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Systematic Literature Review: Exploring Research Focus on Ratio and Proportion

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ABSTRAK

Rasio dan proporsi merupakan materi fundamental dalam pembelajaran matematika yang harus dikuasai siswa karena berperan penting dalam pengembangan penalaran matematis. Fokus penelitian untuk mengkaji dan menganalisis fokus penelitian terdahulu terkait pembelajaran rasio dan proporsi pada periode 2017–2022 melalui Systematic Literature Review (SLR). Sebanyak 19 artikel relevan (13 Scopus, 6 Google Scholar) terpilih melalui bantuan aplikasi *Publish or Perish*. Hasil kajian literatur menunjukkan bahwa kemampuan siswa dalam memahami dan menyelesaikan masalah rasio dan proporsi masih tergolong rendah, terutama dalam merepresentasikan situasi kontekstual ke model matematika, menafsirkan berbagai representasi, mengaitkan konsep dengan kehidupan nyata, serta memahami makna penggunaan rumus. Hasil kajian penelitian design research dan eksperimen menunjukkan bahwa pembelajaran berbasis konteks realistis, pendekatan inkuiri, permainan, dan strategi identifikasi pola secara konsisten mampu meningkatkan pemahaman konseptual dan kemampuan pemecahan masalah siswa. Temuan ini mengimplikasikan pentingnya perancangan pembelajaran rasio dan proporsi yang menekankan keterlibatan aktif siswa, penggunaan konteks yang dekat dengan kehidupan nyata, serta penguatan pemahaman konseptual. Pembelajaran yang berorientasi pada eksplorasi dan pemaknaan konsep berpotensi menjadi strategi efektif untuk meningkatkan kualitas pembelajaran rasio dan proporsi, khususnya pada jenjang sekolah menengah pertama.

Kata kunci: analisis kemampuan siswa, kajian penelitian terdahulu, rasio, systematic literatur review, proporsi

ABSTRACT

Ratios and proportions are fundamental topics in mathematics education that students must master because they play an important role in the development of mathematical reasoning. The focus of this study is to examine and analyze previous research related to the learning of ratios and proportions in the period 2017–2022 through a Systematic Literature Review (SLR). A total of 19 relevant articles (13 Scopus, 6 Google Scholar) were selected using the Publish or Perish application. The results of the literature review show that students' ability to understand and solve ratio and proportion problems is still relatively low, especially in representing contextual situations in mathematical models, interpreting various representations, relating concepts to real life, and understanding the meaning of formula usage. The results of design research and experimental studies show that learning based on realistic contexts, inquiry approaches, games, and pattern identification strategies can consistently improve students' conceptual understanding and problem-solving abilities. These findings imply the importance of designing ratio and proportion learning that emphasizes

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active student involvement, the use of contexts that are close to real life, and the strengthening of conceptual understanding. Learning that is oriented towards exploration and conceptual meaning has the potential to be an effective strategy for improving the quality of ratio and proportion learning, especially at the junior high school level.

Keywords: students' ability analysis; previous research review; ratio; proportion; systematic literature review

INTRODUCTION

One of the fundamental topics in mathematics learning is ratio and proportion (Arican, 2018; Fadilla & Siswono, 2022; Yuliani & Alfin, 2021). Students need to understand ratio and proportion concept to succeed in subsequent mathematics learning (Diba & Prabawanto, 2019). Understanding ratio plays a crucial role in learning success at the middle school level, particularly in grades 6–8 (Sari et al., 2024). Ratio refers to a number that expresses a comparison between two quantities in a specific situation through a multiplicative relationship (Taufik, 2021), while proportion refers to the relationship between two quantities that share the same ratio (Wijaya et al., 2019). Ratio and proportion are foundational topics that should receive appropriate emphasis in the mathematics curriculum (Nur & Sari, 2022). According to Petit et al. (2020), ratio and proportion are included across curricula from elementary to secondary education and are also essential for various professions in real-life contexts. Ratio and proportion are closely related to everyday problems and can be found in situations involving scale, cooking recipes, price comparisons, monetary value, population quantities, body weight, and speed (Nur & Sari, 2022).

