Journal of Honai Math, 7(2), 177-196, August 2024
https:/doi.org/10.30862/jhm.v7i2.557

Research trend mathematics problem solving in primary school: A bibliometric analysis using VOSviewer

Riza Fatimah Zahrah[1*], Turmudi[1], Sufyani Prabawanto[1], Winarti Dwi Febriani[2]

[1] Universitas Pendidikan Indonesia, Jawa Barat, Indonesia
[2] Unversitas Perjuangan, Jawa Barat, Indonesia

[*]Correspondence: rizafatimah@unper.ac.id

Received: 22 April 2024 | Revised: 26 June 2024 | Accepted: 6 July 2024 | Published: 1 August 2024

Abstract

In addition to the cognitive aspects of the problem-solving process, an emotional dimension undoubtedly emerges. This study aims to conduct a bibliometric analysis to map articles focusing on the emotional side of mathematical problem-solving in elementary schools, using Google Scholar as the source and VOSviewer software for analysis. Data collection was facilitated through the reference management application Publish or Perish. This software enabled a comprehensive literature review on mathematical problem-solving in elementary schools. The keywords employed in data collection included "mathematical problem solving" and "primary school." The selected publications spanned the years 2020 to 2023. The results identified 338 articles pertinent to mathematical problem-solving in primary schools published over the past four years. The analysis revealed a declining trend in global research publications on this topic from 2020 to 2023. The bibliometric analysis indicated that "mathematical problem-solving in elementary school" had 166 links. Research findings on positive emotions and psychological well-being in mathematical problem-solving have shown increased student engagement and motivation. In conclusion, the current body of research on the emotional aspects of mathematical problem solving, particularly concerning positive emotions and

psychological well-being in elementary school students, remains limited. This area presents significant opportunities for further investigation in future studies.

Keywords: Bibliometric, mathematics problem solving, primary school, VOSviewer

Introduction

Problem solving is integral to learning mathematics rather than being an isolated component of mathematics education. To develop problem-solving skills, students must regularly face situations that require them to formulate, grapple with, and resolve problems by constructing their own methods (Schoenfeld, 1985; Jäder et al., 2020). Therefore, to enhance students' problem-solving competence, they should be engaged in tasks that challenge them to solve problems independently, without explicit instructions on the methods to be used.

Problem solving in mathematics education is guided by six principles. First, successful problem solving is contingent upon recognizing the essence of the problem (Carson, 2007). Second, it utilizes existing data or information (Csapó, 2017). Third, the initial step in problem solving is to identify potential solutions (Fischer, 2012). Fourth, understanding the core of the problem precedes the attempt to solve it. Fifth, the process of generating innovative ideas must be distinct from their evaluation, as the latter can inhibit the former (Madzík, 2019). Sixth, the given situation should be transformed into a problem situation, which may sometimes need to be further refined into a decision-making situation.

Consequently, teachers should design challenging yet solvable problems that leverage students' mathematical abilities. Instructions should be crafted to clarify the goal without specifying the solution method, thereby encouraging independent problem solving. Research has shown that students who complete directed tasks and successfully construct solutions engage in both problem solving and creative reasoning. This approach underscores the importance of contextual problems in fostering effective learning environments (Granberg, 2015).

In the field of research, the term "mathematics problem solving" is often associated with other concepts, particularly within elementary education. Currently, trends in mathematics problem solving research can be analyzed using various techniques, including bibliometric analysis. Bibliometric analysis involves examining research data by analyzing article publications across several sources over a specific time period. Previous studies have conducted bibliometric analyses in the field of mathematics problem solving (Suseelan et al., 2022). For

instance, there has been bibliometric mapping of research within mathematics education (Özkaya, 2018), and studies focusing on problem solving in elementary schools, particularly in developed countries (Suseelan et al., 2022). However, research on this topic in ASEAN countries, including Indonesia, remains limited, presenting a significant opportunity for further investigation.

This study aims to conduct a bibliometric analysis mapping of articles on mathematics problem solving in elementary schools, sourced from Google Scholar, using VOSviewer software. The analysis will cover the period from 2020 to 2023. This research seeks to identify gaps in the existing literature on problem solving in elementary schools that have yet to be extensively explored. The findings can serve as a reference for future research themes, particularly those related to mathematics problem solving in Indonesia.

Methods

The research method employed in this study is bibliometric analysis. This method was selected for its capability to accurately measure and analyze publications related to mathematics problem solving in elementary schools within the specified database. Bibliometric analysis enables the search, recording, analysis, and visualization of publication documents pertinent to the chosen theme (Marín-Marín, 2021). This study utilizes the Google Scholar database, which is recognized for its accessibility and comprehensive indexing. The analytical tools provided by Google Scholar were deemed sufficient to obtain the majority of the required results.

To facilitate data collection, the Harzing's Publish or Perish application was used to conduct a literature review on the specified theme, "Mathematics Problems." The research process involved the following stages:

1. Data Collection: Using the Harzing's Publish or Perish application on the Google Scholar database, 500 articles related to problem solving in elementary schools were collected.
2. Data Processing: The bibliometric data of the collected articles were processed using the Numbers application. The articles were downloaded, opened, and those relevant to problem solving in elementary schools were selected.
3. Computational Mapping: The selected data were converted into a ".ris" format and processed using the VOSviewer application for computational mapping.

