating. While Desoete et al. (2019) divides metacognitive into two types, namely metacognitive knowledge and metacognitive skills. According to Branigan & Donaldson (2020), there are three processes in metacognitive abilities, namely awareness, regulation, and evaluation. In line with that, Triwahyuningtyas, et al. (2024) also is divided into three activities: metacognitive awareness, metacognitive regulation, and metacognitive evaluation. Metacognitive awareness is the ability possessed by students to understand and obtain information about the problem to be solved, as well as determining the next steps to be taken. Metacognitive regulation is students' ability to choose and apply strategies that will be used to solve problems, as well as choosing the right strategy to correct answers if there are errors. Metacognitive evaluation is the ability of students to assess their metacognitive awareness and metacognitive regulations.

CONCLUSION AND SUGGESTIONS

Since 2000 until now, there has been a significant gradual increase in the number of research articles on metacognitive studies in mathematics education, reflecting the increasing attention of academics and educational practitioners to the important role of metacognition in the mathematics learning process. This publication reflects the growing interest and recognition of the importance of these studies in scientific educational research, as advances in research techniques and resources allow researchers to explore these topics in greater depth. Issues

regarding this study after 2022 have begun to be raised as research study material so it is still very relevant if there is further research on metacognitive studies in mathematics education research. Journal managers must be more selective in looking at the relevance and impact of articles on the focus of metacognitive studies in mathematics education. Other journals need to consistently produce the focus of this study. Researchers must study more metacognitive issues in mathematics education because there is still not much relevance of articles written by previous authors and improve the quality of articles so that they can have an impact on the focus of this study. There are already several sufficient sources that can be used to research the focus of this study.

REFERENCES

Adiansyah, R. (2022). Profil keterampilan metakognitif mahasiswa calon guru biologi di Universitas Muhammadiyah Bone. *Al-Nafis: Jurnal Biologi Dan Pendidikan Biologi*, *2*(1), 27–37.

Ahmad, H., & Febryanti, F. (2018). Description of student's metacognitive ability in understanding and solving mathematics problem. *IOP Conference Series: Materials Science and Engineering*, *300*(1), 012048. https://doi.org/10.1088/1757-899X/300/1/012048

Aituganova, S., Sarekenova, K., Aubakir, Z., Seiputanova, A., Karipbayev, Z., & Aimukhambet, Z. (2023). The impact of online technologies supported by the teaching of poetry poetology on the achievements and attitudes of students. *International Journal of Education in Mathematics, Science and Technology*, *11*(3), 662–682. https://doi.org/10.46328/ijemst.3313

Amir, M. F. (2018). Pengembangan perangkat pembelajaran berbasis masalah kontekstual untuk meningkatkan kemampuan metakognisi siswa sekolah dasar. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, *2*(1), 117–128. https://doi.org/10.31331/medives.v2i1.538

Anggraini, N. P., & Pratiwi, H. (2019). Analysis of higher order thinking skills students at junior high school in Surakarta. *Journal of Physics: Conference Series*, *1211*(1), 012077. https://doi.org/10.1088/1742-6596/1211/1/012077

Anupan, A., & Chimmalee, B. (2024). Analysis of undergraduate students' metacognitive ability in mathematical problem-solving using cloud classroom blended learning. *Anatolian Journal of Education*, *9*(1), 1–18. https://doi.org/10.29333/aje.2024.911a

Arum, R. P., Widjajanti, D. B., & Retnawati, H. (2019). Metacognitive awareness: How it affects mathematical problem-solving process. *Journal of Physics: Conference Series*, *1320*(1), 012054. https://doi.org/10.1088/1742-6596/1320/1/012054

Baten, E., Praet, M., & Desoete, A. (2017). The relevance and efficacy of metacognition for instructional design in the domain of mathematics. *ZDM*, *49*, 613–623. https://doi.org/10.1007/s11858-017-0851-y

Branigan, H. E., & Donaldson, D. I. (2020). Teachers matter for metacognition: Facilitating metacognition in the primary school through teacher-pupil interactions. *Thinking Skills and Creativity*, *38*, 100718. https://doi.org/10.1016/j.tsc.2020.100718

