

## BIBLIOMETRIC ANALYSIS OF MULTY REPRESENTATION (DMR) DISCOURSE LEARNING MODEL ON MATHEMATICAL PROBLEM SOLVING IN ELEMENTARY SCHOOLS

Prisya Firzi Sekarayu<sup>1</sup>, Chairul Amriyah<sup>2</sup>, Yudesta Erfayliana<sup>3</sup>

<sup>1, 2, 3</sup>Universitas Islam Negeri Raden Intan Lampung, Jl. Letkol H. Endro Suratmin, Bandar Lampung, Indonesia  
Email: [sprisyafirzi@gmail.com](mailto:sprisyafirzi@gmail.com)

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### Article History

Received: 25-04-2025

Revision: 09-05-2025

Accepted: 15-05-2025

Published: 18-05-2025

**Abstract.** Research on the Multi-Representation Discourse (DMR) Learning Model in mathematics learning in elementary schools is still limited, especially related to developmental trends and their impact on mathematical problem solving. This study aims to map the research trend of the Multi-Representation Discourse (DMR) Learning Model in solving mathematics problems in elementary schools as well as thematic evolution and technology integration in DMR research. This study uses a bibliometric approach with publication analysis from Google Scholar (2015-2025) using Publish or Perish software and VOSviewer for overlay, density, and network visualization. The results of the analysis show the rapid development of DMR research in mathematics problem solving in elementary schools, with a focus on verbal communication, learning models, and teaching effectiveness. There is a shift towards the integration of technologies such as artificial intelligence and speech recognition, with five main thematic clusters: communication, model effectiveness, basic education, mathematical representation, and technology integration. This research provides insights into the development trends of DMR learning in primary education, which includes the use of technology to improve learning effectiveness.

**Keywords:** Bibliometrics, Multi-Representation Course (DMR), Mathematics, Elementary School

**Abstract.** Penelitian tentang Model Pembelajaran Diskursus Multi Representasi (DMR) dalam pembelajaran matematika di sekolah dasar masih terbatas, terutama terkait tren perkembangan dan dampaknya terhadap pemecahan masalah matematika. Penelitian ini bertujuan untuk memetakan tren penelitian Model Pembelajaran Diskursus Multi Representasi (DMR) dalam pemecahan masalah matematika di sekolah dasar serta evolusi tematik dan integrasi teknologi dalam penelitian DMR. Penelitian ini menggunakan pendekatan bibliometrik dengan analisis publikasi dari Google Scholar (2015-2025) menggunakan perangkat lunak Publish or Perish dan VOSviewer untuk visualisasi overlay, density, dan network. Hasil analisis menunjukkan perkembangan pesat penelitian DMR dalam pemecahan masalah matematika di sekolah dasar, dengan fokus pada komunikasi verbal, model pembelajaran, dan efektivitas pengajaran. Terdapat pergeseran menuju integrasi teknologi seperti kecerdasan buatan dan pengenalan suara, dengan lima kluster tematik utama: komunikasi, efektivitas model, pendidikan dasar, representasi matematika, dan integrasi teknologi. Penelitian ini memberikan wawasan tentang tren perkembangan pembelajaran DMR di pendidikan dasar, yang mencakup pemanfaatan teknologi untuk meningkatkan efektivitas pembelajaran.

**Keywords:** Bibliometrik, Diskursus Multi Representasi (DMR), Matematika, Sekolah Dasar

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**How to Cite:** Sekarayu, P. F., Amriyah, C., & Erfayliana, Y. (2025). Bibliometric Analysis of Multy Representation (DMR) Discourse Learning Model on Mathematical Problem Solving in Elementary Schools. *Indo-MathEdu Intellectuals Journal*, 6 (3), 3101-3112. <http://doi.org/10.54373/imeij.v6i3.3046>

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## INTRODUCTION

Problem solving is one of the core competencies in mathematics learning in elementary schools (Mega & Madani, 2023). However, in reality, many students still have difficulty in solving problems that require deep understanding and logical reasoning (Ms & Alimuddin, 2020). This difficulty is often caused by the lack of learning approaches that are able to present mathematical concepts in various forms of representation (Fauziah & Ruqoyyah, 2022). Learning that only focuses on mechanistic procedures tends to make students not understand the meaning of the mathematical process being carried out (Fakhrany et al., 2024). This shows the need for a learning model that is able to connect abstract concepts with concrete contexts meaningfully.

One approach that is believed to be able to provide a solution to this problem is the Discourse Multi Representation (DMR) model (Herdiana et al., 2021; Sarumaha, 2022). This model integrates various forms of representation such as visual, verbal, symbolic, and contextual, so that students can understand mathematical concepts from various perspectives (Aviani, 2025). This approach is rooted in the theory of constructivism which emphasizes the importance of direct experience and media diversity in building conceptual understanding (Mastiyah, 2023). In learning mathematics, the diversity of representations can make it easier for students to develop problem-solving strategies that are more flexible and meaningful (Nurchayono & Putra, 2023). Although the DMR model is starting to be known in educational literature, studies that specifically discuss its application in the context of elementary schools, especially related to mathematical problem-solving skills, are still very limited. In addition, there has been no bibliometric study that systematically maps publication trends, author influence, and scientific collaboration in studies on DMR. In fact, bibliometric studies are very important to identify how far this topic has developed, who are the main actors in its development, and what research areas still need to be explored further.