4. Result Analysis: The final step involved analyzing the results obtained from VOSviewer to understand problem solving in elementary schools.

Data collection was carried out in March 2024, with the publication range set from 2020 to 2023. The collected data were exported into two distinct files: one in ".csv" format for processing with the Numbers application, and another in ".ris" format for processing with VOSviewer. The VOSviewer application was used to visualize and evaluate trends through bibliometric maps. VOSviewer can display bibliometric maps in three forms: network visualization, density visualization, and overlay visualization, all based on co-citation networks among the items.

Results and Discussion

Publication Data Search Results

The data collection on mathematics problem solving from the Google Scholar database, using Harzing's Publish or Perish application, yielded 338 articles that met the research criteria. The metadata for these articles includes the author's name, article title, year of publication, journal name, publisher, number of citations, DOI, and related URLs. Table 1 provides examples of the data used in the VOSviewer analysis, showcasing the top 20 articles with the highest citation counts over the past four years.

The total number of citations for all articles used in this study was 5,675, with an average of 1,418.75 citations per year. On average, each article received 16.78 citations, and the average number of citations per year per article was 4.19.

Table 1. Mathematics Problems Solving Publication Data

No	Authors	Title	Year	Cites	Reference
1	J Cai, S Hwang	Learning to teach through mathematical problem posing: Theoretical considerations, methodology, and directions for future research	2020	191	(Cai & Hwang, 2020)

No	Authors	Title	Year	Cites	Reference
2	J Jäder, J Lithner, J Sidenvall	Mathematical problem solving in textbooks from twelve countries	2020	122	(Jäder et al., 2020)
3	M Öztürk, Y Akkan, A Kaplan	… comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey	2020	116	(Öztürk et al., 2020)
4	M Hulaikah, I Degeng, FD Murwani	The Effect of Experiential Learning and Adversity Quotient on Problem Solving Ability.	2020	107	(Hulaikah et al., 2020)
5	Hobri, IK Ummah, N Yuliati	The Effect of Jumping Task Based on Creative Problem Solving on Students' Problem Solving Ability.	2020	100	(Hobri et al., 2020)
6	D Juandi	Heterogeneity of problem-based learning outcomes for improving mathematical competence: A systematic literature review	2021	90	(Juandi, 2021)
7	BH Majeed, LF Jawad, H AlRikabi	Tactical thinking and its relationship with solving mathematical problems among mathematics department students	2021	85	(Majeed et al., 2021)
8	S Shanta, JG Wells	T/E design based learning: assessing student critical thinking and problem solving abilities	2022	85	(Shanta, 2022)
9	E Yayuk, AR As' ari	Primary School Students' Creative Thinking Skills in Mathematics Problem Solving.	2020	81	(Yayuk et al., 2020)
10	D Juandi, M Tamur	Review of problem-based learning trends in 2010-2020: A meta-analysis study of the effect of problem-based learning in	2021	80	(Suparman et al., 2021)

No	Authors	Title	Year	Cites	Reference
		enhancing mathematical problem-solving …			
11	AM Pohan, A Asmin, A Menanti	The effect of problem based learning and learning motivation of Mathematical problem solving skills of class 5 students at SDN 0407 Mondang	2020	77	(Pohan et al., 2020)
12	AS Nur, SB Waluya, R Rochmad, W Wardono	Contextual Learning with Ethnomathematics in Enhancing the Problem Solving Based on Thinking Levels.	2020	72	(Nur et al., 2020)
13	A Maksum, IW Widiana, A Marini	Path Analysis of Self-Regulation, Social Skills, Critical Thinking and Problem-Solving Ability on Social Studies Learning Outcomes.	2021	68	(Maksum et al., 2021)
14	S Setiyani, N Fitriyani, L Sagita	Improving Student's Mathematical Problem Solving Skills through Quizizz.	2020	65	(Setiyani et al., 2020)
15	E Ahdhianto, NN Santi	The Effect of Metacognitive-Based Contextual Learning Model on Fifth-Grade Students' Problem-Solving and Mathematical Communication Skills.	2020	61	(Ahdhianto et al., 2020)
16	NH Astuti, A Rusilowati, B Subali	STEM-based learning analysis to improve students' problem solving abilities in science subject: A literature review	2021	60	(Astuti et al., 2021)
17	Sİ Asigigan, Y Samur	The Effect of Gamified STEM Practices on Students' Intrinsic Motivation, Critical Thinking Disposition Levels, and Perception of Problem-Solving Skills.	2021	58	(Asigigan & Samur, 2021)

No	Authors	Title	Year	Cites	Reference
18	T Wijaya, Y Zhou, A Ware, N Hermita	Improving the creative thinking skills of the next generation of mathematics teachers using dynamic mathematics software	2021	53	(Wijaya et al., 2021)
19	AI Barham	Investigating the Development of Pre-Service Teachers' Problem-Solving Strategies via Problem-Solving Mathematics Classes.	2020	49	(Barham, 2020)
20	F Ke, K M. Clark	Game-based multimodal representations and mathematical problem solving	2020	47	(Ke & M. Clark, 2020)

Research Trends in the Field of Mathematics Problems Solving

The trends of research in the field of mathematics problem solving are illustrated in Table 2. A total of 338 articles on this topic were published in journals indexed by Google Scholar over the four-year period from 2020 to 2023. In 2020, there were 129 publications related to mathematics problem solving, marking the peak year for research in this area. In 2021, the number of articles decreased to 106, followed by 55 articles in 2022, and 48 articles in 2023.

