Infinity Journal of Mathematics Education
Volume 12, No. 2, September 2023
p-ISSN 2089-6867
e–ISSN 2460-9285
https://doi.org/10.22460/infinity.v12i2.p243-260

SYSTEMATIC LITERATURE REVIEW ON THE RECENT THREE-YEAR TREND MATHEMATICAL REPRESENTATION ABILITY IN SCOPUS DATABASE

Rizki Wahyu Yunian Putra[1*], Sunyono[1], Een Yayah Haenilah[1], Hasan Hariri[1], Sugeng Sutiarso[1], Nurhanurawati[1], Nanang Supriadi[2]
[1]Universitas Lampung, Indonesia
[2]Universitas Islam Negeri Raden Intan Lampung, Indonesia

Article Info

Article history:

Received Mar 20, 2023
Revised Apr 28, 2023
Accepted May 25, 2023
Published Online Jul 6, 2023

Keywords:

Mathematical representation,
Systematic Literature Review

ABSTRACT

Mathematical representation is essential as the gateway to mastering mathematical literacy. This literature study aims to determine the growth of students' mathematical representation abilities in the last three years. This literature study presents a literature review on the development of mathematical representations, including media, strategies, and measurement instruments to serve as the basis for future mathematical representations. The literature study method used is the SLR (Systematic Literature Review), utilizing a review procedure that refers to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework in the period 2020 to 2022 because the growth in literature studies on mathematical representations is very significant and latest. Data were collected by reviewing 24 Scopus-indexed articles and proceedings from the Scopus database. The study's results reveal that from the 24 selected literature, it can be interpreted if the mathematical representation ability can be improved and fulfills the indicators of mathematical representation itself by providing innovation in media, strategies, and instruments in learning mathematics. The innovations provided can be in the form of technology integration (Geogebra), no longer conventional strategies (RME strategy), and instrument indicators of the representation itself. Thus the ability of students' mathematical representations is no longer included in the low category in solving mathematical problems.

Corresponding Author:

Rizki Wahyu Yunian Putra,
Doctoral Student, Department of Education,
Universitas Lampung
Jl. Prof. Dr. Ir. Sumantri Brojonegoro No.1, Bandar Lampung, Lampung 35141, Indonesia.
Email: rizkiwahyuyp@radenintan.ac.id

How to Cite:

Putra, R. W. Y., Sunyono, S., Haenilah, E. Y., Hariri, H., Sutiarso, S., Nurhanurawati, N., & Supriadi, N. (2023). Systematic literature review on the recent three-year trend mathematical representation ability in scopus database. *Infinity*, *12*(2), 243-260.

1. INTRODUCTION

Contextual problems or problems related to real situations are usually used as a basis for developing mathematical literacy problems because their structure emphasizes the development of various contexts (Lestariningsih et al., 2018). Mathematical literacy problems can be used to measure individual mathematical literacy abilities, which in PISA are based on aspects of mathematical content and context. Based on the results of the Program for International Student Assessment (PISA), the ability of Indonesian students in the field of mathematical literacy is generally still low. The 2015 PISA results show that mathematics achievement in Indonesia is ranked 63 out of 72 countries with a score of 386 (OECD, 2017). Where students have representation skills in mathematical activities to solve mathematical literacy problems. Therefore, it is important to develop mathematical literacy problems for students to support their abilities in the representation (Lestariningsih et al., 2018).

The ability of mathematical representation can assist students in building concepts and expressing mathematical ideas, as well as making it easier for students to develop their abilities (Herdiman et al., 2018). Mathematical representation is the ability to restate mathematical problems through selecting, interpreting, translating, and using objects (graphs, tables, pictures, diagrams, formulas, equations) to express problems (OECD, 2003). One of the competency standards that is the focus of the literature study is the ability to represent mathematically. This problem is related to other literature studies that enrich the ability of mathematical representation.

Mathematical representation ability is the ability to restate notations, symbols, tables, pictures, graphs, diagrams, equations, or other mathematical expressions into other forms. Mathematical representations consist of visual representations, verbal (written text), mathematical equations, or expressions (Lestari et al., 2020). Representation ability is very important for students to have, with representation ability, can make it easier for students to solve mathematical problems (Sari et al., 2022). A problem that is considered complicated and complex can become simpler if the strategy and use of mathematical representations are used in accordance with the problem. Therefore, the selection of the student's representational model plays a very important role in making appropriate and accurate mathematical problem-solving strategy decisions (Ramanisa et al., 2020).

In addition, representation is seen as an important part of mathematical activities and means capturing mathematical concepts because students' success in solving problems cannot be separated from the role of the representation (Hwang et al., 2007). This is because the ability of students' accurate mathematical representations can make them expand their abilities in solving mathematical problems.

Representation is an expression of mathematical ideas or ideas displayed by students in their efforts to find a solution to the problem they are facing. Mathematical representations have forms that include visual, verbal, and symbolic representations. Visual representation, namely making pictures to clarify problems and facilitating their completion, verbal representation, specifically expressing mathematical ideas, writing down the steps for solving mathematical problems, writing interpretations of a representation, and symbolic representations, namely making mathematical models, solving problems involving mathematical expressions (NCTM, 2000). A literature study related to the importance of representation in mathematics, among others, states that students' representational abilities are the key to success in understanding mathematical concepts and solving problems (Birgin, 2012; Villegas et al., 2009).

Based on this description, the researcher argues that a comprehensive review is needed regarding how research descriptions of mathematical representations in learning. For this reason, a literature study is carried out in the form of a systematic review of mathematical representations. Lusiana and Suryani (2014) also stated that SLR can be a theoretical background for future research, useful as a reference, research material, or answering questions related to interesting topics by understanding previous studies. Data collection was in the form of the results of a literature study related to mathematical representations which were then extracted, with questions on the articles being analyzed.

