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Systematic Literature Review: Students' Mathematical Representation Ability in Solving Mathematical Problems

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Abstract. *This study was motivated by the lack of students' ability to understand mathematics through mathematical representation skills. This study aims to determine the mathematical representation ability of students in solving mathematical problems. The method used by researchers is the Systematic Literature Review (SLR) method with a sample of 15 articles related to this research. Data collection is done by exploring related topics in the range of 2019 to 2024 through electronic databases with the help of Publish or Perish in SINTA indexed journals. The articles that have been obtained will be reviewed based on the criteria of publication year, research subject, SINTA level, and research methods, as well as research results. Based on the findings, it shows that the most publications are in 2021, the most dominating research subjects are at the junior high school education level, the most SINTA levels in national journals are in SINTA 3, the research methods in this study all use qualitative methods and the results of the literature conducted using several relevant articles and have met the selection process can be concluded that mathematical representation skills can help students in solving mathematical problems.*

Keywords: *mathematics, mathematical representation ability, systematic literature review*

1. Introduction

Mathematics is a fundamental discipline and plays an important role in various aspects of life. Mathematics is also one of the subjects in school that is considered difficult by students because mathematics is abstract. During learning, students find it difficult to convey arguments for their answers, students feel uncertain about their answers, and are also embarrassed to convey their answers (Damayanti & Afriansyah, 2018). Therefore, it is important to master and understand mathematics from an early age in order to provide a sense of comfort to learners and encourage mastery and technological progress.

Based on the results of the 2022 PISA (Program for International Student Assessment) which were announced on December 5, 2023, Indonesia ranked 68 out of 81 countries. Indonesian students' math ability score is 379. This result is still below the average set by the OECD (Organization for Economic Cooperation and Development) which is 494 (Khalimah et al., 2017). Based on the results of the Trends in International Mathematics and Science Study (TIMSS) in 2015, it is suggested that the mathematics scores of students in Indonesia ranked 44 out of 49 countries with a score of 397 also proves that the ability of students to solve mathematical problems and their application in everyday life is not well implemented (Rahmaini & Ogylva, 2024).

Mathematical representation ability is one of the important aspects of mathematical literacy which is also a focus in the PISA (Programme for International Student Assessment) assessment (Selan et al., 2020) in line with the Regulation of the Minister of Education and Culture Number 22 of 2006 states that one of the learning objectives of mathematics that must be possessed by students at the fourth point is being able to communicate ideas using symbols, tables, diagrams, or other media to clarify problem

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situations. So that when solving mathematical problems, students can understand the problem, design a mathematical model, solve the model and interpret the solution of the mathematical problem they face. Based on this, the ability that covers these aspects is representation ability.

Based on this, according to the National Council of Teachers Mathematics (NCTM) there are five standards of the mathematics learning process that must be owned by students, namely (1) the ability to solve problems (mathematical problem solving); (2) the ability to reason and proof (mathematical reasoning and proof); (3) the ability to communicate (mathematical communication); (4) the ability to connect ideas (mathematical connection); (5) the ability to represent (mathematical representation). Initially NCTM only stated 4 standards in the process of learning mathematics, namely the ability to solve problems, the ability to reason, the ability to communicate, and the ability to connect mathematical ideas. In addition, mathematical representation is still considered in line and part of mathematical communication skills (Damayanti & Afriansyah, 2018). However, what happens during learning in schools is that mathematical representation skills often appear when studying mathematics at all levels of education, so it is considered that representation is a component of ability that needs to be considered. So that the ability of mathematical representation needs to be emphasized and raised in the process of teaching mathematics in schools (Goldin, 2014).

Mathematical representation skills are very important for students and are related to communication skills and mathematical problem solving. Learners must be able to represent well pictures, graphs, diagrams, and other forms of representation to be able to communicate something (Lette & Manoy, 2019). Jones (Narulita, 2013) states the importance of mathematical representation skills, namely: “providing fluency in concept construction and thinking objectively and having the ability and understanding of solid and flexible concepts built by the teacher through mathematical representations”.