Table 2. Research in Mathematics Problems Solving in the Last 4 Years

Year	Number of Publications
2020	129
2021	106
2022	55
2023	48
Total	338
Average	**84,5**

Figure 1 illustrates the development of research on Mathematics Problem Solving over the past four years, from 2020 to 2023. The data indicate a declining trend in research activity during this period. In 2020, there were 129 publications, marking the highest level of research

output. This number decreased to 106 publications in 2021, further declined to 55 publications in 2022, and reached 48 publications in 2023.

The data suggest that the popularity of research on Mathematics Problem Solving has diminished over the last four years. Several factors contribute to this decline, including the COVID-19 pandemic, shifts in research priorities, resource limitations, changes in researchers' focus, and restricted collaboration opportunities. The COVID-19 pandemic particularly caused many researchers to re-prioritize their focus and redirect research resources and funding toward pandemic-related issues. Additionally, the pandemic hindered collaboration in the field of mathematics research, leading to a reduction in the number of publications (NCES, 2022).

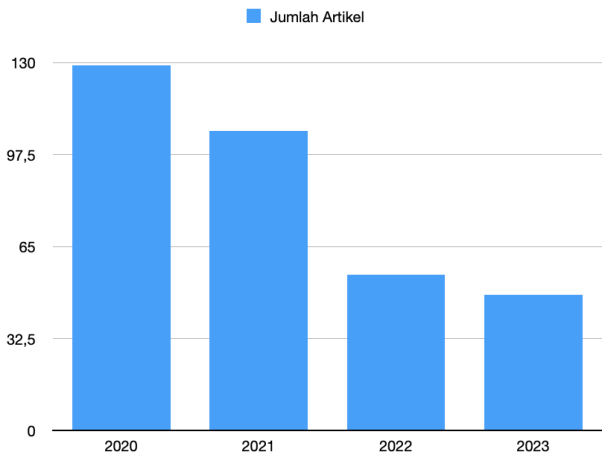

Figure 1. Level of Research Development in Mathematics Problems Solving

Visualization of Mathematics Problems Solving Topic Areas using VOSViewer

Figure 2 illustrates the relationship between various terms within the research on mathematics problem solving. The interconnected network depicted in Figure 2 shows clusters of terms that are frequently researched and associated with this topic. The prominent terms include "ability," "problem," "mathematical problem," "activity," "difficulty," "low ability," and "strategy."

Mathematics problem solving is a multifaceted skill that encompasses various cognitive and metacognitive processes. Its effectiveness and success are influenced by several factors, including ability, the nature of the problems, specific mathematical problems, related activities, encountered difficulties, instances of low ability, and employed strategies (National Report Card, 2022).

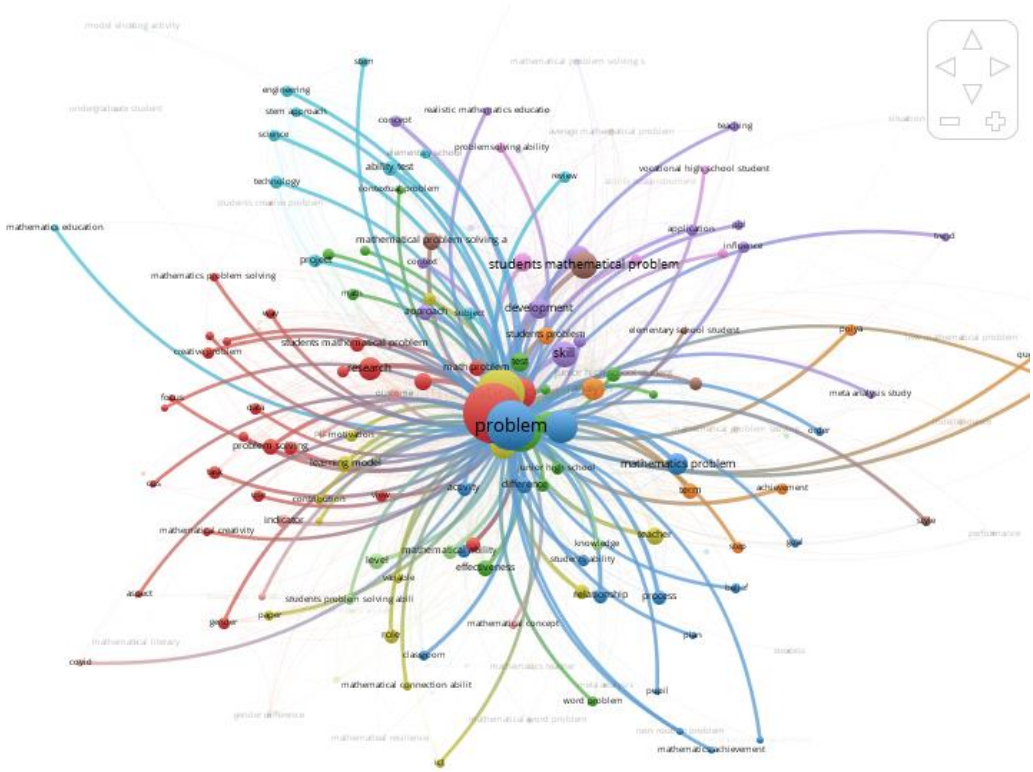

Figure 2. Network Visualization of Research about Mathematics Problems Solving

Figure 3 presents the overlay visualization of research on mathematics problems. The figure highlights that research related to the terms "mathematics problem," "ability," "student mathematics problem," "skills," "difference," "implementation," "case," and "theory" has garnered significant attention.

