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RELATIONAL UNDERSTANDING IN SOLVING MATHEMATICAL PROBLEMS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Relational understanding is the ability to apply and relate one material to another and know the reason. The purpose of this research is to conduct a study related to relational understanding in solving mathematical problems at the elementary, junior high, junior high, high school and university levels. This study used the systematic literature review (SLR) method, with a sample of 21 research results related to relational understanding in solving mathematical problems published within the last nine years. Data collection was carried out by documenting all research related to relational understanding in solving mathematical problems in terms of research year, publication platform index, education level, research demographics, research type and research results. The results showed that the most years of related publications were in 2022, the dominating participants were at the junior high school level, Java Island as one of the largest populations was the most frequent location for research and qualitative research was the type of research often used by researchers with mixed results depending on students' initial mathematical abilities, learning styles, cognitive or non-cognitive styles of students and effective learning methods used to improve relational understanding.
Keywords: Relational Understanding, Math Problems, Systematic Literature Review

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PRELIMINARY

Mathematics is one of the universal fields of science and exists at every level of education. in addition, in development mathematics has an important role in other sciences such as physics, chemistry, economics and even in the development of technology (Ramdani, 2006). Apart from the importance of mathematics in everyday life, one of the basic things that should be mastered in learning mathematics is mathematical understanding (Khoerunnisa & Hidayati, 2022). Mathematical understanding is defined as materials given to students not memorization, more than students can accept, absorb and interpret something that has been learned (Saputra, 2022). Understanding which is defined as the ability to connect one thing with another correctly and can realize the process carried out is relational understanding (Badraeni et al., 2020; Skemp, 1976).

Relational understanding is a deep understanding of mathematics. According to Polya (Sumarno, 2012) relational understanding is the ability to apply formulas meaningfully accompanied by reasons, and relate one idea to another and prove the truth of a formula. Relational understanding is a high-level understanding (Riyani & Maizora, 2017; Rizqiyah et al., 2019). Thus, relational understanding can be interpreted as the ability to apply, relate one material to another and know the reasons for it. The indicators mentioned by Kulsum et al. (2019) are: (1) connecting a concept with other concepts, (2) knowing the relational cause of the answer obtained, and (3) proving the truth of a concept.

There are several benefits of relational understanding for students (Samudro, 2017; Skemp, 1978) namely, students will adapt more easily to new assignments, be easier to always remember, be able to create original ideas and be more effective as a goal of science itself. Apart from the difficulty of relational understanding owned by students(Auliya, 2016), relational understanding can help students in dealing with questions or problems that require several concepts in the process. Relational understanding will make it easier for students to solve math problems. (Fajriah & Dwi, 2014; Skemp, 1989)

When students are faced with problems in situations where they cannot use one procedure to solve but must combine several procedures, relational understanding is needed to solve mathematical problems. Therefore, relational understanding is very important for every student especially when solving math problems by understanding the situations and combining previously learned responses in a new way (Lesh et al., 1979; Walle & Jhon, 2007). Agree with that, Minarni et al. (2016) argue that relational understanding will sharpen problem-solving skills.

Some research related to relational understanding in solving math problems, especially those that have been conducted in Indonesia (Fathonah & Maftuh, 2016; Rahma, 2015; Rizki & Haerudin, 2022; T. Wulandari, 2018; Yazidah et al., 2018). The research results found vary widely. A literature review is needed to obtain comprehensive information about relational understanding in solving mathematical problems. Therefore, this study systematically reviews the literature on relational understanding in solving mathematical problems using the Systematic Literature Review (SLR) method. This study aims to describe the result of research related to relational understanding in solving mathematical problems in Indonesia based on the year of research, publication media, level of education, research demographics, type of research and research results. Therefore, an

important step in SLR research results in aspects that support relational understanding in solving a mathematical problem.

METHODS

The method to be used in this research is Systematic Literature Review (SLR). SLR is a means of identifying, evaluating and interpreting all available research relevant to a particular research question or topic area or phenomenon of interest (Kitchenham, 2004). Secondary data in the form of primary research results regarding relational understanding in solving mathematical problems are data in this study.