A Systematic Literature Review is a rational, transparent, and reproducible way to analyze the existing literature. A systematic Literature Review is a form of secondary study and includes different approaches to building, exploring, and summarizing accessible evidence related to a particular research question (Munn et al., 2018). In addition, SLRs can also help provide a better understanding and monitor research trends (Lame, 2019; Suherman et al., 2021). Systematic Literature Review (SLR) is a survey-based quantitative descriptive approach (Tamur et al., 2023). The survey was conducted on secondary data in the form of basic research results on students' mathematical reasoning abilities. The stages of the research include data collection, data analysis, and drawing conclusions (Tamur & Juandi, 2020). The data collected is in the form of primary research that has been published in national journal articles, data collected from electronic databases registered and indexed by Google Scholar, Semantic Scholar, ERIC, and direct URLs of national journals. Next, extraction of all the articles found was performed.

The purpose of this research is to systematically review the literature related to mathematical representation ability by referring to Type SPIDER with the question model: Sample, Phenomenon of Interest, Design, and Evaluation (Higgins et al., 2021; Newman & Gough, 2020). Therefore the formulation of this research problem includes:

RQ1 What research topics are most studied by researchers?
RQ2 What research methods are often used in the study of mathematical representations?
RQ3 What learning media and teaching materials are used to develop mathematical representations?
RQ4 What learning strategies are used to develop mathematical representations?
RQ5 What instruments are used to measure the mathematical representation?

The following is a summary of Table 1 of type SPIDER in systematically reviewing the literature related to mathematical representation abilities:

Table 1. Summary of SPIDER

Sample	Phenomenon of Interest	Design	Evaluation
Toddlers, preschoolers, students, teachers, prospective teachers, boys, girls	Research problems or objectives: development and validation instruments for measuring mathematical representations, development of representational pedagogy, components of mathematical representations: reflection, motivation, and representational actions.	problem-solving strategies using visual heuristic tools, REACT strategy, Android Challenge-Based Learning, RME, collaborative learning, PMRI and discovery learning, four-dimensional research, pedagogical approach, DDR, case studies, quasi-experiments, exploratory descriptive, task design, and phenomenological qualitative	Visual representation, development of abstract mathematical concepts, solving mathematical word problems, translating from symbolic to verbal form, changing representations of basic functions, complex modeling and problem solving tasks, interdisciplinary models of mathematics and science, theory of representation development, development instruments and measurement validation representation development, representation learning strategy.

By using the Type SPIDER literature study it is easier to analyze the main literature which is then extracted and the data analyzed with the aim of answering questions related to media, strategies, and instruments from mathematical representations.

2. METHOD

This literature study uses the Systematic Literature Review (SLR) method using a review procedure that refers to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework which is used to answer the problem formulation, the stages of the PRISMA framework: planning, implementation and reporting (Higgins et al., 2021; Newman & Gough, 2020). Journals obtained from the Scopus database with the keywords used are mathematical representations. The literature selection process refers to the inclusion and exclusion criteria. Inclusion and exclusion criteria were used in the primary literature selection. The purpose of inclusion and exclusion criteria is used to minimize ambiguity and reduce the possibility of bias in the literature study. These criteria are shown in Table 2 (Higgins et al., 2021; McDonagh et al., 2014; Newman & Gough, 2020).

Table 2. Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
- The literature is in the form of academic studies—philosophical, theoretical, educational practices about mathematical representations. - The population/research subjects consisted of toddlers, pre-school children, college students, teachers, prospective teachers, boys and girls. - Literature published in the last 3 years in a reputable journal, Scopus. - Literature presents a comparison of contexts, learning methods, measurement of mathematical representations. - The literature is supported by research methodologies and empirical data with strong validity. - Literature published in English.	- Incomplete literature. - Literature published more than last 3 years. - Literature in the form of books

The search flow and the amount of literature identified in the PRISMA framework are shown in Figure 1. The literature selection process was carried out in four steps, namely searching for keywords and then selecting literature based on title and abstract, inclusion and exclusion criteria as well as the complete text which will produce the referenced literature.

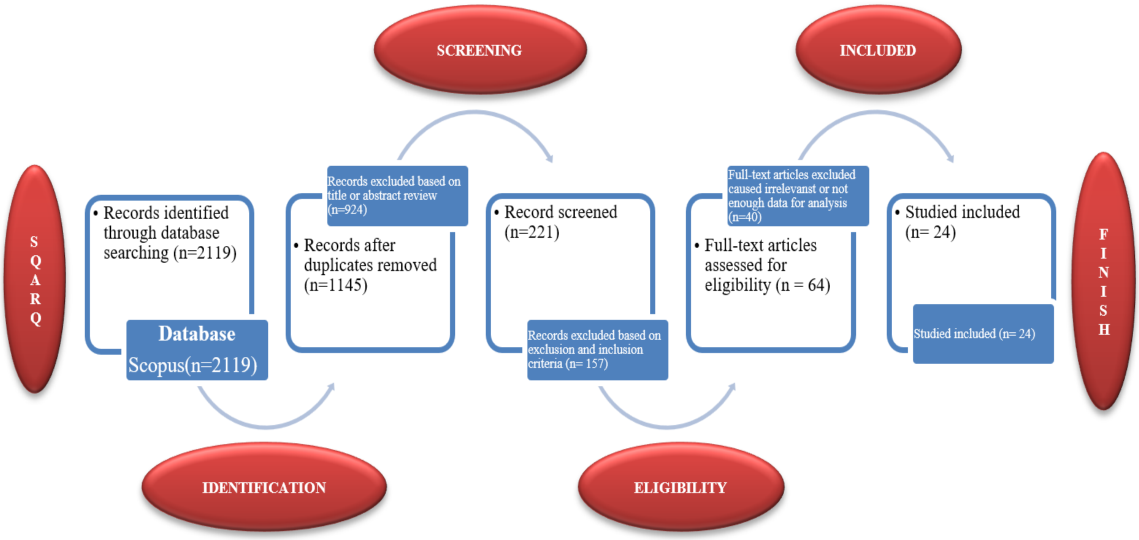

Figure 1. PRISMA procedure

Based on the image above framework PRISMA was obtained from 2119 journals. Then filter by title and abstract obtained from 924 journals. Then with the filter according to the inclusion and exclusion criteria, 157 journals were obtained. Then with a full-text filter, 40 were obtained. Of the 40 journals, 24 were relevant. At the end of the selection, 24 main articles were selected to be analyzed further. The main literature that has been selected is then extracted to collect data that contributes to answering the predetermined research questions. Table 3 represents the iterative data extraction to answer research questions with 5 properties.