Mathematical problems exhibit varying degrees of complexity and difficulty. More complex problems typically demand higher-order thinking skills and involve multiple steps to solve, posing a significant challenge for students, particularly those with lower mathematical abilities (National Report Card, 2022).

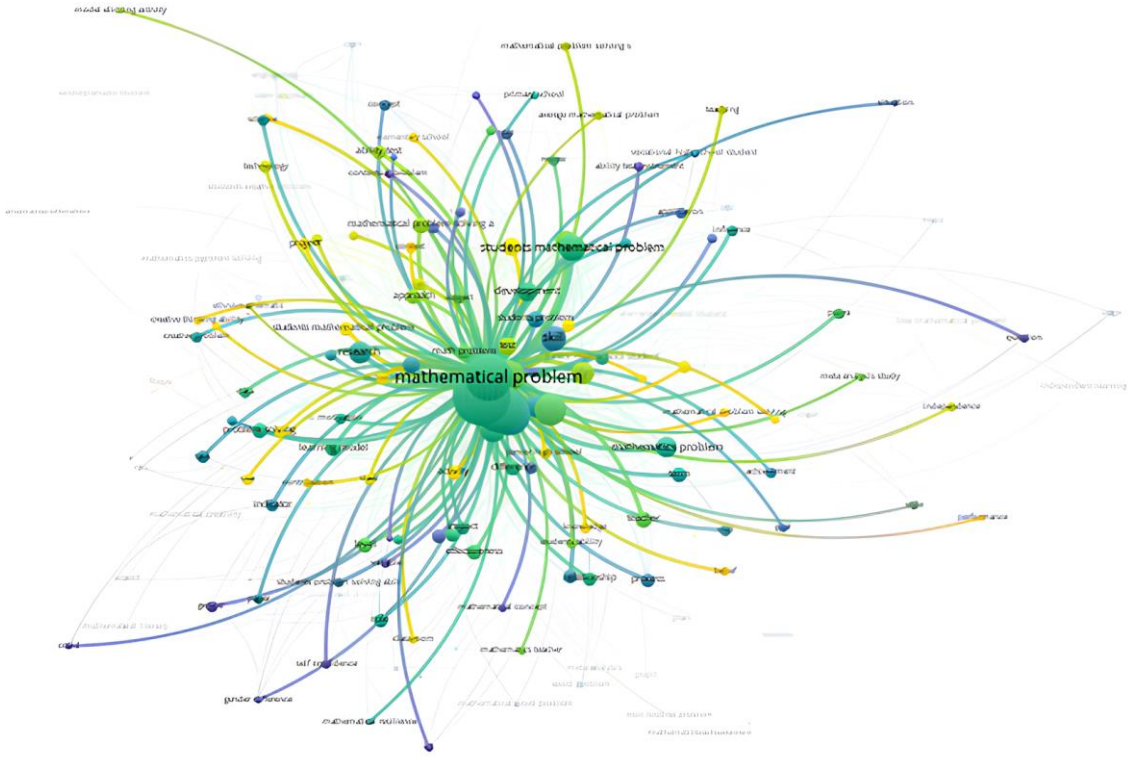

Figure 3. Overlay Visualization of Research about Problem Solving

Figure 4 illustrates the research trends on mathematics problem solving from 2020 to 2023. The data indicate that while research on mathematics problems was highly popular in 2020, interest diminished in the subsequent years. This trend suggests ample opportunities for new research in this area, given the current gaps.

Figure 4 also presents a density visualization, which reflects the volume of research conducted on various related terms. Areas with a more intense color indicate a higher volume of research, whereas terms that appear faded or closer to the background color signify less research activity. The VOSviewer application has facilitated the computational mapping of articles related to mathematics problems, providing a comprehensive view of research density and trends.