This research follows the stages of systematic literature review research proposed by Juandi (2021), which includes data collection, data analysis and conclusion drawing. The data collection process is in the form of primary studies that have been made into national journal articles, data collected from electronic databases registered and published in Sinta, Garuda and Repository media (final project, thesis or dissertation). Data collection is also done by using the publish or perish search to find the number of articles on the topic discussed. Publish or Perish is one of the applications that can be used to retrieve and analyze academic citations (Aulianto, 2019). Based on the search result, 28 studies related to relational understanding in solving mathematical problems was published. Furthermore, extraction of all articles that were relevant and met the inclusion criteria were included in the analysis stage (Juandi, 2021). The inclusion criteria in this study include:

1. Research in the form of proceedings articles, journal articles indexed sinta or garuda, final project, theses and dissertations;
2. Research conducted in Indonesia;
3. Research is a math learning outcome;
4. The period of the research was published from 2015 to 2023;
5. Research on relational understanding in solving mathematical problems;
6. The research samples are elementary to college level; and
7. Contains qualitative, quantitative or mixed method research types.

Based on these criteria, 21 published studies were selected as the sample of this study.

RESULT AND DISCUSSION

The results of the research data analysis contained in this literature review are in the form of a summary of documented research on relational understanding in solving mathematical problems. Based on the inclusion criteria for all relevant research found, the research is categorized based on six categories, namely year of publication, education level, publication media, research demographics, type of research and research result. Table 1 shows the results of the analysis of 21 research samples based on these categories.

Tabel 1. Percentage of Research Samples

Category	Variations	Quantity
Year of Research	2015	1
	2016	1
	2017	0
	2018	3
	2019	4
	2020	2
	2021	4
	2022	5
	2023	1
Participant Education Level	Elementary School	1
	Junior High School	12
	Senior High School	6
	Higher Education	2
Publication Media	Sinta	11
	Garuda	6
	Repository	4
Research Demographics	Sumatra Island	3
	Java Island	14
	Kalimantan Island	1
	Sulawesi Island	1
	NTT and Papua	2
Type of Research	Qualitative	15
	Quantitative	5
	Mixed-Method	1

Table 1 shows that in the last nine years, articles that discuss the topic of students' relational understanding vary in the specified categories. Next, we will describe the studies based on categories that have been determined.

Studies by Year of Publication

Based on research that has been conducted for the last nine years, namely from 2015 to 2023, precisely in February, the data obtained can be seen in Table 1. In the last few years, research was found that was published other than those counted in the table, but

the research did not meet the inclusion criteria such as journals published not in Sinta, Garuda or Repository media, so it was not included in the analysis. More details can be seen in Figure 1 below.

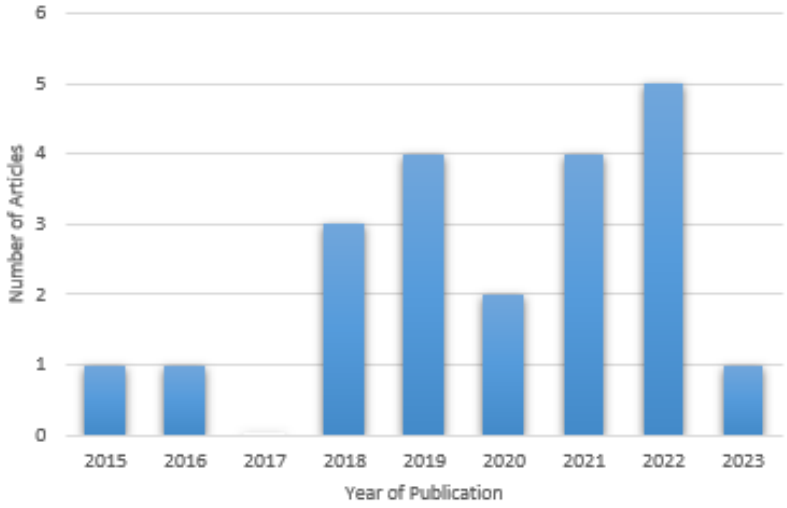

Figure 1. Relational Understanding Research Data Based on Publication Year

In Figure 1, it can be seen the research in 2017 has decreased from the previous year so that no research was found on relational understanding based on inclusion criteria. Furthermore, the decline returned in 2020 and increased again in the following years, namely in 2021 and 2022. In 2023 only taken in January-February so one study was found that examined relational understanding, but it is very possible for more research on relational understanding in solving mathematical problems published throughout 2023.

Study by Participant Education Level

Research on relational understanding in solving problems used as data in this study was conducted from elementary school to university level with details of the amount of data found in Figure 2.