Table 3. Properties of data extraction mapped to research questions

Property Research Questions	Research Questions
Research Topics and Trends	RQ1
Research Methods/Design	RQ2
Research Media	RQ3
Research Strategy	RQ4
Research Instruments	RQ5

Browsing to search the main literature on several journal databases refers to the procedure in the developed SLR (Higgins et al., 2021), then compiled as a guide as a compass in searching and analyzing literature to conduct a review and minimize the possibility of bias (see Figure 2).

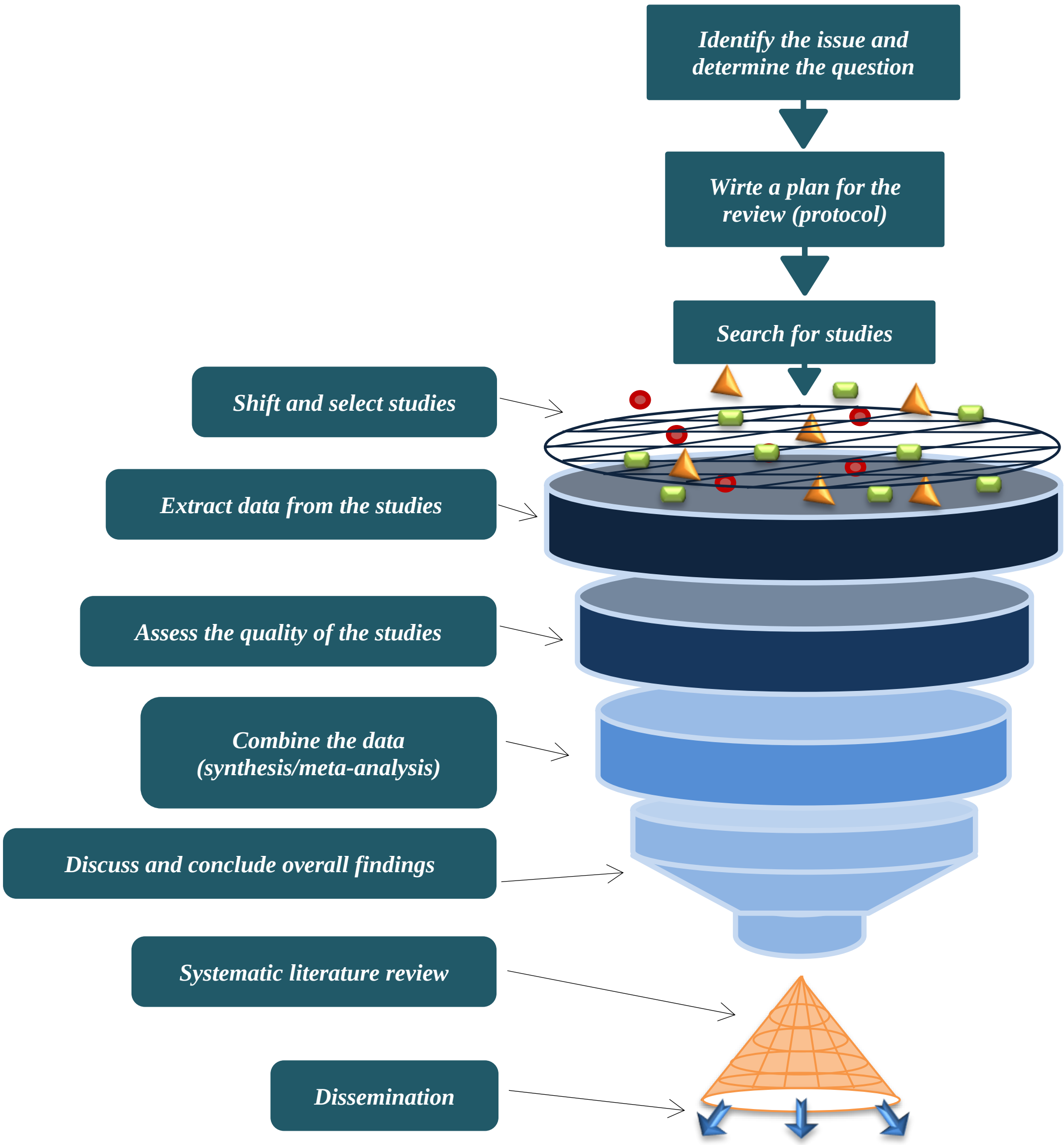

Figure 2. Systematic literature review procedure (Higgins et al., 2021)

After the data is extracted, it is then classified, assessed, compared, analyzed, combined and concluded as a whole. The data extracted and analyzed from the main articles are used to answer the questions of the literature study. For the record, the analysis of this article uses statistical techniques and searches using search engines. This SLR was carried out aiming to analyze literature related to mathematical representation according to statistical techniques and searches using search strings, but not based on manual reading of articles published in various journals. So this SLR may miss several articles regarding mathematical representations in several journals.

3. RESULT AND DISCUSSION

3.1. Results

The results of the research contained in this literature review are in the form of article data tabulations documented related to the ability of mathematical representation articles (see Table 4).