Several previous studies have shown that the use of various representations in mathematics learning has a positive impact on students' understanding. Shoimah et al., found that visual representations can help students understand the concept of fractions more concretely. (Shoimah et al., 2021). Studied the implementation of symbolic and verbal representation in geometry topics, which were proven to improve students' mathematical communication skills (Rukiyah et al., 2020). Amani et al., showed that the DMR approach was able to strengthen connections between concepts and improve higher-order thinking skills (Amani et al., 2023). In addition, Azizah and Handayani stated that the integration of visual and verbal media in DMR encourages students to think critically and reflectively in solving mathematics problems

(Azizah & Handayani, 2020). However, all of these studies are individual and do not provide a comprehensive macro picture of the scientific literature map regarding DMR at the elementary school level.

Based on the background, the formulation of the problem in this study is: (1) How does the Multi-Representation Discourse Learning Model (DMR) influence mathematical problem solving in elementary schools? (2) What are the main thematic clusters in the application of the DMR Learning Model in the context of elementary school mathematics learning? This study is expected to provide important contributions, both theoretically and practically. The implication is that teachers and researchers can obtain a complete picture of the direction of developing DMR-based mathematics learning, as well as strengthen the scientific basis in developing relevant educational policies. The purpose of this study is to analyze and map scientific publication trends related to the Discourse Multi Representation (DMR) learning model in the context of solving mathematical problems in elementary schools through a bibliometric approach, as well as to identify research potentials that are still open to further development in the future.

## **METHOD**

This study uses a bibliometric approach to identify and map research trends related to the Multi-Representation Discourse Learning Model (DMR) in the context of solving mathematical problems in elementary schools. Bibliometric analysis was chosen because it is able to describe the development of science systematically through measuring the metadata of scientific publications. The data in this study were collected from the Google Scholar database, with a publication period between 2015 and 2025. The selection of the year aims to capture the trend of the last decade, which is considered to be the development period of the DMR learning model in mathematics education. The keywords used in the search process are: "discourse multi representation", "multi representation in mathematics", "problem solving in elementary school", and "mathematics education". The search process is carried out using Boolean techniques to maximize relevant search results, and is filtered based on the title, abstract, and keywords that reflect the elementary school context.

The analysis steps are carried out systematically through several main stages. The first stage is the data extraction process, namely downloading publication metadata from scientific databases using Publish or Perish software, with RIS file format. The data obtained is then imported into the latest version of the VOSviewer application for further analysis. VOSviewer is used to build network visualization maps and density visualization maps, which allow

mapping of relationships between keywords (co-occurrence), collaboration patterns between authors (co-authorship), and distribution of publications based on institutions and countries of origin. The inclusion criteria in this study include articles published within the last ten years, in English or Indonesian, and relevant to the topic of DMR and elementary school mathematics problem solving. Articles that do not meet these criteria will be filtered at an early stage before further analysis.

## RESULTS

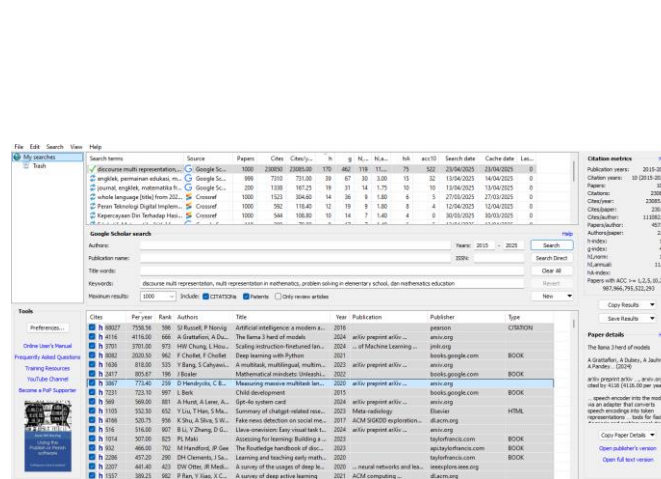


Figure 1. Scholar database search via PoP

Publish or Perish software based on predetermined keywords. From the search results, 1,000 publications were obtained with a total of 230,850 citations. The h-index value of 170 and the g-index of 462 indicate that many articles in this topic have a high level of influence in the scientific community. The hI-index and hA-index values also provide an overview of the individual contribution and stability of the quality of the publications analyzed. This data is an important basis for further mapping using VOSviewer.