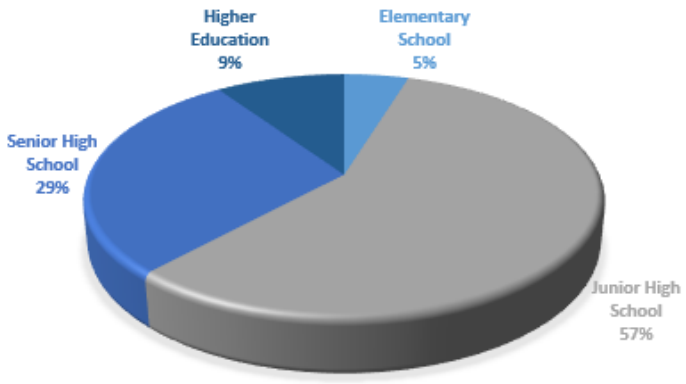

Figure 2. Research Data on Relational Understanding Based on Participant Education Level

In Figure 2, it can be seen that the most research on relational understanding in solving mathematical problems is found at the junior high school level, with a total of 12 studies. While for the elementary school level only 1 study was found, for the high school level 6 studies were found and for the college level, only 2 articles were found. Relational understanding is a higher level of understanding and is more in the process of understanding (Utomo, 2020). While relational understanding is listed in the junior high school curriculum and beyond. So research on relational understanding in solving mathematical problems at the elementary level has the possibility of producing biased data.

However, understanding must still be taught since elementary school. Understanding that is suitable for elementary school can be started from instrumental understanding where instrumental understanding is an understanding that understands concepts separately and memorized formulas with simple calculations (Utomo, 2020). Teachers are expected to teach correct understanding to elementary school students to avoid students' different answers to the same question (Khairunnisa et al., 2022; Radiusman, 2020).

Study by Publication Media

In this study, the data collected was limited to research published in the sinta, garuda, and repository publication media. Several studies were found that were released simultaneously in sinta and garuda media. To avoid confusion in the analysis, research published in sinta and garuda will be categorized as journals with sinta publication media. Research outside the boundaries of the inclusion criteria was not included in the analysis of this study. The analyzed research is in the form of journals, proceedings, final projects, theses and dissertations that can be accessed. The number of research publications on relational understanding is presented in Figure 3.

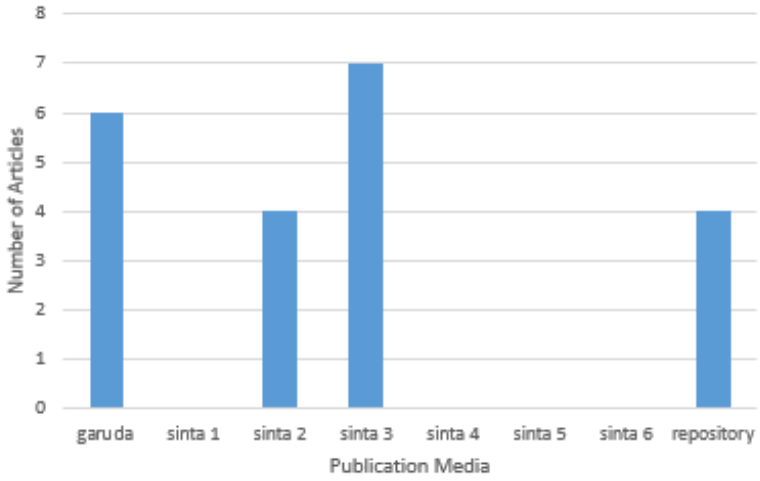

Figure 3. Research Data on Relational Understanding Based on Journal Index

From Figure 3, it can be seen that the results of research on relational understanding in solving mathematical problems are mostly published in national journals indexed by Sinta 3. While for Sinta 1, Sinta 4, Sinta 5 and Sinta 6 no research has been found on relational understanding in solving mathematical problems.

Study by Research Demographics

This category of research is limited to studies conducted in Indonesia regarding relational understanding in solving mathematical problems. Figure 4 shows the explanation of the study based on the demography of Indonesia which is divided into 5 islands, namely the Sumatera Islands, Java Islands, Kalimantan Islands, Sulawesi Islands, and NTT and Papua Islands.