Table 4. Research related to mathematical representations

Authors & Year	Journal	Research Result
Bakar et al. (2020)	EURASIA Journal of Mathematics, Science and Technology Education	The discoveries show that small kids are able photographic artists and their visual portrayal pictures support how they might interpret the idea of expansion. According to the findings of this study, the development of mathematical visual representations is crucial for facilitating the understanding of abstract mathematical concepts.
Fauziyah and Jupri (2020)	Journal of Physics: Conference Series	According to the findings, the test instruments used to measure students' mathematical representation and communication skills were inadequate. Most understudies find it hard to close in view of blunders in understanding the importance of numerical statements, in actuality, settings. Learning activities need to be created based on these findings to achieve the expected indicators, which will help students improve their communication skills and mathematical representations.
Nurrahmawati et al. (2021)	International Journal of Evaluation and Research in Education (IJERE)	Students were still unable to correctly make representations when translating from symbolic form to verbal form (problems in daily life) using a particular equation system, according to the findings of the data analysis. Students still cannot draw a complete graph when asked to translate into graphical form, and because their errors are misinterpretations and implementations, they cannot maintain semantic alignment. between the source portrayal and the objective portrayal. On the basis of this, a lesson plan that can help students differentiate between representations needs to be developed.
Sproesser et al. (2022)	International Journal of STEM Education	According to these findings, lessons on function should include multiple representations and representational changes to help students develop rich function concepts and flexible problem-solving skills, satisfy curriculum requirements, and respond to didactic considerations. Teaching functions, in particular, needs to be more balanced by incorporating tasks with and without situational context and representational adjustments when necessary. These discoveries ought to propel educators, especially those showing non-scholastic streams, to give situational setting a more conspicuous job in their illustrations about capabilities to cultivate their understudies' learning and fabricate spans among science and certifiable circumstances.

Authors & Year	Journal	Research Result
Tytler et al. (2023)	International Journal of Science and Mathematics Education	Making maps, understanding them, measuring and modeling data, sampling data, and using scales are all parts of the mathematical process. This examination offers new experiences into how educators support understudy learning in these two subjects, through the phases of onboarding, testing portrayal, building agreement, and carrying out and extending authentic frameworks.
Santia et al. (2021)	Journal of Physics: Conference Series	Subjects used verbal and symbolic representations to calculate, find and fix errors, and justify their answers when solving unstructured problems, according to the findings. However, only the first subject used visual representations to find and fix errors. When compared to well-structured problems, subjects reveal less information needed to solve unstructured problems.
Sagita et al. (2021)	Journal of Physics: Conference Series	The following conclusions are drawn from the analysis and discussion that took place in the preceding chapter. There were two types of learning barriers: learning barriers related to learning barriers and learning barriers related to 3D material. transferring data or representations from representations to diagrams, graphs, or table representations; (3) obstacles to learning how to draw geometric shapes to help solve problems. 4) related to obstacles to learning. Make use of illustrations to solve problems. 5) related to obstacles to learning how to make images with geometric patterns. Calculating the percentage of teacher and student responses to teaching materials yielded a value of 94.66 percent with very positive criteria and 82.96 percent with positive criteria for teaching materials.
Kaitera and Harmoinen (2022)	LUMAT: International Journal of Mathematics Education, Science and Technology	The findings demonstrated that the teaching strategy, which places an emphasis on discovering various approaches to solving math problems, has the potential to enhance students' test performance, problem-solving abilities, and ability to explain their reasoning in assignments. The discoveries of this review recommend that educators can uphold the improvement of critical thinking systems by empowering class conversation and utilizing, for instance, a visual heuristic instrument called Critical thinking Keys.
Lestariningsih et al. (2020)	Journal of Physics: Conference Series	Based on the findings of the analysis, expert review, and small group discussions, the research demonstrates that the developed problems meet valid and practical criteria. What's more, the issues grew additionally have potential impacts in view of

Authors & Year	Journal	Research Result
		field test examination which shows understudies are engaged to deliver portrayals in taking care of issue.
Rahayu et al. (2021)	Journal of Physics: Conference Series	Five inaccuracies in (1) students' ability to present concepts in various mathematical representations were identified as learning barriers in the study as didactic and epistemological barriers. 2) Recognizing the concept of orthogonal projections in geometry between points on lines; 3) build mathematical types of room to explain issues; (4) Recognizing students' visual representations of the skill of locating a point or line that is perpendicular to a line; 5) Using the Pythagorean theorem and algebraic concepts to perform calculations
Utomo and Syarifah (2021)	Journal of International Education in Mathematics, Science and Technology	The examination results show that visual portrayal happens in both high, medium and low limit classes. Students with high and low abilities perform symbolic representation tasks at the understanding level, whereas capacity students perform symbolic representation tasks at the problem-solving level. Additionally, students with high abilities write conclusions as they write topics. Students with moderate writing ability complete their questions by writing conclusions. The low-skilled students wrote down what they understood, and questions about the problems were posed to them.
Septian et al. (2020)	Journal of Physics: Conference Series	Students who use GeoGebra in integral fields increase their mathematical representation abilities more effectively than students who use conventional learning, according to high and low categories of mathematical representation abilities. In the high and low prerequisite ability categories, Geogebra in the Integral Field is superior to conventional learning for prerequisite skills.
Susilawati (2020)	Journal of Physics: Conference Series	When compared to students in the control group, the Android-Based Challenge-Based Learning students' mathematical representation skills improved. In the high, medium, and low categories, students with Android-based Challenge-Based Learning and conventional learning based on prior knowledge of mathematics perform identically when it comes to mathematical representation. Students engage in a challenge-based learning interaction with the Android app, and expository learning based on prior math knowledge is used to assess the mathematical representation abilities of high, medium, and low students. Challenge-based learning on Android makes conflict resolution, discovery, and social interaction easier.