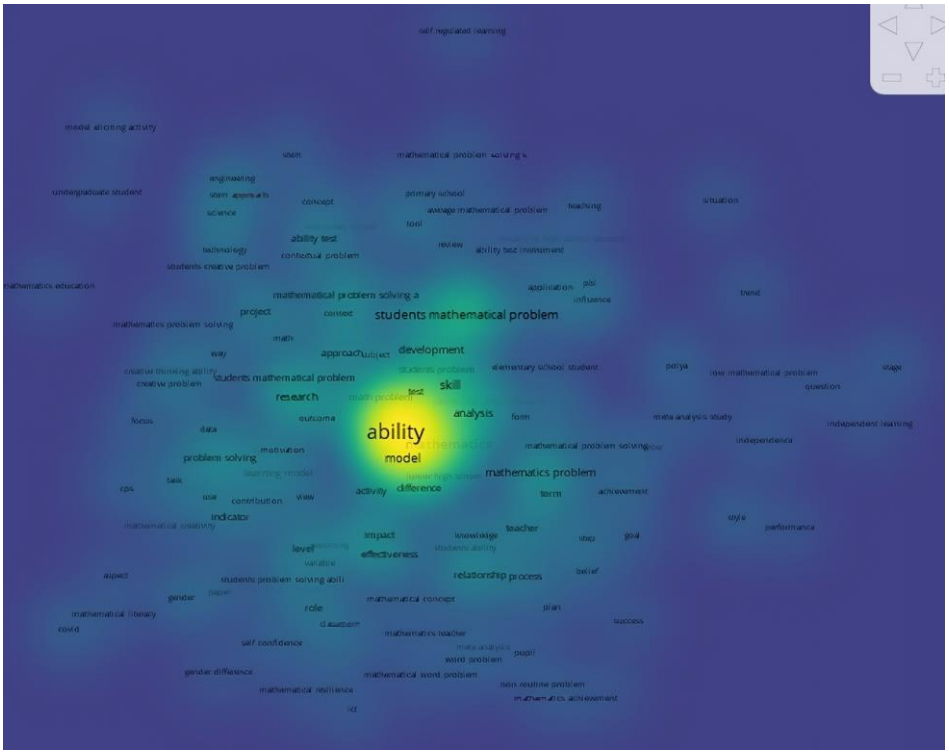

Figure 4. Density Visualization of Research about Mathematics Problem Solving

The items in the study are grouped into 11 clusters, encompassing a total of 166 items. The mapping of these clusters is as follows:

1. Cluster 1 (red) includes 31 items: ability, adversity quotient, aspect, cognitive style, CPS (creative problem solving), creative problem, creative thinking ability, data, flexibility, focus, gender, gender difference, impact, information, interest, math problem, mathematical creative thinking ability, mathematical creative thinking, mathematics problem solving, problem solving, research, social arithmetic material, solution, strategy, students' creative problem, student mathematical problem solving ability, study, task, use, view, and way.
2. Cluster 2 (green) consists of 20 items: cognitive ability, contextual problem, difficulty, effect, effectiveness, factor, form, implementation, increase, junior high school, junior high school student, low ability, math, mathematical reasoning ability, mathematical word problem, meta-analysis, reasoning, student, test, and word problem.

3. Cluster 3 (blue) contains 20 items: activity, belief, classroom, difference, goal, mathematics, mathematics achievement, mathematics problem, metacognitive awareness, non-routine problem, order, plan, problem, process, pupil, relationship, school, students' ability, students' problem solving, and success.
4. Cluster 4 (yellow) comprises 19 items: class, contribution, ethnomathematics, ICT, learning model, mathematical connection ability, mathematical problem, mathematical reasoning, mathematical anxiety, mathematical teacher, model, motivation, paper, picture, role, self-confidence, self-efficacy, teacher, and variable.
5. Cluster 5 (purple) includes 18 items: application, approach, concept, context, development, grade, influence, learning, mathematical problem solving, meta-analysis study, PBL (project-based learning), primary school, realistic mathematics education, skill, teaching, tool, tools, and trend.
6. Cluster 6 (sky blue) contains 14 items: ability test, elementary school, engineering, mathematical problem-solving ability, mathematics education, model eliciting activity, project, review, science, STEM (science, technology, engineering, and mathematics), STEM approach, subject, and undergraduate student.
7. Cluster 7 (orange) comprises 11 items: achievement, analysis, independence, independent learning, low mathematical problem, Polya, question, stage, step, students' problem, and term.
8. Cluster 8 (brown) includes 9 items: average mathematical, elementary school student, mathematical problem solving, mathematical problem-solving ability, mathematics problem solving ability, performance, self-regulated learning, students' mathematical problem, and style.
9. Cluster 9 (light purple) consists of 9 items: ability test instrument, device, high school student, instrument, physics problem, problem solving ability, problem-solving ability, situation, and vocational high school.
10. Cluster 10 (light brown) contains 8 items: COVID-19, indicator, mathematical concept, mathematical literacy, outcome, pandemic, PJBL (project-based learning), and systematic literature review.
11. Cluster 11 (light green) includes 7 items: knowledge, level, mathematical ability, mathematical problem solving, mathematical resilience, mental computation, and students' problem solving.

Each cluster illustrates the relationships between items, with terms represented by colored circles. The size of each circle varies according to the frequency of the term's occurrence; larger circles denote terms that appear more frequently in the literature. This positive correlation indicates that terms with a higher frequency are represented by larger circle labels.

The computational mapping visualization is analyzed through three distinct aspects: network visualization (Figure 2), overlay visualization (Figure 3), and density visualization (Figure 4). Each type of visualization provides a different perspective on the relationships and trends within the research data.