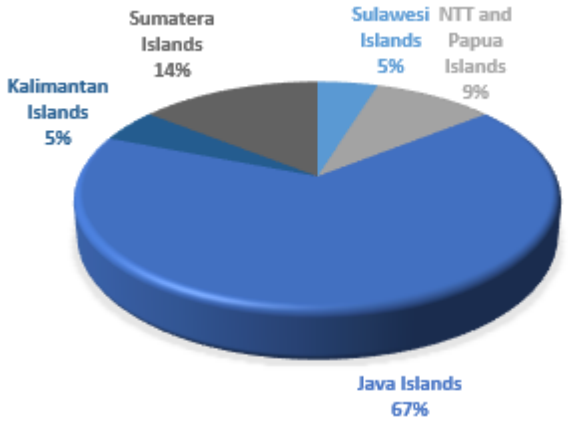

Figure. 4 Relational Understanding Research Data Based on Research Demographics

From Figure 4, it can be seen that research on relational understanding in solving mathematical problems is mostly conducted on Java Island, which 67%. Based on several Study Literature Review (SLR) studies, it was found that Java Island dominates every research on mathematical ability (Agusantia & Juandi, 2022; Ariati & Juandi, 2022;

Khairunnisa et al., 2022; Klorina & Juandi, 2022). In addition, Java Island has a dense population of 151.6 million people or 56% of the total population in Indonesia (Khairunnisa et al., 2022). In contrast to other islands with at least 1 study in Kalimantan and Sulawesi, 2 studies in NTT and Papua and 3 studies found in Sumatra. Therefore, research on relational understanding in solving mathematical problems should be conducted in various provinces in Indonesia so that teachers can make the right way to improve students' relational understanding.

Study by Research Type

Some types of research that can be used include qualitative, quantitative, or mixed-method. The types used in research on relational understanding in solving mathematical problems are presented in Figure 5 as follows.

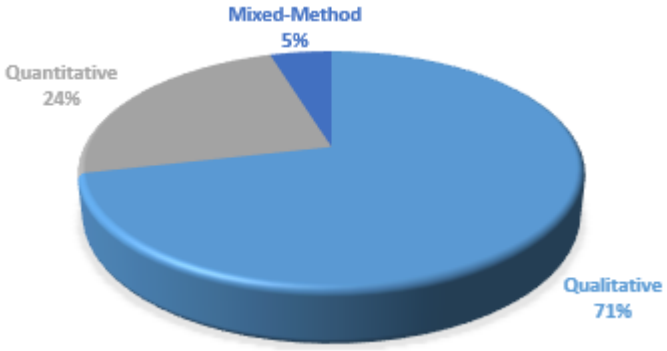

Figure 5. Research Data on Relational Understanding Based on Research Type

Based on Figure 5, research on relational understanding in solving mathematical problems in the last nine years is dominated by using qualitative research types, namely 15 studies found or 71% of all studies analyzed. Iskandar (2009) says a qualitative approach is a process of research and understanding based on methods that investigate social phenomena and human problems. Research with quantitative types found as many as 5 studies. Quantitative research is characterized by structuring relationships between factors or clarifying relationships or factors (Gumilang, 2016). Meanwhile, research that used mixed-method is the least type of research, namely 1 study. Khairunnisa et al., (2022) argue that this is because the type of mixed-method research is a mixture of qualitative and quantitative so it requires in-depth knowledge of both.

Study Based on Research Results

Research on relational understanding in solving mathematical problems found varied results. Published research on relational understanding in solving mathematical problems has been reviewed from several aspects, such as initial mathematics ability,

problem-solving ability, learning style, cognitive or non-cognitive style and learning method. The results of the 21 studies used as data in this study are presented in Table 2.

Table 2. Research Data on Relational Understanding Based on Research Results

Ability Type	Summary of Results Based on	
Relational Understanding	**Mathematical Ability**	
	(Murtalib et al., 2019)	Students with high mathematical ability fulfill all indicators of relational understanding in circle material.
	(Rahma, 2015)	Students with high, medium or low levels of mathematical ability in relational understanding are still lacking.
	(Utomo, 2021)	Student with high ability can fulfill all indicators of relational understanding while students with low ability only fulfill half of the specified indicators.
	(Yazidah et al., 2018)	Students with high and medium academic achievement have a relational understanding ability.
	(T. Wulandari, 2018)	Students with high mathematical ability meet 7 indicators of relational understanding, students with moderate mathematical ability meet 4 indicators out of 9 specified indicators of relational understanding.
	(Astuti & Haryadi, 2023)	Some students are categorized as low, not fulfilling the indicators of relational understanding, especially in probability material.
	Solving Math Problems	
	(Mahmudi, 2021)	A relational understanding of 34 7th-grade students of 77.52% is categorized as sufficient.
	(Sholihah, 2018)	As many as 22.97% of students can achieve indicators of relational understanding in geometry material.
	(Badraeni et al., 2020)	It was found that students had difficulties in not being able to relate one concept to another in working on problems, especially on flat-sided geometric material.
	(Novita, 2021)	Students who are the subject of both studies fulfill all indicators of relational understanding.
	(Taufik & Susanti, 2022)	Students' relational understanding appears when solving proof problems.
	(Rizki & Haerudin, 2022)	It was found that students who have high relational comprehension skills can solve the problems given compared to students who have moderate and low relational comprehension skills.
	Learning Style	
	(Fathonah & Maftuh, 2016)	Students with divergent, accommodative and convergent learning styles meet the indicators of relational understanding while students with