Authors & Year	Journal	Research Result
Fiantika (2021)	Journal of Physics: Conference Series	The findings demonstrated that mental rotation made use of feature coding, imaginary angle stimulus rotation, and fast stimulus matching, as well as symbolic number sense, ordinal magnitude sense, and line division in math skills.
Pedersen et al. (2021)	MDPI	The outcomes uncover a reasonable connection between the numerical points covered and the kind of portrayal utilized, and further propose that specific parts of illustrative capability are rethought when DT is utilized. In order to facilitate representational competence in relation to the utilization of DT, we offer five recommendations for the creation of math tasks. Finally, we inquire as to whether the DT only initiates a new activity or a new representation.
Saskiyah and Putri (2020)	Journal of Physics: Conference Series	Students' ability to solve problems involving mathematical expressions and load problem situations based on the provided data or representations had improved, according to the findings. Drawing geometric shapes to clarify the issue and facilitate its resolution is a rare indicator. Giving a genuine setting through PMRI and cooperative growing experiences helps understudies in creating marks of numerical portrayal.
Sirajuddin et al. (2020)	Journal of Education for Talented Young Scientists	The study found that algebraic symbol representation, image representation, and geometric representation are the three types of representations that the subject raises when expressing algebra. A large portion of the members created mathematical emblematic portrayals and a few experienced troubles in delivering pictorial portrayals and mathematical portrayals. The same patterns, namely perception, appearance, strategy, and re-examination, were also observed in the production of geometric representations by the researchers.
Taqwa and Rahim (2022)	Journal of Physics: Conference Series	The outcomes showed that understudies' capacity to comprehend vector ideas with numerical portrayals was superior to understudies' verbal portrayals. The understudies' mean scores in the verbal and numerical portrayal designs were 33.91 and 59.17 separately. The paired sample t test yielded the following results: t count = -12.96 and sig. = 0.00. According to these findings, students' comprehension of vector concepts in verbal and mathematical representations differ significantly. The aftereffects of this study show that's how understudies might interpret vector ideas actually relies upon the portrayal of the inquiries in light of the fact that their comprehension isn't lucid. Based on these findings, vector learning must focus not only on mathematics but also on connecting the

Authors & Year	Journal	Research Result
		meanings of vector operations in different representations and the meanings of vectors in different representations.
Post and Prediger (2022)	Journal of Mathematics Education Research	Case studies show that teaching methods can vary greatly: For students with advanced comprehension, translating condensed concepts from a given text into other representations—visual area models, fractional symbolic representations, and three language variations—seems sufficient. Some students need the teacher's help to break down a complex concept like "parts" into several concept elements like "part," "whole," and "part-whole relations," and to explicitly link the concept elements in some representation for the concept elements rather than just translating them. different. Theories about teaching practice with multiple representations and professional development may benefit from these findings.
Björklund and Palmér (2022)	Educational Studies in Mathematics	This study examines and expands the potential of interactive book reading as an educational tool for quality improvement and adds to our understanding of how to teach numbers to toddlers.
Rahayu and Kuswanto (2021)	Journal of Technology and Science Education	The exploration discoveries show that MIKIMOM is powerful in further developing understudies' decisive reasoning abilities and numerical portrayal with a score of 0.287 (enormous impact size) and 0.179 (medium impact size).
Hakim et al. (2020)	Journal of Physics: Conference Series	Students who use mobile learning have better representational learning outcomes than students who use traditional learning, according to the study's findings.
Awantagusnik et al. (2021)	AIP Conference Proceedings	The results of the study show that Shaden is able to use more than one representation to solve contextual problems, but students are still found to be able to use only one mathematical representation, namely verbal representation.
Jewaru et al. (2021)	AIP Conference Proceedings	The results showed that students who understood vectors were easy physics concepts, but most students had problems with vector concepts. Students seem to respond correctly to the mathematical representation test, but there are still many errors in the physical representation.

After analyzing the data in the 24 selected articles (see Table 4), we will focus on discussing the three main pillars that support mathematical representation abilities: theory, strategy, and measurement. In addition, we will also reveal the types of research gaps that are the keys to opening up research opportunities in the future.

RQ1: Mathematical Representation Research Topics

Some of the main descriptions obtained from the results of this analysis are that research on mathematical representations currently focuses on topics: 1) contextual learning through PMRI, RME, and ethnomathematics theories; 2) Development and validation of mathematical representation measurement instruments such as teaching materials using Geogebra or; 3) Development of learning strategies oriented to mathematical representations in didactic designs.

The tendency of mathematical representation research focuses on mathematical literacy activities. This is also a more specific development in generating mathematical representations in students. Researchers of mathematical representations for students need to highlight how various roles such as contextual learning through PMRI, RME, or ethnomathematics whose teaching materials with Geogebra and didactic designs can lead to psychological studies which then raise questions about how the coherent sequence (sequence) is appropriate in developing representations. mathematical.

RQ2: Development of Mathematical Representation Research Methods

After analyzing 24 articles through a bibliometric perspective, a review of the contents began. Based on the method aspect of the article, it shows the variation in the use of research methods. Some articles that use a qualitative approach such as case studies, observations, interviews, and phenomenology as much as 79%. Several other articles use a quantitative approach, especially those relating to the development of measurement instruments as much as 17%. Whereas in other contexts, mathematical representation has been widely studied using a mixed method approach, for example developing a measurement instrument for mathematical representation with a scale and deeply interviewing as much as 4%.

RQ3: Development of Mathematical Representation-Oriented Learning Media

The results of the analytical review found several theories that underlie the development of media in learning that is oriented toward mathematical representations. From the several articles that have been analyzed, we found at least 3 of the latest learning media that are offered to develop mathematical representation skills offered, namely teaching materials such as visual heuristic tools, MIKIMOM, mobile learning using Geogebra, and the Carom comic game.

RQ4: Mathematical Representation-Oriented Learning Strategies

From the several articles that have been analyzed, we found at least 6 of the latest learning strategies offered to develop mathematical representation abilities as can be known, namely: problem-solving strategies using visual heuristic tools, REACT strategies, Android Challenge-Based Learning, Realistic Mathematics Education (RME), collaborative learning, PMRI, and discovery learning. Based on tracing research developments regarding mathematical representations, it concerns contextually oriented learning which is then in the form of ethnomathematics which is developed with a didactical design.

