

SYSTEMATIC LITERATURE REVIEW: MATHEMATICAL REASONING ABILITY IN MATHEMATICS LEARNING

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ABSTRACT

Many studies discuss the effect of mathematical reasoning on learning mathematics. Collecting and analyzing the results of this research needs to be done in order to get an idea of how mathematical reasoning influences the learning of mathematics. The Systematic Literature Review (SLR) method is used to synthesize studies that are relevant to the purpose of this study. By using the Google Scholar, Libgen, Science Direct search engines, 20 articles published from 2016 to 2022 were included in the criteria which were then analyzed further. The results of the research show that mathematical reasoning can improve mathematics learning.

Keywords: Systematic literature review, mathematical reasoning, learning mathematics

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INTRODUCTION

Mathematics is a science that is studied at every level of education, from pre-school, elementary school, junior high school, high school, to college. Mathematics is also a fundamental knowledge that is very important for developing the science and technology needed in this rapidly changing era, as mathematics plays an important role in developing students' thinking skills (Purwanti & Adriyani, 2018). In the process of learning mathematics, Bruner (1982) stated the importance of emphasizing students' ability in intuitive and analytical thinking, which will enhance their ability to make predictions and be skilled in identifying patterns and relationships (Gatot Muhsetyo, 2010). The learning process of mathematics that has been carried out by teachers so far is as follows: (1) explaining mathematical objects, (2) giving examples of newly explained mathematical objects, (3) asking students to solve similar problems with the examples, and (4) providing exercise problems. The exercise problems given usually vary, starting from problems similar to the examples to the application of mathematical objects in daily life (Iis Holisin, 2007). The new paradigm of education today is still expected to emphasize students as human beings who have the potential to learn and develop. Students must be active in the search and development of knowledge. The truth of science is not limited to what is conveyed by the teacher. Teachers must change their role, no longer as the highest authority of knowledge and indoctrinator, but as facilitators who guide students towards forming their own



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knowledge (Gazali, 2016). The National Council of Teachers of Mathematics (NCTM) (2000:29) set mathematical proficiency standards such as problem solving, reasoning and proof, communication, connections, and representation, which should be possessed by students. All of these abilities that are expected to be possessed by students cannot be achieved solely by relying on the learning process that has been accustomed to exist in our schools, with step-by-step sequences such as teaching theory and definitions, giving examples and exercises without actively involving students in learning (Siagian, 2016).

Reasoning is a thinking process in drawing a conclusion in the form of knowledge from several statements whose truth has been proven. The mathematical reasoning ability in this study is students' ability to think in drawing a conclusion from several statements related to mathematical objects (Setiawan, 2016). In terms of reasoning, mathematical material and mathematical reasoning are two inseparable things. Mathematical material is understood through reasoning, and reasoning is understood and trained through learning mathematical material. Students can think and reason about a mathematical problem if they can understand the problem. A student's perspective on a mathematical problem also influences the thought pattern of the solution that will be carried out (Bani, 2011).

Mathematical reasoning is a mathematical ability that needs to be possessed by students. The importance of mathematical reasoning ability in students is essentially in line with the vision of mathematics, especially to meet future needs (Santosa et al., 2020). Mathematical reasoning ability helps students to conclude and prove a statement, build new ideas, and solve problems in mathematics. Therefore, mathematical reasoning ability must always be practiced and developed in every mathematics learning (Sumartini, 2015).

METHODS

This study uses the method of Systematic Literature Review (SLR). SLR aims to synthesize research results as a whole based on specific questions, using a systematic, clear, and reproducible procedure in each stage of the process (Juandi, 2021). SLR is useful for identifying relevant research journals systematically according to the established protocol. The SLR method used in this study aims to identify, carefully evaluate, and collect findings from relevant studies that describe mathematical reasoning abilities in mathematics learning. Thovawira et al. in (Rahmawati et al., 2022) revealed the stages of SLR, including formulating research questions, applying referenced journal criteria, searching for relevant studies related to the research theme, selecting studies to be used as primary studies, analyzing study findings, and finally creating research report. The research question in this study is how is the mathematical reasoning ability in mathematics learning?