From several journals reviewed, we found that there are still students who have difficulty in fulfilling all three indicators of mathematical representation ability in solving mathematical problems, namely linear equations of one variable, some only fulfill two indicators and some even only one indicator (Panduwinata et al., 2019). In research (Deswantari et al., 2020) students in mathematical expression indicators have difficulty while in other indicators students have the same thing, namely being able to do the problem correctly. In line with previous research (Syafitri, 2020) suggests that students who have extroverted personalities experience difficulties in the visual aspect in the indicator of representation of mathematical equations or expressions, students do not understand when the teacher explains how to make a mathematical model of the story problem that has been given.

Based on the description above, it was decided to conduct research with the title “Systematic Literature Review (Slr): Mathematical Representation Ability of Learners in Solving Mathematical Problems”. The purpose of this study is to conduct a literature review on the mathematical representation skills of students in learning mathematics. Literature review: Many studies have been conducted on the mathematical representation ability of learners to solve mathematical problems. The use of learners' mathematical representations can help solve mathematical problems during learning. To achieve the research objectives, two research questions were formulated, namely:

a. How is the diversity of the selected literature based on the year of publication, level of sinta, research subjects, and research methods in 2019 - 2024?

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b. How is the mathematical representation ability of students in solving mathematical problems in the range 2019 - 2024?

2. Method

The method used in this research is Systematic Literature Review (SLR). Systematic Literature Review is a method carried out by reviewing, evaluating, and interpreting various studies that are relevant to the formulation of the problem to be studied. Through this method, researchers will identify, evaluate, and review all research relevant to the problem. Researchers review journals systematically with each process following the stages applied. The stages applied to conduct a systematic literature review are (1) developing research questions; (2) identifying research articles; (3) evaluating the feasibility of research articles; (4) summarizing research articles; and (5) interpreting findings in research articles. The purpose of this Systematic Literature Review research is to find ways that can help overcome the problems faced and identify different points of view regarding the problem being studied and reveal theories that are relevant to the problems in the study.

3. Results and Discussions

The results of the selection that has been done are 15 articles that are relevant to the keywords used. Furthermore, researchers reviewed articles that were relevant to the problem. The following journal characteristics will be presented in Table 1.

Table 1. Journal characteristics

Category	Variation	Total
Year of Research	2019	3
	2020	2
	2021	8
	2022	1
	2023	1
	2024	0
Research Subject	Elementary School	0
	Junior High School	10
	Senior High School	5
Sinta Level	Sinta 1	0
	Sinta 2	2
	Sinta 3	9
	Sinta 4	4
	Sinta 5	0
	Sinta 6	0
Research Type	Qualitative	15
	Quantitative	0
	Mix – Method	0

Research Question 1:

What is the diversity of literature selected based on year of publication, Sinta level, research subject, and research method in 2019 - 2024?

Figure 1 shows the amount of literature in the year of publication on the topic of

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students' mathematical representation abilities in solving mathematical problems published in the range 2019 - 2024 and from 2019 decreased in 2020 then increased in 2023 by 8 articles and decreased further in 2022 - 2024. Figure 2 shows that the literature selected from national journals is also in the moderately high to low category, based on the results of the acquisition of Sinta levels, namely at Sinta 1, Sinta 2, Sinta 3, Sinta 4, Sinta 5, and Sinta 6 with the most level of literature obtained being at Sinta 3 as many as 9 articles.