RQ5: Measurement of Mathematical Representation

After discussing learning theories and strategies, the review of the development of mathematical representation measurement instruments aims to reveal the various instruments that have been developed and currently exist. Because another element of learning mathematical representation that is also important to analyze is measurement. Most of the instruments are like creating geometric shapes to clarify problems and facilitate solving, solving problems involving mathematical expressions, and creating problem situations based on the data or representations provided.

3.2. Discussion

This systematic literature review reveals how far research has progressed regarding mathematical representations over the last three years. Several research results show that the development of mathematical representations has reached various areas of study, including Engineering, Computer Science, and Physics. So that studies on mathematical representations can look further at how this ability is generated in the field of Engineering. In line with this, the development of learning strategies that are oriented toward mathematical representations has also developed rapidly and is increasingly varied. Where learning can be done through contextual learning such as REACT strategies, problem-solving strategies using visual heuristic tools, Android Challenge Based Learning, Realistic Mathematics Education (RME), collaborative learning, PMRI, and discovery learning (Hidayat et al., 2023; Nuraida & Amam, 2019; Prahmana et al., 2020). Besides that, the development of media or teaching materials that support and facilitate the learning of mathematical representations has also developed a lot, such as visual heuristic tools, MIKIMOM, mobile learning using Geogebra, and the Carom comic game. Apart from this, learning designs also need to be developed as in Didactical Design Research (DDR) (Rosita et al., 2019; Sari & Darhim, 2020).

This can be a reference in determining learning and research on mathematical representations in the future, namely deepening how communication and representational skills can be improved, where students need to be more accustomed to being introduced to math problems with the help of appropriate methods, using representations in other fields of mathematics, developing translation skills in learning when understanding concepts and solving problems, varying the frequency of solutions beyond characteristics, teachers can be oriented to guide student transduction, increase the number of subjects and extend the study period, Implementation of Teaching Materials, understand the natural development of problem solving skills and strategies and whether kind of "out-of-the-textbook" approach in math class,developing and paying attention to student representation in solving mathematical literacy problems or contextual problems, hypothetical didactic designs, assessing students' visual skills, teaching materials using Geogebra, providing real contexts through PMRI and collaborative learning processes, misunderstandings in the concept of dividing equations, providing real contexts through PMRI and collaborative learning processes, misunderstandings in the concept of sharing equations, expanding the data corpus, theoretical assumptions about the conditions needed to learn mathematics, and preparing and checking in advance all mobile devices that will be usedteaching materials using Geogebra, providing real context through PMRI and collaborative learning processes, misunderstandings in the concept of sharing equations, providing real contexts through PMRI and collaborative learning processes, misunderstandings in the concept of sharing equations, expanding the corpus of data, theoretical assumptions about the conditions necessary for learning mathematics, as well as prepare and check in advance all mobile devices that will be usedteaching materials using Geogebra, providing real context through PMRI and collaborative learning processes, misunderstandings in the concept of sharing equations, providing real contexts through PMRI and collaborative learning processes, misunderstandings in the concept of sharing equations, expanding the corpus of data, theoretical assumptions about the conditions necessary for learning mathematics, as well as prepare and check in advance all mobile devices that will be usedas well as prepare and check in advance all mobile devices that will be usedas well as prepare and check in advance all mobile devices that will be used.

4. CONCLUSION

Based on the explanation above, it is found that the application of mathematical representations, among others, has limited competence related to changes in the representation of basic functions then the generative nature of the interdisciplinary model of mathematics and science has significant implications for curriculum and practice reviews. However, students' ability to solve mathematical word problems still shows that students are still experiencing difficulties so the creation of mathematical visual representations is very important to facilitate the development of abstract mathematical concepts. Students' mathematical representation abilities have increased, including solving problems involving mathematical expressions and loading problem situations based on the data or representations provided. In translating from symbolic form to verbal form (problems in everyday life) that follow a given system of equations, students are still not able to make representations correctly. When students are asked to translate into graphical form, students still cannot draw a complete graph and the mistakes made by students are misinterpretation and implementation, so they cannot maintain semantic harmony between source representation and target representation. verbal and symbolic representations are used by subjects to calculate, detect and correct errors, and justify their answers in solving unstructured problems but visual representations are used only by the first subject to detect and correct errors.

Then also the REACT strategy can be applied to develop representational abilities, reasoning, and mathematical dispositions that involve students actively. As well as challenge-based learning based on Android facilitates processes of conflict, discovery, social interaction, and students' reflective processes so that mathematical representation abilities increase while the material is easy to understand and exciting and mobile learning has better representational learning achievements than students who use conventional learning. the mathematical representation ability of students who use GeoGebra in integral fields is better than students who use conventional learning and the ability of mathematical representation in high and low categories. prerequisite abilities using Geogebra in integral fields are better than those carrying out conventional learning in the high and low prerequisite ability categories. This means that representation is important to study further because it affects the ability of unstructured problems. The limitation of this research is that it is only limited to reviewing Scopus-indexed journals, even though it is not only Scopus indexed but there are also many other journals such as WOS, Sinta, Scimogo Rank and Publish or Perish journals.