Desoete, A., Baten, E., Vercaemst, V., De Busschere, A., Baudonck, M., & Vanhaeke, J. (2019). Metacognition and motivation as predictors for mathematics performance of Belgian elementary school children. *ZDM*, *51*, 667–677. https://doi.org/10.1007/s11858-018-01020-w

Dewi, K. H. S., Sudiatmika, I. P. G. A., Fernando, A., Raspati, Y. A. B. P., & Jayaningsi, A. A. R. (2023). Diagnostik Kesulitan Belajar Mahasiswa Berdasarkan Sistem Metakognif pada Taksonomi Marzano. *Jurnal Review Pendidikan Dan Pengajaran (JRPP)*, *6*(2), 115–124.

Dindar, M., Järvelä, S., & Järvenoja, H. (2020). Interplay of metacognitive experiences and performance in collaborative problem solving. *Computers & Education*, *154*, 103922. https://doi.org/10.1016/j.compedu.2020.103922

Erdoğan, V. (2019). Integrating 4C skills of 21st century into 4 language skills in EFL classes. *International Journal of Education and Research*, *7*(11), 113–124.

Fatmanissa, N., & Qomaria, N. (2021). Beliefs on Realism of Word Problems: A Case of Indonesian Prospective Mathematics Teachers. *Mathematics Teaching Research Journal*, *13*(4), 221–241.

Fernie, B. A., Kopar, U. Y., Fisher, P. L., & Spada, M. M. (2018). Further development and testing of the metacognitive model of procrastination: Self-reported academic performance. *Journal of Affective Disorders*, *240*, 1–5. https://doi.org/10.1016/j.jad.2018.07.018

Fitri, R. (2017). Metakognitif pada proses belajar anak dalam kajian neurosains. *JP (Jurnal Pendidikan): Teori Dan Praktik*, *2*(1), 56–64. https://doi.org/10.26740/jp.v2n1.p56-64

Güner, P., & Erbay, H. N. (2021). Metacognitive Skills and Problem-Solving. *International Journal of Research in Education and Science*, *7*(3), 715–734. https://doi.org/10.46328/ijres.1594

Halmo, S. M., Yamini, K. A., & Stanton, J. D. (2024). Metacognition and Self-Efficacy in Action: How First-Year Students Monitor and Use Self-Coaching to Move Past Metacognitive Discomfort During Problem Solving. *CBE—Life Sciences Education*, *23*(2), ar13.

Hariadi, B., Jatmiko, B., Sunarto, M. J., Prahani, B. K., Sagirani, T., Amelia, T., & Lemantara, J. (2022). Higher Order Thinking Skills Based Learning Outcomes Improvement with Blended Web Mobile Learning Model. *International Journal of Instruction*, *15*(2), 565–578. https://doi.org/10.29333/iji.2022.15231a

Hidayat, R., Qudratuddarsi, H., Mazlan, N. H., & Zeki, M. Z. M. (2021). Evaluation of a test measuring mathematical modelling competency for indonesian college students. *Journal of Nusantara Studies (JONUS)*, *6*(2), 133–155. https://doi.org/10.24200/jonus.vol6iss2pp133-155

Hidayat, R., Zulnaidi, H., & Syed Zamri, S. N. A. (2018). Roles of metacognition and achievement goals in mathematical modeling competency: A structural equation modeling analysis. *PloS One*, *13*(11), e0206211. https://doi.org/10.1371/journal.pone.0206211

Juniati, D., & Budayasa, I. K. (2020). The mathematics anxiety: Do prospective math teachers also experience it? *Journal of Physics: Conference Series*, *1663*(1), 012032. https://doi.org/10.1088/1742-6596/1663/1/012032

Laksana, S. D., Setyosari, P., Praherdhiono, H., Kuswandi, D., & Jannan, D. (2024). The Effect of the Use of Digital Gamification and Metacognitive Skills on Students' Mathematics Solving Ability. *Pegem Journal of Education and Instruction*, *14*(3), 117–125. https://doi.org/10.47750/pegegog.14.03.11

Melinda, R., & Margareta, A. (2019). Analisis kesalahan konsep siswa dalam menyelesaikan soal ulangan matematika dengan metode newman. *ANALISIS KESALAHAN KONSEP SISWA DALAM MENYELESAIKAN SOAL ULANGAN MATEMATIKA DENGAN METODE NEWMAN*.