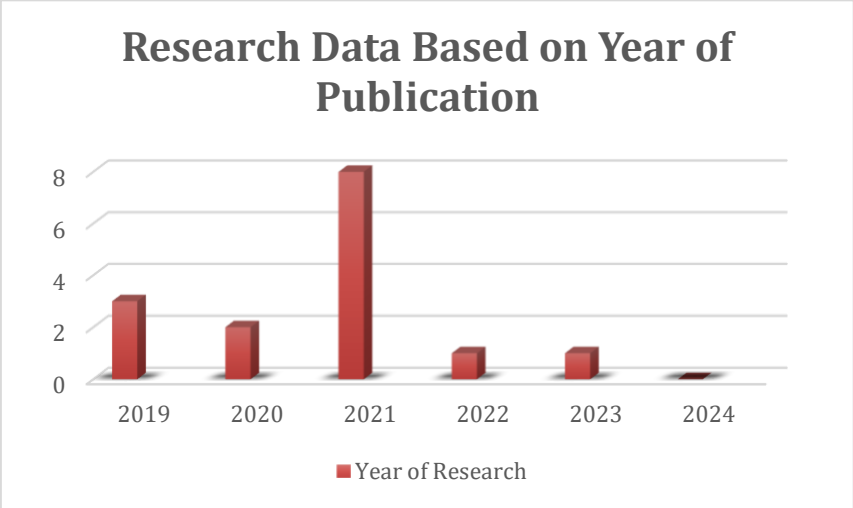

Figure 1. Research data based on year of publication

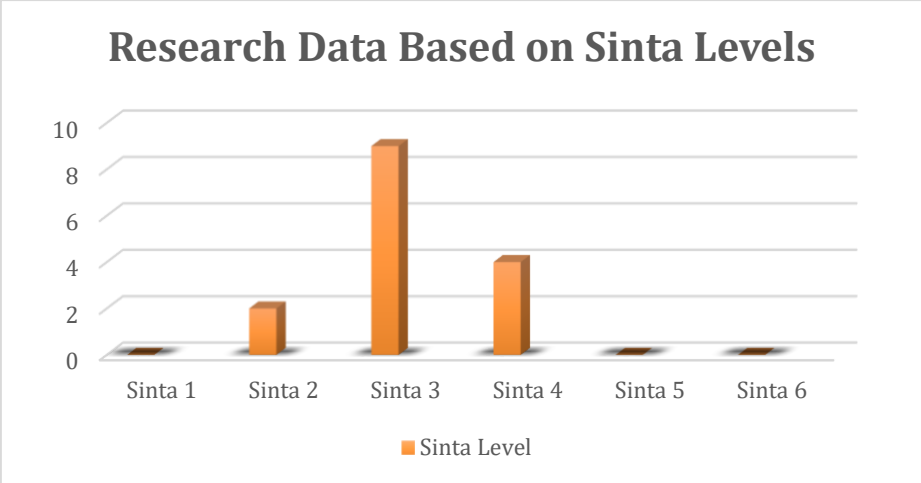

Figure 2. Research data based on Sinta levels

Figure 3 shows the information for elementary school research subjects in orange, junior high school research subjects in yellow, and senior high school research subjects in green. Then when analyzed, research on students' mathematical representation abilities in solving mathematical problems was mostly carried out at the junior high school level, namely 67%, while the least research was carried out at the elementary school level at 0%. Figure 4 shows the literature obtained regarding mathematical representation skills in solving mathematics using qualitative methods, while no literature has been found using quantitative methods and mixed methods.

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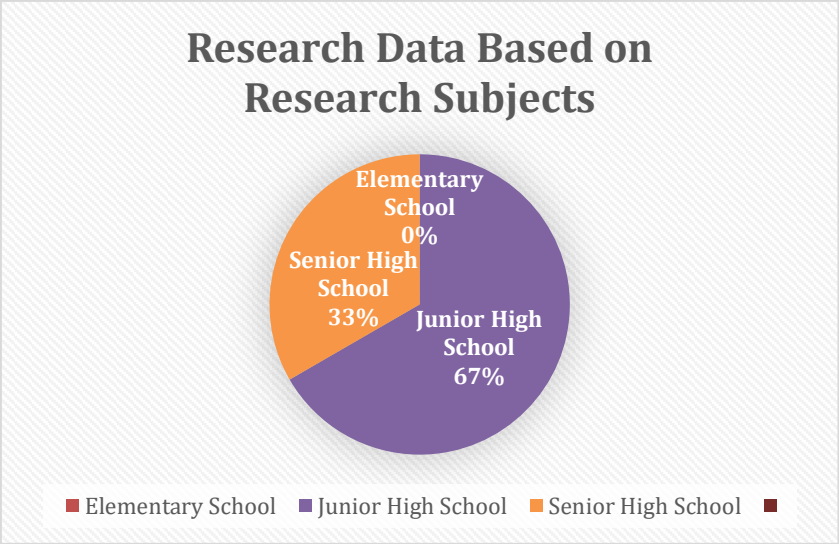

