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HETEROGENEITY OF INTERACTIVE LEARNING MEDIA OUTCOMES FOR IMPROVING MATHEMATICAL COMPETENCE: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT
This study analyzes how using interactive learning media affects math skills in different educational levels: elementary school, middle school, high school, and college. We used the Systematic Literature Review method, looking at 90 studies published between 2014 and 2023. These studies focused on how interactive learning media influences math understanding, problem-solving, communication, representation, and connections. We included all relevant school levels in our research. Our main questions were about how interactive learning media impacts students' math skills, considering factors like the school year, education level, and the number of students. The results of our analysis show a significant increase in research on this topic over the past ten years. Specifically, more studies focused on high school and college students, and larger groups of 30 or more students were common in these studies.
Keywords: Interactive Learning Media, Mathematical Competence, Learning Motivation, Systematic Literature Review

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PRELIMINARY

The use of interactive learning media in modern education has become a key element in improving students' mathematical competence (Hafni et al., 2021; Ott, 2022; Yanti, 2019). Interactive learning media promises a more dynamic learning approach, focuses on students' learning experiences, and has the potential to improve their understanding of complex mathematical concepts (Khairunnisak et al., 2021; Way & Cartwright, 2023; Nurjanah et al., 2020). However, despite the great potential of interactive learning media in improving mathematics learning, many questions still need to be answered about how such media heterogeneously influence student learning outcomes (Romadiah et al., 2022)

The significance of comprehending the diversity in learning outcomes associated with interactive learning media within mathematical competency has become increasingly apparent. This recognition is particularly salient given the variations in teaching methods, software, and platforms (Lin, 2023; Putra et al., 2021; Sulianta, 2020). individual research findings suggest potential effectiveness in utilizing interactive learning media to develop high-level mathematical abilities (Chiu et al., 2020; Mudrikah, 2022), a conclusive affirmation is yet to be established. Discrepancies exist among the outcomes of these studies, and inherent biases may be present. Hence, there is a pressing need for a comprehensive examination that elucidates the implementation of interactive learning media in mathematics education. Consequently, this study undertakes a systematic review to assess the application of interactive learning media in enhancing high-level mathematical abilities.

This article explores the heterogeneity in learning outcomes produced by using interactive learning media in the context of mathematical competence, emphasizing understanding, problem-solving, reasoning, representation, communication, and mathematical connections. To understand the factors that can influence these diverse results, this article can provide practical guidance for educators, teachers, and learning media developers to design more effective and relevant learning strategies. Apart from that, this article can also be a basis for further research to continue to increase the effectiveness of interactive learning media in improving students' mathematical competence.

This investigation aims to elucidate the outcomes stemming from integrating interactive learning media concerning advanced mathematical proficiencies. These proficiencies encompass comprehension, problem-solving, reasoning, representation, communication, and connection. The analysis considers variables such as study year, level, duration, and sample size. Consequently, a pivotal phase in this systematic literature review (SLR) involves collecting data manifested in experimental research findings on interactive learning media to enhance the aforementioned mathematical abilities. Employing the obtained data from interactive learning media research, the researcher poses pertinent inquiries as outlined below.

1. How does the use of interactive learning media impact the improvement of mathematical skills, considering the academic year?
2. How does interactive learning media affect the enhancement of mathematical competence across different study levels?

3. How is the impact of interactive learning media on mathematical competence described concerning sample size?

   How does interactive learning media improve students' mathematical competence?

METHODS

The chosen research methodology is a Systematic Literature Review (SLR). As articulated by Khalaf & Zin (2018), Dixon-Woods characterizes SLR as "a scientific process guided by explicit and rigorous rules aimed at showcasing thoroughness, resistance to bias, and transparency and accountability in technique and execution." Consistent with this perspective, Littell, Corcoran, and Pillai, as cited in Juandi (2021), assert that SLR is a survey-based research method employing a quantitative descriptive approach.

The methodology employed in this study encompasses data collection, analysis, and conclusion. Primary data collection involves sourcing research articles indexed by Scopus. Utilizing the Scopus database facilitates a systematic approach to data collection. Subsequently, filtration is implemented to include only pertinent articles or journals in this research selectively. The identification and selection of relevant data are executed following the PRISMA protocol. This protocol comprises four stages: identification, screening, eligibility, and inclusion. A graphical representation of the PRISMA diagram illustrates the progression from the identification and screening stages to the eligibility and inclusion phases.

Identification

At this stage, keywords are identified for the search process. The search process uses the Scopus database. Keywords used in the search process are separated based on each mathematical competency. They are starting with "Mathematical Competence " and "the use of Interactive Learning Media and Technology." Based on a search using the Scopus database with the previous keywords, a total sample of 31,679 was found.