REFERENCES

Awantagusnik, A., Susiswo, S., & Irawati, S. (2021). Mathematical representation process analysis of students in solving contextual problem based on Polya’s strategy. *AIP Conference Proceedings*, *2330*(1), 040016. https://doi.org/10.1063/5.0043422

Bakar, K. A., Yunus, F., Mohamed, S., & Karim, A. A. (2020). Addition concept through the lenses of young children: Creating visual representation with digital cameras. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(6), em1854. https://doi.org/10.29333/ejmste/7950

Birgin, O. (2012). Investigation of eighth-grade students' understanding of the slope of the linear function. *Bolema: Boletim de Educação Matemática*, *26*, 139-162. https://doi.org/10.1590/S0103-636X2012000100008

Björklund, C., & Palmér, H. (2022). Teaching toddlers the meaning of numbers—connecting modes of mathematical representations in book reading. *Educational Studies in Mathematics*, *110*(3), 525-544. https://doi.org/10.1007/s10649-022-10147-3

Fauziyah, R. R., & Jupri, A. (2020). Analysis of elementary school students' ability on mathematical communication and mathematical representation. *Journal of Physics: Conference Series*, *1521*(3), 032080. https://doi.org/10.1088/1742-6596/1521/3/032080

Fiantika, F. R. (2021). Mathematical and mental rotation skill in internal representation of elementary students. *Journal of Physics: Conference Series*, *1776*(1), 012011. https://doi.org/10.1088/1742-6596/1776/1/012011

Hakim, D. L., Herman, T., & Kartasasmita, B. G. (2020). The use of mobile learning at SMP Negeri 3 Karawang Barat in improving students' mathematical representation ability. *Journal of Physics: Conference Series*, *1663*(1), 012038. https://doi.org/10.1088/1742-6596/1663/1/012038

Herdiman, I., Jayanti, K., & Pertiwi, K. A. (2018). Kemampuan representasi matematis siswa smp pada materi kekongruenan dan kesebangunan [The mathematical representation ability of junior high school students on congruence material]. *Jurnal Elemen*, *4*(2), 216-229. https://doi.org/10.29408/jel.v4i2.539

Hidayat, W., Rohaeti, E. E., Hamidah, I., & Putri, R. I. I. (2023). How can android-based trigonometry learning improve the math learning process? *Frontiers in Education*, *7*, 1016. https://doi.org/10.3389/feduc.2022.1101161

Higgins, J. P., López-López, J. A., & Aloe, A. M. (2021). Meta-Regression. In C. H. Schmid, T. Stijnen, & I. White (Eds.), *Handbook of Meta-Analysis* (pp. 129-150). CRC Press.

Hwang, W.-Y., Chen, N.-S., Dung, J.-J., & Yang, Y.-L. (2007). Multiple representation skills and creativity effects on mathematical problem solving using a multimedia whiteboard system. *Journal of Educational Technology & Society*, *10*(2), 191-212.

Jewaru, A. A. L., Umrotul, Kusairi, S., & Pramono, N. A. (2021). Senior high school students understanding of vector concepts in mathematical and physical representations. *AIP Conference Proceedings*, *2330*(1). https://doi.org/10.1063/5.0043433

Kaitera, S., & Harmoinen, S. (2022). Developing mathematical problem-solving skills in primary school by using visual representations on heuristics. *LUMAT: International Journal on Math, Science and Technology Education*, *10*(2), 111-146. https://doi.org/10.31129/LUMAT.10.2.1696

Lame, G. (2019). Systematic literature reviews: An introduction. *Proceedings of the Design Society: International Conference on Engineering Design*, *1*(1), 1633-1642. https://doi.org/10.1017/dsi.2019.169

Lestari, I., Kesumawati, N., & Ningsih, Y. L. (2020). Mathematical representation of grade 7 students in set theory topics through problem-based learning. *Infinity Journal*, *9*(1), 103-110. https://doi.org/10.22460/infinity.v9i1.p103-110

Lestariningsih, L., Amin, S. M., Lukito, A., & Lutfianto, M. (2018). Exploring mathematization underpinnings of prospective mathematics teachers in solving mathematics problems. *Beta: Jurnal Tadris Matematika*, *11*(2), 167-176.

Lestariningsih, L., Nurhayati, E., Susilo, T. A. B., Cicinidia, C., & Lutfianto, M. (2020). Development of mathematical literacy problems to empower students' representation. *Journal of Physics: Conference Series*, *1464*(1), 012018. https://doi.org/10.1088/1742-6596/1464/1/012018

Lusiana, L., & Suryani, M. (2014). Metode SLR untuk mengidentifikasi isu-isu dalam software engineering [SLR method for identifying issues in software engineering]. *Sains dan Teknologi Informasi*, *3*(1), 1-11. https://doi.org/10.33372/stn.v3i1.347

McDonagh, M., Peterson, K., Raina, P., Chang, S., & Shekelle, P. (2014). Avoiding bias in selecting studies. In R. Kronick, J. Slutsky, & S. Chang (Eds.), *Methods guide for effectiveness and comparative effectiveness reviews* (pp. 163-179).

Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology*, *18*(1), 143. https://doi.org/10.1186/s12874-018-0611-x

Newman, M., & Gough, D. (2020). Systematic reviews in educational research: methodology, perspectives and application. In O. Zawacki-Richter, M. Kerres, S. Bedenlier, M. Bond, & K. Buntins (Eds.), *Systematic reviews in educational research: methodology, perspectives and application* (pp. 3-22). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-27602-7_1

Nuraida, I., & Amam, A. (2019). Hypothetical learning trajectory in realistic mathematics education to improve the mathematical communication of junior high school students. *Infinity Journal*, *8*(2), 247-258. https://doi.org/10.22460/infinity.v8i2.p247-258

Nurrahmawati, N., Sa'dijah, C., Sudirman, S., & Muksar, M. (2021). Assessing students' errors in mathematical translation: From symbolic to verbal and graphic representations. *International Journal of Evaluation and Research in Education*, *10*(1), 115-125. https://doi.org/10.11591/ijere.v10i1.20819

OECD. (2003). *The PISA 2003 assessment framework mathematics, reading, science and problem solving, knowledge and skills*. OECD.