Figure 3. Research data based on research subjects

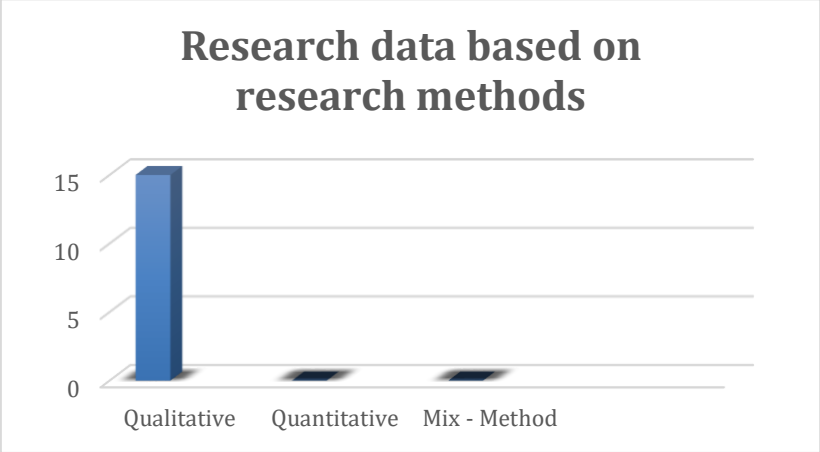

Figure 4. Research data based on research methods

Research Question 2: How is the mathematical representation ability of students in solving mathematical problems in the range 2019 - 2024?

In an effort to find out how the mathematical representation ability of students in solving mathematical problems, it is necessary to analyze the results of research from the selected literature. The results of the analysis will be presented in a table regarding the mathematical representation ability of students in solving mathematical problems.

Table 2. Research analysis results from selected literature

Author	Research Results
(Rohana et al., 2021)	Research on students' representation ability revealed several main findings: students showed high ability in using mathematical expressions with a score of 80.37 but had difficulty in visual representation with a score of 43.33 because most students could not identify or describe the intersection points on cartesian coordinates. Overall, students' representation skills are in the medium category with a score of 62.66. In this study, the lack of understanding of the pre-requisite material is a suggestion for further research.
(Huda et al., 2019)	Research conducted on the mathematical representation abilities of students at MTsN Batusangkar shows varying levels of ability in various types of

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Author	Research Results
	representation. The results showed that students showed satisfactory ability in visual and symbolic representation with a percentage of 79% and 73% which fell into the satisfactory category but in the verbal representation category was less satisfactory at 66%. This study highlights the need for targeted interventions to improve verbal representation skills.
(Yuwono et al., 2021)	Research on students' mathematical representation in solving linear program material at SMA Negeri 5 Malang, from 33 participants obtained their mathematical representation abilities: 4 students in the very high category, 5 students in the high category, 9 students in the medium category, 8 students in the low category, and 7 students in the very low category. Learners are able to do well in visual representations, written text, and mathematical expressions but there are some prominent difficulties in the representation of mathematical expressions in expressing mathematical functions.
(Fitrianingrum & Basir, 2020)	Research on the mathematical representation of students in solving algebraic material at SMA Islam Sultan Agung 3 Semarang, students show high ability in symbolic representation with a score of 91.22%, on the other hand, in verbal representation the ability of students is in the medium category with a score of 67.54%. Overall, this study highlights the importance of improving students' mathematical representation skills for understanding and solving mathematical problems.
(Ramadhan & Aini, 2021)	Research on the mathematical representation ability of class VIII students in solving space building material at SMP Islam Telukjambe, students are able to provide correct answers so that it shows their understanding of verbal, visual, and symbolic representations can be mastered. Overall this research highlights the importance of mastering mathematical representation skills to solve problems effectively.
(Harahap & Rakhmawati, 2020)	Research on the mathematical representation ability of students in solving the material of the system of linear equations of two variables (SPLDV) at MTS Al-Jam'iyatul Wasliyah Tembung, students have difficulty in representing mathematical expressions and verbals. Subject S1 got 0% in the representation of mathematical expressions whereas S5 in verbal representation got 62.5%. Overall these findings highlight a general lack of understanding and ability to make visual representations of mathematical problems.
(Rahma & Nur, 2023)	Research on the representation ability of students in solving set material in one of the junior high schools in Karawang Regency, out of 34 students only a small proportion (9%) showed high representation ability, while the majority (73%) were in the medium category which indicated a fairly good understanding of the material. However, (18%) learners were in the low category. Overall learners excelled in verbal and visual representations and faced difficulties in symbolic representations.
(Silviani et al., 2021)	Research on the representation ability of students in solving statistics material, the research findings show that the mathematical representation ability of the three subjects studied is generally adequate, especially in verbal and visual representations, where they show good understanding. Overall, the average understanding of statistics among the subjects was satisfactory. This study emphasizes the need for interesting teaching methods to enhance the learning experience.
(Puspitasari & Susanah, 2022)	Research on students' mathematical representation abilities in solving social arithmetic material in junior high school class VII, the subjects in this study were only 2 and both students predominantly used verbal and symbolic representations, but did not use visual representations at each stage of problem solving. This indicates a gap in their ability to utilize different types of mathematical representations effectively.
(Yusriyah & Noordyana, 2021)	Research on students' mathematical representation skills in solving data presentation materials in Bungbulang Village, almost all students show