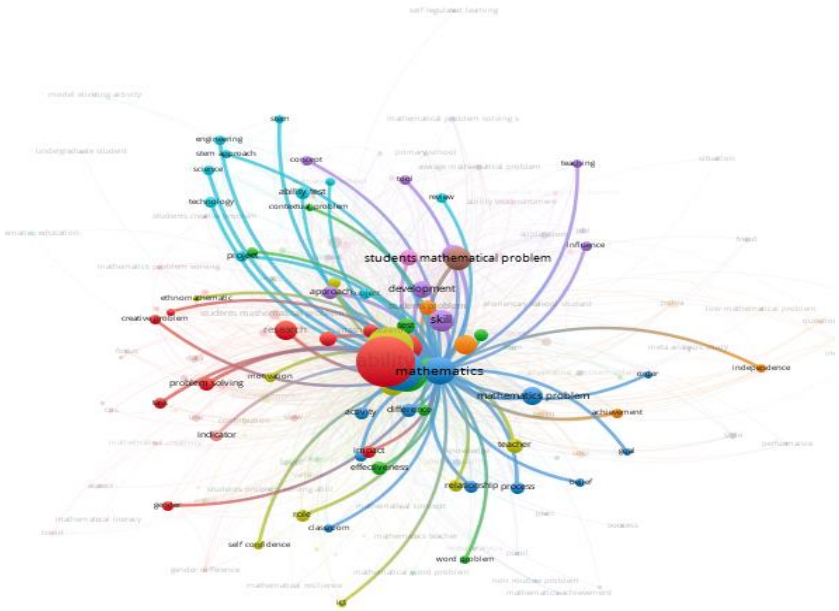

Figure 5. Network Visualization of Research about Mathematics

Figure 5 illustrates that the prominent themes in mathematics research include mathematics, skills, mathematical problems, teachers, impact, students, and problem solving. The role of teachers in mathematics education is a critical research area, encompassing teacher preparation, instructional methods, and professional development. Effective teaching practices and the influence of teacher expertise on student learning outcomes are central topics. Additionally, research explores how teachers can create a positive learning environment and enhance student engagement in mathematics.

The impact of various educational interventions and teaching methods on student learning is another major research theme. This includes evaluating the effectiveness of different instructional strategies, curriculum designs, and technological tools in improving mathematics outcomes. Research often aims to identify best practices and evidence-based approaches to enhance mathematics education (National Report Card, 2022).

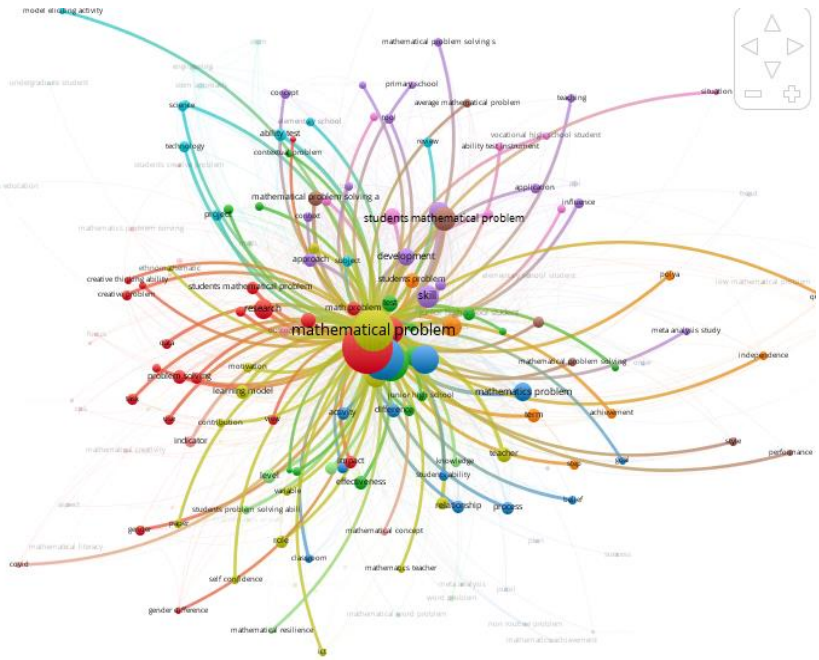

Figure 6. Network Visualization of Research about Mathematics Problem Solving

The data reveals that the term "mathematics problem solving" is related to other terms within the research context. According to the mapping results, the term "mathematics" is located in Cluster 3, with 125 links and a link strength of 584, while the term "problem" is also in Cluster 3, with 161 links and a link strength of 1400. This indicates that both terms have relatively low linkage and connectedness concerning mathematical problems in elementary schools.

Research on mathematical problem solving in elementary schools, particularly concerning student well-being and the emotions involved in the problem-solving process, is relatively sparse. Cognitive functions can be significantly influenced by psychological well-being. Positive emotions have been shown to broaden thinking by fostering more holistic

processing (Fredrickson, 2005) and facilitating more inclusive social categorization (Isen, 1992; Dovidio, 1998). Furthermore, a positive mood appears to enhance creativity in all its dimensions—fluency, flexibility, originality, and insight—which are crucial for generating problem-solving solutions (Baas, 2008). It can be concluded that research publications focusing on the emotional aspects of mathematical problem solving in elementary schools are still limited. This presents a significant opportunity for future research, which could enhance the novelty and impact of studies in this area.

Research on mathematical problem solving and its impact on positive emotions and psychological well-being holds significant implications for educators, policymakers, educational practitioners, and society at large. The following are key implications derived from this research:

1. Implications for Educators:
    a. Increased Student Engagement: Educators can leverage these findings to design teaching strategies that foster positive emotions, such as excitement and satisfaction during problem-solving. This approach can enhance student engagement and motivation in mathematics learning.
    b. Teaching Method Development: Understanding that psychological well-being influences problem-solving ability allows teachers to adopt more student-centered methods, including positive feedback and the recognition of students' efforts. This approach contributes to a supportive and encouraging learning environment.
    c. Teacher Training: Professional development programs for teachers should incorporate training on the importance of emotional well-being in mathematics education, along with techniques for maintaining a positive emotional climate in the classroom.
2. Implications for Policymakers:
    a. Supportive Education Policies: Policymakers can formulate policies that foster positive learning environments, such as comprehensive school wellness programs and initiatives that support teacher training in wellness-oriented classroom management.
    b. Investment in Education: Allocating resources to programs that integrate psychological well-being with mathematics learning can enhance educational outcomes. This includes funding for further research to develop and evaluate interventions that promote student well-being.