Research on mathematics learning related to ratio and proportion has been widely conducted in previous studies (Arican, 2018; Dewi & Ekawati, 2022; Maryam & Sampoerno, 2021). However, there is still a lack of systematic literature studies that specifically examine and synthesize research findings on mathematics learning in ratio and proportion topics. Therefore, this article aims to review and analyze previous studies on research of ratio and proportion published between 2017 and 2022.

The discussion in this article focuses on three main aspects: (1) research subjects involved in studies on ratio and proportion, (2) research methods employed in investigating ratio and proportion learning, and (3) research findings related to students' understanding and learning of ratio and proportion. Through this systematic analysis, the article is expected to contribute a comprehensive overview and structured synthesis of existing research on ratio and proportion learning during the 2017–2022 period, as well as to provide a reference for future research directions in mathematics education.

METHOD

This study used Systematic Literature Review (SLR) method. SLR is a research method that systematically identifies, reviews, evaluates, and interprets relevant studies related to a particular research topic (Sari et al., 2022). The SLR process in this study is conducted through three main stages, as illustrated in Figure 1.

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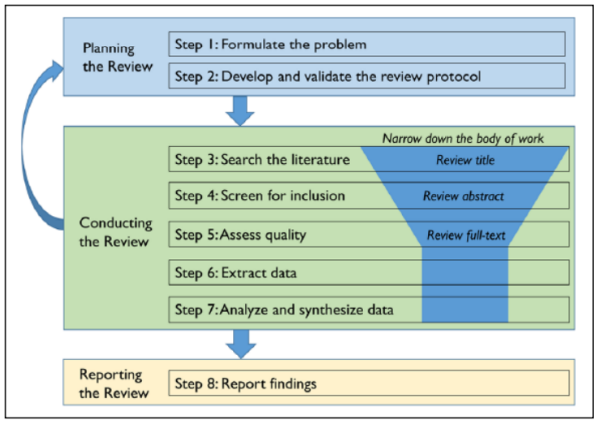

Figure 1. SLR stages (Xiao & Watson, 2019)

The first stage is Planning the Review, which involves formulating the research question, namely how the focus of research on ratio and proportion from 2017 to 2022 is viewed in terms of research subjects, methods, and findings. Subsequently, a review protocol was developed by defining search keywords, including “ratio”, “proportion”, “ratio and proportion in mathematics”, and “rasio dan proporsi dalam matematika”. The selected databases for this review were Scopus and Google Scholar.

The second stage is Conducting the Review. At this stage, article searches were conducted using the Publish or Perish (PoP) application to collect relevant studies from the Scopus and Google Scholar databases. The inclusion criteria consisted of studies related to mathematics learning on ratio and proportion published between 2017 and 2022. The initial search yielded 329 articles, comprising 129 articles from Scopus and 200 articles from Google Scholar. After excluding 25 books, 304 articles remained for further screening. Title and abstract screening resulted in the exclusion of 274 articles due to irrelevance, incomplete information, or inaccessibility. Full-text analysis identified 19 relevant articles, consisting of 13 Scopus articles and 6 Google Scholar articles.

The final stage, Reporting the Review, involved an in-depth analysis of the 19 selected articles based on research subjects, methodologies, and findings. The results were then systematically described in accordance with the research objectives. The article selection process was conducted rigorously and transparently, as summarized in Figure 2.