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Author	Research Results
	proficiency in pictorial representation and successfully solve problems using visual aids. However, the results showed a significant gap in symbolic representation because almost all learners had difficulty solving problems using symbols.
(Khoerunnisa & Maryati, 2022)	Research on students' mathematical representation ability in solving quadrilateral material in junior high school class VIII, specifically although visual representations are generally well understood, students struggle to apply this knowledge to different contexts, often failing to be mastered by some students due to lack of confidence among other students.
(Sari & Kusaeri, 2020)	Research on students' mathematical representation skills in solving geometry material at MAN 2 Mataram, students show high representation skills meet all three indicators of ability which include visual representation, mathematical expression, and verbal description. Learners who have moderate ability fulfill two of these indicators, while learners who have low ability only achieve proficiency in visual representation. This study emphasizes the need for targeted educational strategies to improve overall mathematical representation skills.
(Putri et al., 2021)	Research on students' mathematical representation ability in solving mathematical problems at SMA N 1 Setu Bekasi, students showed varying levels of proficiency in using various types of mathematical representations, including symbolic, written text, and visual combinations. The results showed that students often had difficulty in using accurate representations which affected the effectiveness of their problem solving. Overall, these findings indicate the need for improved learning strategies to improve students' mathematical representation abilities.
(Syarifuddin, 2019)	Research on students' mathematical representation abilities in solving fractional material at SMP N Kabupaten Bima NTB, this study identified several major difficulties faced by students in representing mathematical problems involving fractions. Specifically, it was found that many students had difficulty with verbal, graphic, and arithmetic symbol representations related to fractions. In addition, some students in solving fractional problems used verbal representations but failed.
(Lisarani & Qohar, 2021)	Research on students' mathematical representation abilities in solving story materials in junior high and high school, students in grade VIII of junior high school rely on external representations, such as pictures and written words to capture their ideas, but they do not fully utilize these representations to find solutions effectively. In contrast, students in grade X of senior high school tend to optimize their internal representations which allow them to visualize the context of the problem and document the problem-solving process systematically using mathematical expressions. This shows a development in the use of mathematical representations from junior high school to senior high school.

4. Conclusions

This study highlights the importance of students' mathematical representation skills in solving mathematical problems. These skills include visual, symbolic, and verbal representations that help students understand and solve problems more effectively. The results showed that students who can use various forms of representation tend to have a deeper understanding of concepts. In addition, mathematical representation helps students formulate more structured and systematic problem-solving strategies. This ability also encourages creativity in finding alternative and innovative solutions. Teachers play an important role in developing this ability by providing exercises involving various forms of mathematical representation. Therefore, the development of this ability should be a focus in mathematics learning to improve students' problem-solving skills. Therefore,

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more research is needed to evaluate students' proficiency in solving mathematical problems using various models, media, techniques, technologies, and other strategies.

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