3. Implications for Practitioners in Mathematics Education:
   a. Curriculum Development: Practitioners can create curricula that address not only technical skills but also the emotional and psychological aspects of learning. This may involve activities designed to build self-confidence and mitigate math-related anxiety.
   b. Intervention Programs: Practitioners can implement programs aimed at improving students' psychological well-being, such as counseling services or extracurricular activities focused on emotional and social development.

Emphasizing the importance of positive emotions and psychological well-being in mathematical problem solving offers several potential benefits. These include:

1. Increased Student Motivation and Engagement: Fostering a learning environment that prioritizes positive emotions can enhance students' motivation and engagement in mathematics.
2. Development of Effective Teaching Methods: Insights into the relationship between psychological well-being and problem-solving can lead to the creation of more effective teaching methods that cater to students' emotional needs.
3. Supportive Educational Policies: Emphasizing student well-being can inform the development of educational policies that create a supportive and inclusive learning environment.

   Ultimately, integrating positive emotions and psychological well-being into mathematics education contributes to a more positive and inclusive learning environment, thereby supporting both academic achievement and overall student well-being.

Conclusion

This study aims to conduct a bibliometric analysis to map research articles on mathematical problems in elementary schools, utilizing Google Scholar and VOSviewer software. The analysis focuses on publications from 2020 to 2023, using the keywords "mathematical problem" and "elementary school." The results identified 338 relevant articles within this timeframe. The findings indicate a decline in research publications on mathematical problems in elementary schools from 2020 to 2023. This decline underscores the opportunity for further investigation, particularly in the area of students' emotional and psychological well-being in mathematical problem solving. The novelty in research on mathematical problem-solving lies

in exploring the emotional dimensions and psychological well-being of students. Research highlights those positive emotions, such as happiness and satisfaction, significantly enhance student engagement and motivation in mathematics. Students who experience positive emotions are more likely to be engaged and motivated to tackle mathematical problems. Additionally, psychological well-being has a profound effect on performance. Studies demonstrate that students with positive emotional states and psychological well-being are better equipped to manage stress and anxiety, leading to improved performance in mathematical problem solving.

Conflicts of Interest

No conflict of interest regarding the publication of this manuscript.

References

Ahdhianto, E., Marsigit, Haryanto, & Santi, N. N. (2020). The effect of metacognitive-based contextual learning model on fifth-grade students' problem-solving and mathematical communication skills. *European Journal of Educational Research*, *9*(2), 753–764. https://doi.org/10.12973/eu-jer.9.2.753

Asigigan, S. I., & Samur, Y. (2021). The effect of gamified stem practices on students' intrinsic motivation, critical thinking disposition levels, and perception of problem-solving skills. *International Journal of Education in Mathematics, Science and Technology*, *9*(2), 332–352. https://doi.org/10.46328/IJEMST.1157

Astuti, N. H., Rusilowati, A., & Subali, B. (2021). STEM-Based learning analysis to improve students' problem solving abilities in science subject: a Literature Review. *Journal of Innovative Science Education*, *9*(3), 79–86. https://doi.org/10.15294/jise.v9i2.38505

Baas, M. D. (2008). A meta-analysis of 25 years of mood- creativity research: hedonic tone, activation, or regulatory focus?. *Psychological Bulletin*, *134*(6), 779–806. https://doi.org/10.1037/a0012815

Barham, A. I. (2020). Investigating the development of pre-service teachers' problem-solving strategies via problem-solving mathematics classes. *European Journal of Educational Research*, *9*(1), 129-14. https://doi.org/10.12973/eu-jer.9.1.129

Cai, J., & Hwang, S. (2020). Learning to teach through mathematical problem posing: Theoretical considerations, methodology, and directions for future research. *International Journal of Educational Research*, *102*, 1–8. https://doi.org/10.1016/j.ijer.2019.01.001

Carson, J. (2007). A problem with problem solving: Teaching thinking without teaching knowledge. *The Mathematics Educator*, *17*(2), 7-14. *https://ojs01.galib.uga.edu/tme/article/view/1912*

Csapó, B. &. (2017). *The Nature of Problem Solving. Using research to inspire 21st century learning.* Paris: OECD Publishing.

Dovidio, J. F., Isen, A. M., Guerra, P., Gaertner, S. L., & Rust, M. (1998). Positive affect, cognition, and the reduction of intergroup bias. In C. Sedikides, J. Schopler, & C. A. Insko (Eds.), Intergroup cognition and intergroup behavior (pp. 337–366). Lawrence Erlbaum Associates Publishers.