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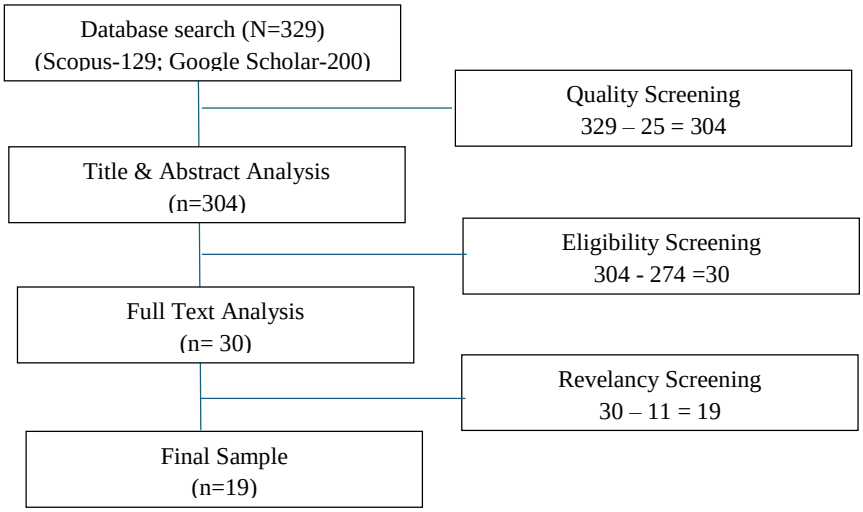

Figure 2. Article selection process

RESULT AND DISCUSSION

The data resulting from the SLR analysis of 18 articles include descriptions of research subjects, research methods, and research findings related to mathematics learning on ratio and proportion. Specifically, the research findings concerning ratio and proportion published during the period 2017–2022 are summarized and systematically presented in Table 1.

Tabel 1. Summary of literature review findings on ratio and proportion (2017–2022)

No	Researcher and Year	Subject	Method	Result of research
1	Muttaqin et al., (2017)	Middle School	Design Research	Designing ratio and proportion learning using the context of East OKU in the form of the Komering River discharge and the East OKU map has been proven to improve students' proportional reasoning skills. Designing ratio and proportion learning using the context of East OKU in the form of the Komering River discharge and the East OKU map has been proven to improve students' proportional reasoning ability.
2	Zuhra et al., (2018)	Middle school	Design Research	Using timpan recipes to teach direct proportion through a learning trajectory that begins with students selecting various timpan flavors, analyzing different timpan recipes, calculating the ratios of ingredients across the recipes, and representing these ratios using graphs and mathematical equations.

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3	Arican (2018)	Prospective Teacher	Qualitative	Prospective mathematics teachers have misconceptions about proportional and non-proportional relationships, and difficulties in interpreting and presenting proportional and non-proportional relationships. This is due to an inaccurate understanding of basic concepts related to fractions, ratios, and proportions.
4	Setyaningsih et al., (2018)	Middle school	Qualitative	Male students solved ratio and proportion problems using the unit rate strategy and the cross-product strategy, whereas female students employed the equivalent class strategy and the build-up strategy.
5	Oktaviani, (2019)	Middle school	Design Research	Designing proportional learning activities by engaging students in observing and calculating the quantities of berets, shoes, and weapons in a military parade. Furthermore, students take part in counting beads for crafting necklaces and bracelets, sharing marbles, calculating travel time using Transjakarta buses, and recognizing proportional relationships in daily life contexts
6	Wahyuningrum et al. (2019)	Middle school	Qualitative	Students' difficulties in solving ratio and proportion problems can be classified into three types: ontogenic obstacles, which refer to insufficient prior knowledge; didactic obstacles; and epistemological obstacles, where important ideas and relationships between concepts are overlooked. As a result, classroom instructional practices fail to foster conceptual understanding, and students have limited experience in applying ratio and proportion concepts.
7	Diba & Prabawanto (2019)	Middle school	Qualitative	Students can use ratio and proportion formulas but cannot understand the reasons for using them; students use memorization rather than understanding to solve problems.
8	Ayan et al., (2019)	Middle school math teacher	Design Research	Design learning activities on ratios and proportions by recognizing and comparing pictures of fish and fish food sticks, using comparison tables, and changing comparison rules.