Screening

The population in this study is all research on the Use of Interactive Learning Media and technology and Mathematical Competence (Mathematical Understanding, Problem Solving, Resoning, Representation, Communication, Connection), published in Scopus-indexed journals within the last ten years, from 2014 to 2023. The selection process is carried out at this stage based on previously established inclusion criteria. Only primary studies that meet the criteria in this selection process will be included in the data

group used. Based on the selection process, by limiting the year of publication, subject, type of article, and language in the Scopus database, a sample of 760 articles was obtained.

Eligibility

The remaining articles from the screening process then undergo a third process, namely the eligibility process. At this stage, the researcher manually checks the article thoroughly to ensure compliance with the specified criteria. Data was extracted by reading the abstract and then the complete article to identify themes and subthemes corresponding to the theme raised. From this process, the researchers found several articles that did not meet the inclusion criteria, so after filtering, the researchers found that the remaining sample was 90 articles.

Included

The final stage, namely the included stage, is to examine in depth all elements of the primary study to ensure that the data obtained is genuinely by the theme raised. After going through this stage, the researcher found that all the primary studies obtained had fulfilled all the requirements as data that could be used in this systematic literature review research. Therefore, the total data obtained after going through the entire series of PRIMA stages was 90 articles.

RESULT AND DISCUSSION

The outcomes of this investigation were systematically derived to address the pre-established research query. The study involved meticulously analyzing scholarly journals focused on interactive learning media to enhance mathematical competencies. Following a rigorous search and selection process guided by inclusion criteria, 90 articles were identified. These articles pertain to the application and advancement of interactive learning media within mathematics education, spanning approximately the last ten years.

Upon applying the inclusion criteria to the pertinent studies, a subsequent categorization was performed, delineated by four moderating variables: academic year, study level and sample size. The presentation of descriptive data is encapsulated in Table 1.

Table 1. Categorization of Studies According to Prespecified Criteria

Criteria		Mathematical Competence					
		A	**B**	**C**	**D**	**E**	**F**
year of study	2014-2015	2	5	1	1	0	0
	2016-2017	3	5	2	2	2	2
	2018-2019	2	2	3	1	5	4

	Criteria	Mathematical Competence					
		A	**B**	**C**	**D**	**E**	**F**
	2020-2021	1	8	1	0	11	10
	2022-2023	3	5	4	4	1	0
	2014-2023	**11**	**25**	**11**	**8**	**19**	**16**
Study Level	Elementary School	1	5	1	0	1	3
	Junior High School	2	5	3	2	9	2
	Senior High School	3	7	3	0	4	9
	University	5	8	4	6	5	2
Sample Size	< 30	3	16	4	7	3	4
	≥30	8	9	7	1	16	12

A=Understanding, B= problem solving, C= Reasoning, D= Representation, E= Communication, F= Connection.

Drawing upon the information in Table 1, a discernible trend has emerged over the past decade, emphasizing a predominant research emphasis on enhancing problem-solving skills within mathematics education. Notably, these studies have achieved successful dissemination through publication in diverse journals indexed within the Scopus database. This observation indicates a favorable acknowledgment from researchers toward the orientation of mathematics learning, as delineated in the autonomous curriculum and endorsed by the National Council of Teachers of Mathematics (NCTM).

Furthermore, research on improving mathematical communication skills was ranked second in the studies conducted during the last decade. However, research regarding increasing mathematical understanding and reasoning through interactive learning media has had a limited number of studies during the same period. This challenges researchers to continue to strive to develop understanding, especially reasoning abilities, through the application of interactive learning media (Ikhtiyariyah, 2023; Kamid et al., 2022). In order to gain deeper insight, this research will continue to discuss the moderator variables that have been previously determined.

Data Base on Year of Research

Grouping based on year of research is only shared in five periods: 2014-2015, 2016-2017, 2018-2019, 2020-2021, and 2022-2023. In the period, the data was obtained in figure 1.