The criteria for referenced articles in this study include articles that discuss mathematical reasoning abilities in mathematics learning, which are taken from national and international indexed journals. Primary studies were conducted from 2016 to 2022. The study collection strategy was carried out using search engines such as Google Scholar, Libgen, and Science Direct. Keywords used to search for journals include mathematical reasoning ability, mathematics learning.

The selection and evaluation process of articles was carried out to obtain articles that are relevant to the research theme. Articles that are relevant to the research topic will be further analyzed. Thirty-six selected articles were found to be relevant to the research theme, but then were further selected, resulting in 20 articles that were deemed relevant. To obtain comprehensive and balanced information, the selected articles were analyzed and the research findings from the articles were reported.

RESULTS AND DISCUSSIONS

The purpose of this study was to explore Mathematical Reasoning Ability in mathematics learning. A total of 40 articles were found and after selection, 20 articles met the inclusion criteria for analysis.

(Name, Year)	Title	Result
(Santosa et al., 2020)	The Effectiveness of Google Classroom Learning on Students' Mathematical Reasoning Ability	Based on the research findings, it was found that learning through Google Classroom is effective in improving students' mathematical reasoning abilities.
(Setiawan, 2016)	The Causal Relationship of Mathematical Reasoning on Mathematics Learning Achievement in Plane Figures of Solid Figures Material, Viewed from Students' Mathematics Learning Motivation	Based on the results of the analysis and discussion of the hypothesis testing, and referring to the research questions formulated in this study, it was found that students with high mathematical reasoning ability have better learning achievements than students with moderate mathematical reasoning ability.
(Sudiantini & Shinta, 2018)	The Effect of Learning Media on Students' Creative Thinking and Mathematical Reasoning Abilities	There is a significant influence of learning media on creative thinking and mathematical reasoning abilities in a multivariate manner on the sub-topic of sets in 7th-grade students.
(Wibowo, 2017)	The Influence of Realistic and Scientific Mathematics Learning Approaches on Learning Achievement, Mathematical Reasoning Ability, and Learning Interest.	The realistic learning approach is effective for learning achievement, mathematical reasoning ability, and student interest in learning; and the scientific learning approach is effective for learning achievement and student interest in learning.
(Nabila & Putri, 2022)	Students' mathematical reasoning skills on number pattern using PMRI and collaborative learning approach	Based on the research findings, it was found that the use of video media with PMRI approach and collaborative learning in teaching number patterns to 8th grade students at SMP Srijaya Negara Palembang effectively improved students' mathematical reasoning skills with an average score of 68.89. The use of video media with PMRI approach and collaborative learning during the learning process can enhance students' mathematical reasoning ability.
(Putri et al., 2019)	The Mathematical Reasoning Ability Reviewed from Problem-Solving Skills	Based on the research findings, it was found that the use of video media with PMRI approach and collaborative learning in teaching number patterns to 8th grade students at SMP Srijaya Negara Palembang effectively improved students' mathematical reasoning skills with an average score of 68.89. The use of video media with PMRI approach and collaborative learning during the learning process can enhance students' mathematical reasoning ability.
(Akuba et al., 2020)	The Influence of Reasoning Ability, Self-Efficacy, and Problem-Solving Ability on Mathematics Concept Mastery	The results of this study lead to the conclusion that: 1) students' mathematical reasoning ability positively influences their mastery of mathematical concepts; 2) students' mathematical reasoning ability positively influences their self-efficacy; 3) students' mathematical reasoning ability positively influences their problem-solving ability.
(Ario, 2016)	Analysis of Students' Mathematical Reasoning	Kemampuan penalaran matematis