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9	Phuong & Loc (2020)	Elementary school	Experiment	Using pattern identification strategies is a useful way to improve ratio and proportion problem-solving skills for elementary school students in Vietnam.
10	Andinasari et al., (2020)	Middle school	Design Research	The proportion learning design using the tangram context begins with tangram exploration activities, understanding the concept of equivalent values and reciprocal relationships through contextual problem solving, such as installing tiles or marble flooring, by examining the relationship between work speed, area size, and completion time.
11	Nofriati et al., (2020)	Middle school	Design Research	Proportional learning is designed using the context of a trip to the Musi River, beginning with activities that compare quantities with the same and different units, and introducing direct and inverse proportionality through problem solving using ratio tables and boat models.
12	Pratiwi & Sudihartinih, (2021)	Middle school	Qualitative	The mathematical connection skills of junior high school students in Sukabumi on ratio and proportion topics are considered low, with only 50% of students able to connect mathematical concepts to other mathematical ideas, link them to other disciplines, and apply them to everyday life problems.
13	Şen et al. (2021)	Middle school	Experiment	The application of inquiry-based learning (IBL) to teach ratios and proportions effectively develops mathematical reasoning skills.
14	Maryam & Sampoerno, (2021)	Middle school	R&D	The development of interactive learning media using the theme “The Scouts Activity” by combining RME principles and the use of technology is excellent and suitable for teaching junior high school ratio and proportion material.
15	Tsng et al. (2021)	Middle school	Experiment	The use of tic-tac-toe positively influences students’ ability to solve problems related to ratios, rates, and proportions by fostering critical thinking, enhancing communication skills, and promoting an interactive learning environment.

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16	Wardani & Prahmana, (2021)	Middle school	Experiment	This study introduces direct proportion concept with pen and money context. The results show that the PMRI approach improves slow learners' mathematical understanding of direct and inverse proportion concepts.
17	Dewi & Ekawati (2022)	Middle school	Qualitative	Students are not yet able to solve ratio proportion problems related to analyzing information presented in the form of images, tables, and graphs, as well as interpreting the results of their analysis in decision making and drawing conclusions.
18	Ambarwati & Ekawati (2022)	Middle school	Qualitative	In solving HOTS proportion problems, students can use mathematical concepts and procedures, but they are not yet able to formulate mathematical representations of situations into mathematical models and are not yet capable of translating mathematical results within real-world contexts.
19	Sugiarni et al., (2024)	Middle School	Design Research	Designing direct proportion learning using context the Rice Farmers' Activities Pandanwangi, Cianjur, with a learning path that begins with an introduction to the context through observation of the activities of Pandanwangi rice farmers, followed by apply it in solving contextual problems about seeds and crop yields, and conclude the learning by communicating their findings in the form of simple direct proportion methods or formulas.

Based on Table 1, it is evident that out of the 19 reviewed articles, 16 studies focused on junior secondary school students as the research subjects for ratio and proportion. This dominance of research at the junior secondary level is consistent with NCTM, which highlights the importance of teaching ratio and proportion from Grades 5 through 8 (Şen et al. 2021). In addition, the Common Core State Standards for Mathematics (CCSM) state that Grade 7 students should be able to examine proportional relationships and apply them to solve both real-world and mathematical problems (Diba & Prabawanto, 2019). Consequently, many researchers have selected junior secondary school students as the primary subjects for studies on ratio and proportion.

In terms of research methods, among the 19 reviewed articles, seven employed design research to develop instructional designs for ratio and proportion, seven used qualitative methods to analyze students' abilities and learning obstacles, four applied experimental methods in ratio and proportion instruction, and one focused on

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instructional development for this topic. Qualitative research was the most frequently used approach in studies on ratio and proportion. Research published between 2017 and 2022 largely focused on examining students' and teachers' difficulties and describing their competencies related to ratio and proportion. As noted by Dewi & Ekawati (2022), ratio and proportion are challenging topics for students to understand and complex for teachers to teach. Consequently, many researchers have adopted qualitative approaches to explore learning difficulties and to describe students' and teachers' understanding of ratio and proportion.