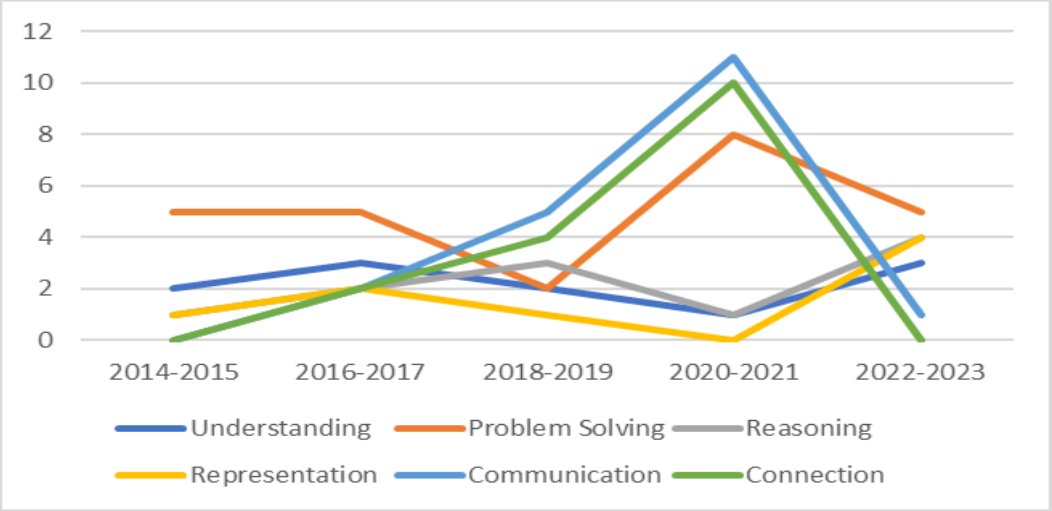

Figure 1. Distribution of Studies Across Research Years

Based on Figure 1, it can be concluded that from early 2018 to the end of 2021, research regarding the use of interactive learning media to improve mathematics competence has experienced a significant increase. However, from 2022 to 2023, there is a visible decline in interest in this research. Furthermore, problem-solving abilities are the main focus of research, compared to the other five mathematical competencies.

This shows the high interest of researchers in understanding problem-solving abilities (Hermaini & Nurdin, 2020; Sintema & Mosimege, 2023; Susanto et al., 2023), while interest in mathematical understanding and reasoning abilities tends to be lower. These two competencies are more often researched through other approaches outside of interactive learning media. These results indicate that interactive learning media has considerable potential to improve mathematics competence, as discussed in previous studies (Lozano et al., 2023).

Study Based on Academic Level

Organizing the studies according to academic levels involves categorization into four distinct groups: elementary, lower secondary, upper secondary, and tertiary education. The distribution of studies based on experimental methodologies across these academic levels is depicted in Figure 2 below.

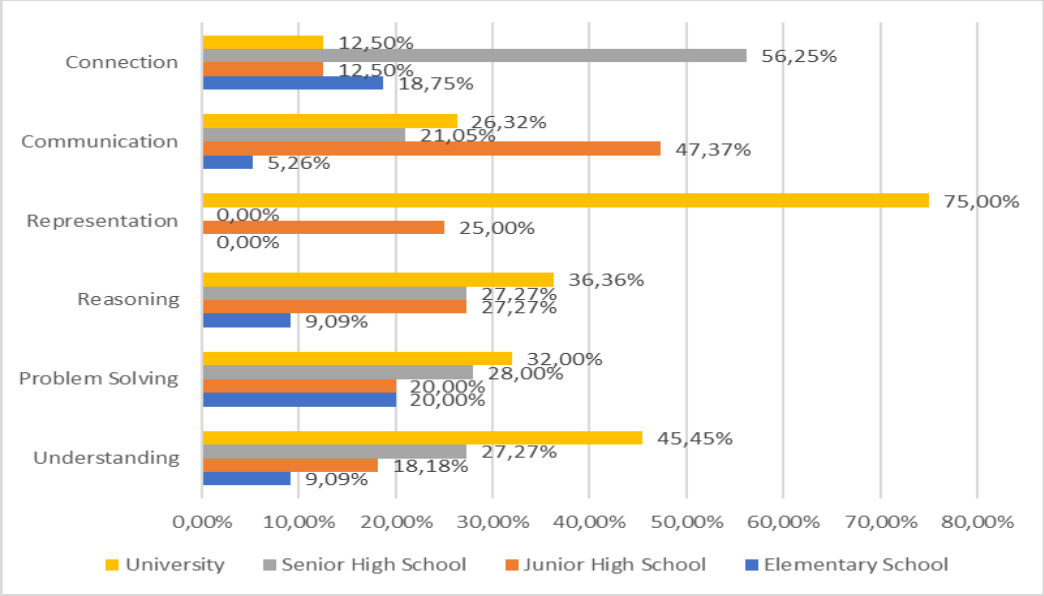

Figure 2. Distribution of Studies Across Academic Level

Based on the data presented in Figure 2, which reflects recent research trends, almost all aspects of mathematical abilities, especially problem-solving abilities, are receiving more attention in research at the university level. However, interestingly, mathematical connection and communication skills are more widely researched at the junior and senior high school levels. On the other hand, research focusing on the elementary school level still needs to be completed (Wahyuni, 2020). However, it has significant potential in developing mathematical competence early.