	Ability in Vocational High School after Following Problem-Based Learning	siswa setelah mengikuti pembelajaran berbasis masalah termasuk baik dengan tingkat ketercapaian 77,19 %.
(Pamungkas & Yuhana, 2016)	Developing Teaching Materials to Improve Mathematical Reasoning Abilities of Prospective Mathematics Teachers.	The mathematical reasoning ability of students after participating in problem-based learning is considered good with an achievement rate of 77.19%..
(Yunus et al., 2019)	The Influence of Contextual Approach on Mathematical Reasoning Ability as Viewed from Students' Cognitive Styles	The mathematical reasoning ability of students taught using a contextual approach is better than those taught using direct instruction.
(Palinussa et al., 2021)	Realistic mathematics education: Mathematical reasoning and communication skills in rural contexts	The realistic mathematics education (RME) has a significant effect on students' mathematical reasoning and communication abilities at every school level in rural contexts. Therefore, RME is recommended for enhancing students' mathematical reasoning and communication skills in island-based rural contexts.
(Saputri et al., 2017)	The Mathematical Reasoning Ability of Students Using Metaphorical Thinking Approach on Ratio Material in Grade VIII of SMPN 1 Indralaya Utara.	Based on the research results in class VIIIA of Indralaya Utara State Junior High School, it can be concluded that the mathematical reasoning ability of students using the Metaphorical Thinking approach in the topic of ratios can be categorized as adequate.
(Fedistia & Musdi, 2020)	Improving Students' Critical Thinking and Mathematical Reasoning Ability through Brain-Based Learning Model.	The flipped classroom-based learning tool is effective in improving students' mathematical reasoning ability.
(Nur Sholihat et al., 2018)	Self-Esteem and Mathematical Reasoning of Junior High School Students (MTS)	The research results show that there is a positive influence between self-esteem and students' mathematical reasoning ability, and the causes of this positive influence include: students who have self-esteem in mathematics tend to be more courageous and confident in taking steps to solve problems, outside of the general procedures.
(Suherman et al., 2020)	The Effectiveness of AR-Geometry Interactive Book in Increasing Students' Mathematical Reasoning Skill	The use of Interactive AR-Geometry Book proves that Augmented Reality (AR) technology has been successfully implemented and can display solid 3-dimensional objects. By using this book, the learning process becomes more interesting, interactive, and enjoyable. The research results also indicate that using the book leads to an improvement (reaching 33.4% improvement) in students' reasoning abilities from the beginning.
(Saleh et al., 2018)	Improving The Reasoning Ability Of Elementary School Student Through The Indonesian Realistic Mathematics Education	The research results indicate that the achievement and improvement of students' mathematical reasoning abilities using the PMRI approach are better than those using conventional learning methods.
(Susanti & Rustam, 2018)	The Effectiveness Of Learning Models Realistic Mathematics Education And Problem Based Learning Toward Mathematical	There is an improvement in students' mathematical reasoning ability after being taught using RME, PBL, and Direct Instruction learning models.

	Reasoning Skills At Students Of Junior High School	
(Abidin, 2020)	Project-Based Learning - Literacy In Improving Students' Mathematical Reasoning Abilities In Elementary Schools	Project-Based Learning (PJBL) is effective in improving mathematical reasoning abilities. This is because PJBL can present contextual problems with literacy works in daily life
(Pahrudin et al., 2020)	The Effects of the ECIRR Learning Model on Mathematical Reasoning Ability in the Curriculum Perspective 2013: Integration on Student Learning Motivation	The ECIRR (Elicit, Confront, Identification, Resolve, Reinforce) learning model has an effect on students' mathematical reasoning ability and learning motivation in solving mathematical problems, based on the treatment of the learning model and the category of students' learning motivation towards mathematical reasoning ability. Therefore, it can be concluded that ECIRR can improve students' mathematical reasoning ability and learning motivation.
(Fatra et al., 2022)	The impact of habits of mind on students' mathematical reasoning: The mediating initial ability	There is a direct influence between students' thinking habits, initial ability, and mathematical reasoning. There is an indirect influence of thinking habits on students' reasoning ability through initial ability as a mediating variable. The findings of this study reflect that the better students' thinking habits, the better their mathematical reasoning and initial ability..