Based on Table 1, research on ratio and proportion includes the development of interactive learning media using the theme *"The Scouts Activity"* conducted by Maryam & Sampoerno (2021). The qualitative studies reviewed mainly focus on analyzing misconceptions in basic ratio and proportion concepts among pre-service teachers (Arican, 2018), examining differences in ratio and proportion problem solving based on gender (Setyaningsih et al., 2018), analyzing students' difficulties in solving ratio and proportion problems (Wahyuningrum et al., 2019), and describing students' abilities in solving ratio and proportion tasks (Ambarwati & Ekawati, 2022; Dewi & Ekawati, 2022; Diba & Prabawanto, 2019; Pratiwi & Sudihartinih, 2021).

Based on the analysis of articles employing qualitative methods, students' ability to solve ratio and proportion problems remains relatively low. Identified difficulties include students' inability to represent mathematical situations in the form of mathematical models and to interpret mathematical results in real-world contexts (Ambarwati & Ekawati, 2022), difficulties in analyzing information presented in images, tables, and graphs and in interpreting the results for decision making and drawing conclusions (Dewi & Ekawati, 2022), as well as limitations in connecting ratio and proportion concepts with other mathematical concepts and real-life situations (Pratiwi & Sudihartinih, 2021). In addition, students often fail to understand the rationale behind the use of ratio and proportion formulas (Diba & Prabawanto, 2019). These difficulties are attributed to insufficient prior knowledge, weak conceptual understanding, and limited experience in applying concepts meaningfully (Wahyuningrum et al., 2019). Overall, the findings indicate that students' competence in solving ratio and proportion problems is still low, with major challenges related to contextual representation, interpretation of multiple representations, conceptual connections, and conceptual justification of formulas.

The design research studies reviewed in this article indicate that the use of realistic contexts closely related to students' daily lives in teaching ratio can support students' understanding of ratio concepts and make ratio and proportion learning more meaningful. Examples include the use context local of East OKU in the form of the Komering River discharge and the East OKU map (Muttaqin et al., 2017), the *Timpan* recipe context (Zuhra et al., 2018), Bus Transjakarta, army cloth, necklaces, bracelets, and marbles (Oktaviani, 2019), fish and fish feed (Ayan et al., 2019), tangram (Andinasari et al., 2020), Musi Tour (Nofriati et al., 2020), and Pandanwangi rice farming in Cianjur (Sugiarni et al., 2024). These findings demonstrate that incorporating realistic contexts that are familiar to students consistently enhances their understanding of ratio and proportion concepts and contributes to more meaningful learning experiences.

Based on previous research, several experimental studies have been shown to be effective in supporting students' understanding of ratio and proportion concepts. These methods include the use of games in learning (Tsng et al., 2021), the implementation of inquiry-based learning (IBL) approaches (Şen et al. 2021), the use of real-life

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contexts such as pens and money (Wardani & Pramana, 2020), and the application of pattern-identification strategies to enhance problem-solving skills in ratio and proportion (Phuong & Loc, 2020). Overall, these findings indicate that ratio and proportion instruction becomes more effective when designed through experimental methods that emphasize active student engagement. Such approaches consistently improve students' conceptual understanding and problem-solving abilities by promoting exploration, reasoning, and meaningful connections between mathematical concepts and real-world situations.

CONCLUSION

The conclusions drawn from the literature review indicate that research on ratio and proportion is predominantly conducted with junior secondary school students, in line with curricular demands and international standards that emphasize the importance of mastering these concepts at this level. Findings from qualitative studies reveal that students' ability to understand and solve ratio and proportion problems remains low, particularly in representing contextual situations as mathematical models, interpreting multiple representations, connecting concepts to real-life contexts, and understanding the meaning behind the use of formulas. In contrast, design research and experimental studies demonstrate that instruction based on realistic contexts, meaningful activities, and active student engagement consistently enhances students' conceptual understanding and problem-solving abilities in ratio and proportion.

For future researchers, it is recommended to extend studies on the development and evaluation of innovative instructional designs that systematically integrate realistic contexts, multiple representations, and exploratory strategies, particularly to address students' conceptual difficulties. In addition, ratio and proportion instruction should be designed to emphasize conceptual understanding through contexts close to students' real-life experiences, the use of various representations, and activities that promote reasoning and reflection, so that students not only apply formulas but also understand their meaning and use them meaningfully.

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