Given the importance of providing a solid foundation in mathematics from an early age, there is an urgency to pay greater attention to studies related to this level of education. Steps taken to understand and strengthen mathematical competencies in the early stages of education will significantly impact forming a solid foundation for higher mathematical understanding later in life (Bateman et al., 2017; Citra et al., 2023; Li & Disney, 2023). Therefore, studies focusing on educational levels need to be expanded and deepened so that mathematical competency skills can be introduced and developed early.

Data Base on Sample Size

Distinguishing the study's duration, the trials were stratified into two cohorts: samples with fewer than 30 and samples with 30 or more. The corresponding data is elucidated in Figure 3 below.

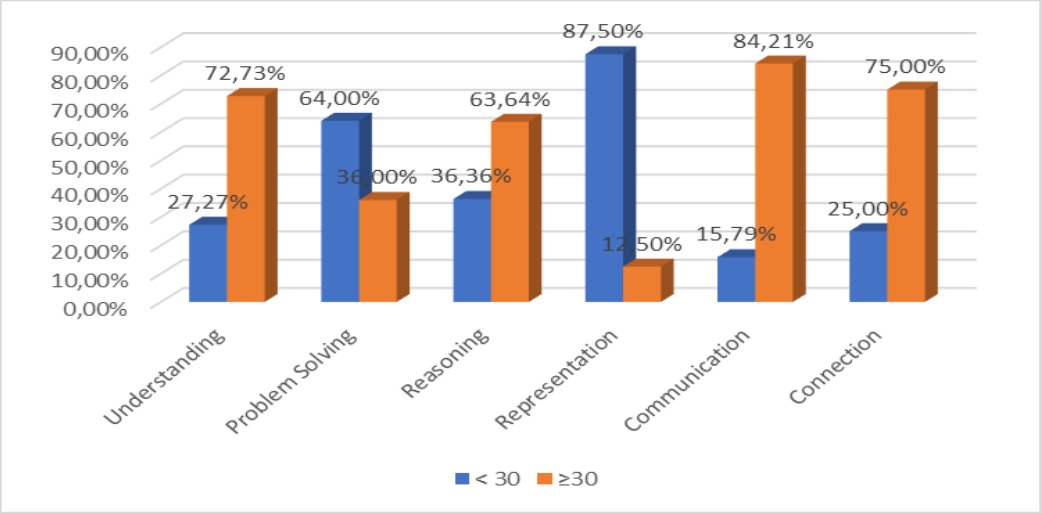

Figure 3. Distribution of Studies by Sample Size

The inference drawn from the examination of Figure 3 reveals that between 2014 and 2023, investigations into the application of instructional media to enhance mathematical competence have predominantly favored studies characterized by sample sizes, specifically exceeding 30 samples. Nevertheless, it is noteworthy that a limited proportion of research on the initial exploration of the sixth dimension of competence, specifically mathematical representation, involves smaller sample sizes, i.e., fewer than 30.

This matter reflects that the study about the application of learning media interactively and technologically to increase the ability of mathematics has gotten significant attention, especially in context enhancement problem-solving and representation of mathematics ability.

Interactive Learning Media Impact on Mathematical Competence

The results of literature research about the effect of the use of learning media, as expressed in this Systematic Literature Review (SLR) study, show significant variation in the use of interactive learning learning (Novaliendry et al., 2021; Sahroni et al., 2020). The use of this media creates responses various positives to the enhancement of ability mathematics and motivation Study students, with a percentage increase in average height. Findings in line with various literature previously highlighted the impact of the positive use of learning media on various aspects of competence mathematics and motivation Study students.

This high number of positive responses reflects the application of technology in learning in a way that contributes positively to enhancing students' abilities, especially in understanding concepts, problem-solving, reasoning, representation, communication, connection, and learning motivation. Therefore, using various types of learning media is a

potential option in designing learning strategy to increase competence in mathematics and motivate student learning. Integration technology in learning is a critical factor that can impact the learning process and results (Eom, 2023; Timotheou et al., 2023).

CONCLUSION

Research on using interactive learning media and technology in mathematics learning has received significant attention based on the results and analysis carried out in the last ten years. The research focuses mainly on improving students' mathematical problem-solving and communication abilities. However, remember that this study has several limitations that need to be considered. One of the main limitations is that the data used in this research is limited to information sources from the Scopus database, so it only includes some existing studies. In addition, the available information only covers data up to 06/08 / 2023, so it does not include research that may have been conducted in 2023.

Therefore, this systematic review recommends continuing research using more robust methods, such as meta-analysis, taking into account relevant moderating variables. This will provide a deeper understanding of research trends and the impact of interactive learning media and technology in improving students' mathematical competence.

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