OECD. (2017). *PISA 2015 Results (Volume V)*. https://doi.org/10.1787/9789264285521-en

Pedersen, M. K., Bach, C. C., Gregersen, R. M., Højsted, I. H., & Jankvist, U. T. (2021). Mathematical representation competency in relation to use of digital technology and task design—A literature review. *Mathematics*, *9*(4), 444. https://doi.org/10.3390/math9040444

Post, M., & Prediger, S. (2022). Teaching practices for unfolding information and connecting multiple representations: the case of conditional probability information. *Mathematics Education Research Journal*. https://doi.org/10.1007/s13394-022-00431-z

Prahmana, R. C. I., Sagita, L., Hidayat, W., & Utami, N. W. (2020). Two decades of realistic mathematics education research in Indonesia: A survey. *Infinity Journal*, *9*(2), 223-246. https://doi.org/10.22460/infinity.v9i2.p223-246

Rahayu, E. G. S., Juandi, D., & Jupri, A. (2021). Didactical design for distance concept in solid geometry to develop mathematical representation ability in vocational high school. *Journal of Physics: Conference Series*, *1882*(1), 012077. https://doi.org/10.1088/1742-6596/1882/1/012077

Rahayu, M. S. I., & Kuswanto, H. (2021). The effectiveness of the use of the android-based carom games comic integrated to discovery learning in improving critical thinking and mathematical representation abilities. *Journal of Technology and Science Education*, *11*(2), 270-283. https://doi.org/10.3926/jotse.1151

Ramanisa, H., Khairudin, K., & Netti, S. (2020). Analisis kemampuan representasi matematis siswa [Analysis of students' mathematical representation ability]. *Jurnal Magister Pendidikan Matematika (JUMADIKA)*, *2*(1), 34-38. https://doi.org/10.30598/jumadikavol2iss1year2020page34-38

Rosita, C. D., Nopriana, T., & Silvia, I. (2019). Design of learning materials on circle based on mathematical communication. *Infinity Journal*, *8*(1), 87-98. https://doi.org/10.22460/infinity.v8i1.p87-98

Sagita, L., Setiyani, S., & Sumiarsih, S. (2021). Designing teaching materials based on process skills approach to mathematical representation ability in polyhedron. *Journal of Physics: Conference Series*, *1957*(1), 012015. https://doi.org/10.1088/1742-6596/1957/1/012015

Santia, I., Purwanto, P., Subanji, S., Sudirman, S., & Sutawidjadja, A. (2021). Characteristics of prospective student teacher's representation in solving ill-well algebraic problems. *Journal of Physics: Conference Series*, *1779*(1), 012001. https://doi.org/10.1088/1742-6596/1779/1/012001

Sari, D. P., & Darhim, D. (2020). Implementation of REACT strategy to develop mathematical representation, reasoning, and disposition ability. *Journal on Mathematics Education*, *11*(1), 145-156. https://doi.org/10.22342/jme.11.1.7806.145-156

Sari, P. M., Herlina, K., & Abdurrahman, A. (2022). Online learning with multi-representation worksheets for oral and written communication skills on light reflecting material. *Online Learning in Educational Research*, *2*(1), 49-56. https://doi.org/10.58524/oler.v2i1.122

Saskiyah, S. A., & Putri, R. I. I. (2020). Mathematical representation on fraction operation for seventh-grade students using collaborative learning. *Journal of Physics: Conference Series*, *1663*(1), 012001. https://doi.org/10.1088/1742-6596/1663/1/012001

Septian, A., Darhim, D., & Prabawanto, S. (2020). Geogebra in integral areas to improve mathematical representation ability. *Journal of Physics: Conference Series*, *1613*(1), 012035. https://doi.org/10.1088/1742-6596/1613/1/012035

Sirajuddin, S., Sa'dijah, C., Parta, N., & Sukorıyanto, S. (2020). Multi-representation raised by prospective teachers in expressing algebra. *Journal for the Education of Gifted Young Scientists*, *8*(2), 857-870. https://doi.org/10.17478/jegys.688710

Sproesser, U., Vogel, M., Dörfler, T., & Eichler, A. (2022). Changing between representations of elementary functions: students' competencies and differences with a specific perspective on school track and gender. *International journal of STEM education*, *9*(1), 33. https://doi.org/10.1186/s40594-022-00350-2

Suherman, S., Komarudin, K., & Supriadi, N. (2021). Mathematical creative thinking ability in online learning during the COVID-19 pandemic: A systematic review. *Online Learning in Educational Research*, *1*(2), 75-80.

Susilawati, W. (2020). Improving students' mathematical representation ability through challenge-based learning with android applications. *Journal of Physics: Conference Series*, *1467*(1), 012010. https://doi.org/10.1088/1742-6596/1467/1/012010

Tamur, M., & Juandi, D. (2020). Effectiveness of constructivism based learning models against students mathematical creative thinking abilities in Indonesia: A meta-analysis study. *Pervasive Health: Pervasive Computing Technologies for Healthcare*, *1*, 107-114. https://doi.org/10.4108/eai.12-10-2019.2296507

Tamur, M., Ndiung, S., Weinhandl, R., Wijaya, T. T., Jehadus, E., & Sennen, E. (2023). Meta-analysis of computer-based mathematics learning in the last decade scopus database: Trends and implications. *Infinity Journal*, *12*(1), 101-116. https://doi.org/10.22460/infinity.v12i1.p101-116

Taqwa, M. R. A., & Rahim, H. F. (2022). Students' conceptual understanding on vector topic in visual and mathematical representation: a comparative study. *Journal of Physics: Conference Series*, *2309*(1), 012060. https://doi.org/10.1088/1742-6596/2309/1/012060

Tytler, R., Prain, V., Kirk, M., Mulligan, J., Nielsen, C., Speldewinde, C., White, P., & Xu, L. (2023). Characterising a representation construction pedagogy for integrating science and mathematics in the primary school. *International Journal of Science and Mathematics Education*, *21*(4), 1153-1175. https://doi.org/10.1007/s10763-022-10284-4

Utomo, D. P., & Syarifah, D. L. (2021). Examining mathematical representation to solve problems in trends in mathematics and science study: Voices from Indonesian secondary school students. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, *5*(3), 540-556. https://doi.org/10.46328/ijemst.1685

Villegas, J. L., Castro, E., & Gutiérrez, J. (2009). Representations in problem solving: A case study with optimization problems. *Electronic Journal of Research in Educational Psychology*, *7*(1), 279-308.