Ability Type	Summary of Results Based on	
		assimilative learning styles do not meet the indicators of relational understanding.
	Cognitive or non-cognitive style	
	(Nuringtyas & Yunianta, 2019)	Students with high and medium cognitive abilities can fulfill the indicators of relational understanding while students with low cognitive abilities do not fulfill the indicators of relational understanding.
	(Tonapa, 2021)	Students with high self-esteem levels fulfill two indicators of relational understanding, students with moderate self-esteem levels fulfill three indicators of relational understanding while students with low self-esteem fulfill one indicator of understanding from the four indicators of relational understanding given.
	(Muchlas, 2022)	Students with reflective cognitive style have good relational understanding while students with impulsive cognitive style do not have good relational understanding.
	Learning Methods	
	(Rasyid et al., 2023)	The blended learning method has not been able to optimize students' relational understanding.
	(F. Wulandari & Rakhmawati, 2019)	Students with index card match learning strategy have better relational comprehension skills than students with conventional learning methods.
	(Kulsum et al., 2019)	The use of Geometer's skecthpad received a positive response to a relational understanding of function derivatives.
	(Rahmi et al., 2021)	Building relational understanding is more effective with realistic mathematics-oriented learning, especially on chance materials.
	(Hali et al., 2022)	The combination of Think Pair Share learning model with problem-based learning approach is more effective in building students' relational understanding.

Based on the explanation in Table 2, several variations of students' relational understanding in solving mathematical problems were found. However, participants with high mathematical ability met the indicators of relational understanding (Murtalib et al., 2019; Nuringtyas & Yunianta, 2019; D. P. Utomo, 2021; T. Wulandari, 2018; Yazidah et al., 2018), while those with low mathematical ability did not fulfill all the indicators of relational understanding given. (Astuti & Haryadi, 2023; Rahma, 2015; Utomo, 2020; T. Wulandari, 2018). Some studies have found that students with moderate ability fulfill all indicators (Nuringtyas & Yunianta, 2019; Yazidah et al., 2018), but there are also studies that find contradictory results (Rahma, 2015).

Table 2 describes some effective learning methods for relational understanding. Such as the combination of the Think Pair Share learning model with a problem-based learning approach (Hali et al., 2022) and realistic mathematic education (Rahmi et al., 2021). However, there is research found by Rasyid et al., (2023) that the blended learning model is not effective. PBL and RME have similarities in the use of contextual problems in their learning (Wati et al., 2022), contextual problems are problems that require several steps in solving them (Nafi'an, 2021) so that it can be effective for practicing relational understanding.

Some research on students' relational understanding in terms of learning styles (Fathonah & Maftuh, 2016), reflective and impulsive cognitive styles (Muchlas, 2022) and self-esteem (Tonapa, 2021). The results showed diversity between grouping and relational understanding. This is very possible because the research used a qualitative approach and Bachri (2010) states that qualitative research conclusions only apply to certain subjects and cannot be generalized.

CONCLUSION

Based on the results and discussion presented above, it can be concluded that research on relational understanding in solving mathematical problems over the past nine years is most commonly found in 2022 and the research participants found are most often carried out at the junior high school education level. Most studies are published in journals indexed by Sinta 3. Java Island as one of the largest populations is also the most frequently conducted research location and qualitative research is a type of research that is often used by researchers with diverse results. The results found in the research vary in the ability of relational understanding in solving mathematical problems studied in Indonesia depending on students' mathematical ability, learning style cognitive or non-cognitive style and effective learning methods to improve relational understanding.

Based on the results of this study, other researchers who are interested in examining relational understanding in solving mathematical problems can be carried out at the high school or college level and research can be carried out other than on the island of Java. In addition, research on improving relational understanding by using other learning methods such as lectures, experiments, inquiry discovery and others can be researched for other researchers.

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