Fischer, A. G. (2012). The process of solving complex problems. *Journal of Problem Solving, 4*(1), 19-42. http://dx.doi.org/10.7771/1932-6246.1118

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. Cognition and Emotion, 19(3), 313–332. https://doi.org/10.1080/02699930441000238

Granberg, C., & Olsson, J. (2015). ICT-supported problem solving and collaborative creative reasoning: Exploring linear functions using dynamic mathematics software. The Journal of Mathematical Behavior, *37*, 48–62. https://doi.org/10.1016/j.jmathb.2014.11.001

Hobri, Ummah, I. K., Yuliati, N., & Dafik. (2020). The effect of jumping task based on creative problem solving on students' problem solving ability. *International Journal of Instruction*, *13*(1), 387-406. https://doi.org/10.29333/iji.2020.13126a

Hulaikah, M., Degeng, I. N. S., Sulton, & Murwani, F. D. (2020). The effect of experiential learning and adversity quotient on problem solving ability. *International Journal of Instruction*, *13*(1), 869–884. https://doi.org/10.29333/iji.2020.13156a

Isen, A. N. (1992). An influence of positive affect on social categorization. *Motivation and Emotion*, *16*(1), 65–78. http://doi.org/10.1007/BF00996487

Jäder, J., Lithner, J., & Sidenvall, J. (2020). Mathematical problem solving in textbooks from twelve countries. *International Journal of Mathematical Education in Science and Technology*, *51*(7), 1120–1136. https://doi.org/10.1080/0020739X.2019.1656826

Juandi, D. (2021). Heterogeneity of problem-based learning outcomes for improving mathematical competence: A systematic literature review. *Journal of Physics: Conference Series*, *1722*(1). https://doi.org/10.1088/1742-6596/1722/1/012108

Ke, F., & M. Clark, K. (2020). Game-Based Multimodal Representations and Mathematical Problem Solving. *International Journal of Science and Mathematics Education*, *18*(1), 103–122. https://doi.org/10.1007/s10763-018-9938-3

Madzík, P. (2019). Capture and evaluation of innovative ideas in early stages of product development. *The TQM Journal, 31*(6), 908-927. *https://doi.org/10.1108/TQM-02-2019-0050*

Majeed, B. H., Jawad, L. F., & Al-Rikabi, H. T. S. (2021). Tactical thinking and its relationship with solving mathematical problems among mathematics department students. *International Journal of Emerging Technologies in Learning*, *16*(9), 247–262.

https://doi.org/10.3991/ijet.v16i09.22203

Maksum, A., Wayan Widiana, I., & Marini, A. (2021). Path analysis of self-regulation, social skills, critical thinking and problem-solving ability on social studies learning outcomes. *International Journal of Instruction*, *14*(3), 613–628. https://doi.org/10.29333/iji.2021.14336a

Marín-Marín, J. A. G. T. B. (2021). STEAM in education: A bibliometric analysis of performance and co-words in Web of Science. *International Journal of STEM Education*, *8*(41), 1-21. https://doi.org/10.1186/s40594-021-00296-x

National Report Card. (2022). *Mathematics assessment*. National Assessment of Educational Progress (NAEP) Retrieved from: https://www.nationsreportcard.gov/highlights/mathematics/2022/

NCES, N. C. (2022). *New school survey data 2022.* Amerika: NCES.

Nur, A. S., Waluya, S. B., Rochmad, R., & Wardono, W. (2020). Contextual learning with Ethnomathematics in enhancing the problem solving based on thinking levels. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *5*(3), 331–344. https://doi.org/10.23917/jramathedu.v5i3.11679

Özkaya, A. (2018). Bibliometric analysis of the studies in the field of mathematics education. *Educational Research and Reviews, 13*, 723–734. http://dx.doi.org/10.5897/ERR2018.3603

Öztürk, M., Akkan, Y., & Kaplan, A. (2020). Reading comprehension, Mathematics self-efficacy perception, and Mathematics attitude as correlates of students' non-routine Mathematics problem-solving skills in Turkey. *International Journal of Mathematical Education in Science and Technology*, *51*(7), 1042–1058. https://doi.org/10.1080/0020739X.2019.1648893

Pohan, A. M., Asmin, A., & Menanti, A. (2020). The effect of problem based learning and learning motivation of mathematical problem solving skills of class 5 students at SDN 0407 Mondang. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *3*(1), 531–539. https://doi.org/10.33258/birle.v3i1.850

Schoenfeld, A. (1985). *Mathematical problem solving.* Orlando, FL: Academic Press.

Setiyani, S., Fitriyani, N., & Sagita, L. (2020). Improving student's mathematical problem solving skills through Quizizz. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *5*(3), 276–288. https://doi.org/10.23917/jramathedu.v5i3.10696

Shanta, S. W. (2022). T/E design based learning: assessing student critical thinking and problem solving abilities. *International Journal of Technology and Design Education, 32*, 267–285. https://doi.org/10.1007/s10798-020-09608-8

Suparman, Juandi, D., & Tamur, M. (2021). Review of problem-based learning trends in 2010-

2020: A meta-analysis study of the effect of problem-based learning in enhancing mathematical problem-solving skills of Indonesian students. *Journal of Physics: Conference Series*, *1722*(1). https://doi.org/10.1088/1742-6596/1722/1/012103

Suseelan, M., Chew, C. M., & Chin, H. (2022). Research on mathematics problem solving in elementary education conducted from 1969 to 2021: A bibliometric review. *International Journal of Education in Mathematics, Science and Technology*, *10*(4), 1003–1029. https://doi.org/10.46328/ijemst.2198

Wijaya, T. T., Zhou, Y., Ware, A., & Hermita, N. (2021). Improving the creative thinking skills of the next generation of mathematics teachers using dynamic mathematics software. *International Journal of Emerging Technologies in Learning*, *16*(13), 212–226. https://doi.org/10.3991/ijet.v16i13.21535

Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281