The research presented in Table 1 shows that the reasoning ability of students taught with a contextual approach is better than those taught with direct learning (Yunus et al., 2019). The ability of students' mathematical reasoning using the Metaphorical Thinking approach on comparison material can be categorized as sufficient (Saputri et al., 2017). Realistic learning approaches are effective in improving learning achievement, mathematical reasoning ability, and student interest in learning (Wibowo, 2017). Project-Based Learning (PJBL) is effective in improving mathematical reasoning ability as it can present contextual problems with literacy works in everyday life (Abidin, 2020). There is an improvement in students' mathematical reasoning abilities after being taught using the RME, PBL, and Direct learning models (Susanti & Rustam, 2018). The ECIRR (Elicit, Confront, Identification, Resolve, Reinforce) learning model has an effect on students' mathematical reasoning ability and learning motivation in mathematics problems between the treatment of learning models and categories of student learning motivation towards mathematical reasoning abilities, so overall it can be concluded that ECIRR can improve students' mathematical reasoning and learning motivation (Pahrudin et al., 2020).

There is a significant effect of learning media on creative thinking and mathematical reasoning ability in a multivariate manner (Sudiantini & Shinta, 2018), and learning through Google Classroom is more effective in improving students' mathematical reasoning ability (Santosa et al., 2020). Teaching materials to improve reasoning skills for prospective mathematics teachers are appropriate to be used with a trial presentation in the "very strong" category (Pamungkas & Yuhana, 2016). A flipped classroom-based learning device is effective in improving students' mathematical reasoning abilities (Fedistia & Musdi, 2020). Students' mathematical reasoning abilities after the learning process using video media with PMRI approach and collaborative learning have a significant effect on improving students' mathematical reasoning and communication skills at every school level (Palinussa et al., 2021). The use of AR-Geometry Interactive Books proves that Augmented Reality (AR)

technology shows that using the book can improve students' mathematical reasoning ability (Suherman et al., 2020).

Students with high mathematical reasoning abilities have better learning achievement than those with moderate mathematical reasoning abilities (Setiawan, 2016). Mathematical reasoning abilities in solving mathematical problems for fourth-grade students should be taught continuously because mathematical reasoning abilities can continue to develop with the increasing number of problem-solving exercises (Putri et al., 2019). Students' mathematical reasoning abilities positively affect their mastery of mathematical concepts, self-efficacy, and problem-solving abilities (Akuba et al., 2020). Students' mathematical reasoning abilities after following problem-based learning are good, with an achievement level of 77.19% (Ario, 2016). The better students' thinking habits, the better their mathematical reasoning ability and initial ability (Fatra et al., 2022). There is a positive influence between self-esteem and students' mathematical reasoning abilities (Nur Sholihat et al., 2018). The achievement and improvement of students' mathematical reasoning abilities in mathematics learning using the PMRI approach are better than conventional learning (Saleh et al., 2018).

CONCLUSIONS

There are many studies that show the positive influence of various methods and learning media on students' mathematical reasoning abilities. Some effective methods include learning through Google Classroom, realistic learning approaches, problem-based learning, contextual approaches, and the ECIRR learning model. There is also a positive correlation between students' mathematical reasoning abilities and academic achievement, self-efficacy, problem-solving abilities, and mastery of mathematical concepts. Realistic Mathematics Education (RME) is also recommended as an effective learning method in enhancing students' reasoning and communication skills. For future researchers, it is recommended to further study and develop the influence of mathematical reasoning in mathematics education.

RECOMMENDATIONS

Based on the presented research, future researchers can explore several areas related to improving students' mathematical reasoning abilities. One area is to investigate the integration of different approaches, such as contextual, metaphorical thinking, and realistic learning, to find the most effective approach in improving students' mathematical reasoning abilities. Additionally, researchers can explore the potential of different learning models, such as PJBL, RME, PBL, and ECIRR, in improving students' mathematical reasoning abilities. Another area that future researchers can explore is the effectiveness of different teaching materials, media, and technology, such as flipped classrooms, AR-Geometry Interactive Books, and Google Classroom, in improving students' mathematical reasoning abilities. Furthermore, researchers can investigate the relationship between students' thinking habits, self-esteem, and their mathematical reasoning abilities. Finally, future researchers can explore the long-term impact of continuously teaching mathematical reasoning abilities on students' achievement and development.

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