Mishra, B. (2019). An age and gender-based analysis of 'Metacognitive Awareness Inventory'(MCAI) among first-year MBBS students from a Central Indian medical college. *The Journal of Community Health Management*, *6*(3), 77–81. https://doi.org/10.18231/j.jchm.2019.018

Nguyen, H. (2023). PERCEIVED SUPPORT FROM INSTRUCTOR & PEERS AND STUDENTS'SELF-REGULATED LEARNING DURING TEMPORARY ONLINE PIVOTED LEARNING. *Turkish Online Journal of Distance Education*, *24*(3), 192–208. https://doi.org/10.17718/tojde.1140242

Purwati, H., Indiati, I., & Savira, A. M. (2024). The Influence of STEM: Integrated PjBL Learning Models on Students' Mathematical Creative Thinking Abilities Examined from a Metacognitive Perspective. *KnE Social Sciences*, 528–540. https://doi.org/10.18502/kss.v9i6.15302

Raymond, K. M. (2019). First-year secondary mathematics teachers' metacognitive knowledge of communication activities. *Investigations in Mathematics Learning*, *11*(3), 167–179. https://doi.org/10.1080/19477503.2018.1425590

Sa'diyah, M., Sa'dijah, C., & Handayani, U. (2019). How Students Build Their Mathematical Dispositions towards Solving Contextual and Abstract Mathematics Problems. *Journal of Physics: Conference Series*, *1397*(1), 012090. https://doi.org/10.1088/1742-6596/1397/1/012090

Safitri, M., & Suryani, N. (2024). Validity of Metacognitive Awareness Inventory as A Measuring Tool for Metacognitive Ability in Mathematics Problem Solving. *Journal of Law and Sustainable Development*, *12*(1), e2246–e2246.

Saparbaikyzy, S., Assilbayeva, F., Botabayeva, A., Kim, O., Akparova, Z., & Bekbayeva, M. (2023). A study on scientific thinking skills and professional experience of teachers. *International Journal of Education in Mathematics, Science and Technology*, *11*(3), 570–585. https://doi.org/10.46328/ijemst.3308

Soeharto, S., Martono, M., Hairida, H., Akhmetova, A., Arifiyanti, F., Benő, C., & Charalambos, C. (2024). The metacognitive awareness of reading strategy among pre-service primary teachers and the possibility of rating improvement using Rasch analysis. *Studies in Educational Evaluation*, *80*, 101319.

Suliani, M., Juniati, D., & Lukito, A. (2024). Mathematics belief impact on metacognition in solving geometry: Middle school students. *Journal of Education and Learning (EduLearn)*, *18*(2), 286–295.

Triwahyuningtyas, D., Sa'dijah, C., Muksar, M., & Subanji, S. (2024). Analysis of metacognitive characteristics in group discussion on grade 5 fraction materials. *JPPI (Jurnal Penelitian Pendidikan Indonesia)*, *10*(1), 399–408. https://doi.org/10.29210/020243715

Wangi, N. B. S., Setyosari, P., Kuswandi, D., & Dwiyogo, W. D. (2018). Gamification as a strategy to improve student learning motivation: Preparing student for 21st century. *International Journal of Engineering and Technology*, *7*, 323–325.

Wess, R., Klock, H., Siller, H.-S., & Greefrath, G. (2021). *Measuring professional competence for the teaching of mathematical modelling: A test instrument*. Springer Nature. https://doi.org/10.1007/978-3-030-78071-5

Widodo, B. S., Utaya, S., Sholeh, M., & Nugraheni, L. (2023). The Effectiveness of Integrating Learning Management to Online Project-Based Learning on Students' Metacognitive Abilities. *Studies in Learning and Teaching*, *4*(1), 183–194. https://doi.org/10.46627/silet.v4i1.221

Zendrato, S. I. S., & Harefa, A. O. (2023). Pengaruh Minat, Motivasi dan Kemampuan Metakognitif Terhadap Hasil Belajar Matematika Siswa SMP Negeri 1 Hiliduho. *Pedagogy: Jurnal Pendidikan Matematika*, *8*(2).