## Trends on DMR on Mathematics Problem Solving in Elementary School

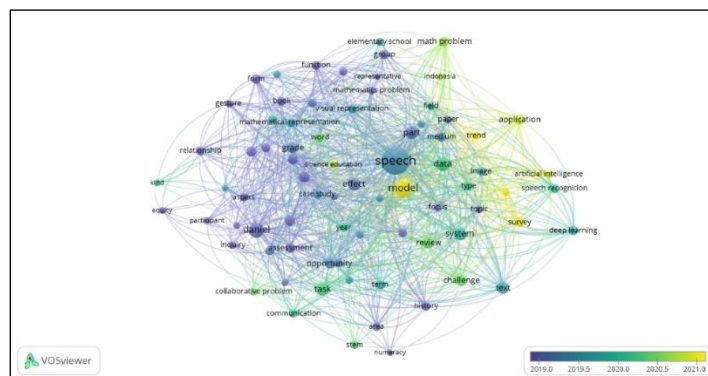


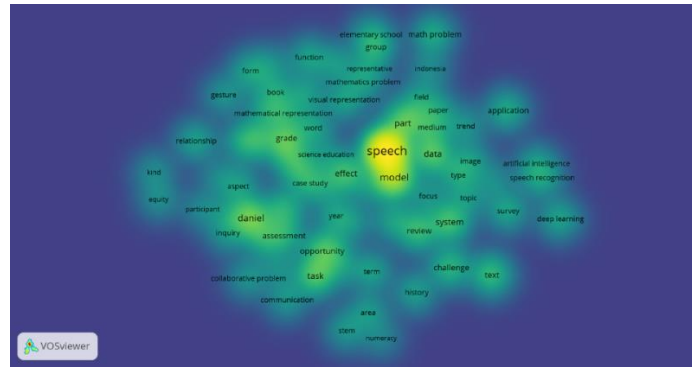
Figure 2 . Overlay visualization

Bibliometric analysis using overlay visualization displays provides an overview of the temporal evolution of research focus related to the Multi-Representational Discourse Learning Model (DMR) in the context of elementary school mathematics problem solving. The colors in the visualization indicate the chronology of publications by year, with a gradient from dark blue (older) to bright yellow (newer), which provides important information about the dynamics and trends of research in this field. In general, dominant keywords such as speech, model, and effect appear in the center of the network and are marked with green to bright yellow, indicating that these issues remain a major concern in the period 2020 to 2021. This indicates the consistency and relevance of the topic in the latest literature, especially in explaining the effectiveness of DMR as a pedagogical approach that relies on verbal interaction, the use of learning models, and its influence on improving students' problem-solving abilities.

Keywords such as collaborative problem, communication, and gesture appear in purplish blue, indicating that early studies on DMR focused more on the social and interactive aspects of learning, including communication and collaboration in mathematical problem solving. This color evolution indicates a shift in research focus from the social interaction approach in the early years (2019) to the integration of artificial intelligence (AI) technologies and applications in the following years. Keywords such as speech recognition, artificial intelligence, application, and deep learning appear in bright yellow, indicating the latest trends in research. This suggests that the DMR approach is beginning to be integrated with cutting-edge technologies, including natural language processing and machine learning, to enhance the effectiveness of discourse-based learning.

This trend confirms an important transition in DMR studies, from conventional approaches to the use of technology in the context of mathematics learning in the digital era. Keywords such as elementary school, math problem, and visual representation remain central to the network, indicating that the main focus of research remains on elementary education and how multi-modal representation can strengthen the understanding of mathematical concepts. The presence of Indonesian words also shows the contribution of research from local contexts in enriching global literature.

Overall, this visualization illustrates that research on DMR has undergone a dynamic thematic development, from an initial emphasis on social interaction and communication, to the integration of AI-based technologies. This evolution opens up new opportunities for the development of a DMR approach in mathematics learning that is more adaptive, contextual, and innovative, especially in responding to the challenges of education in the 21st century.



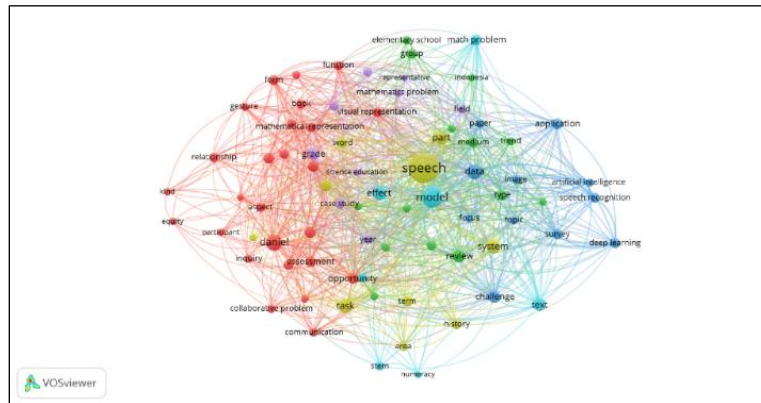
**Figure 3 .** Density visualization

Density visualization provides a bibliometric mapping that highlights the intensity of the frequency of occurrence of keywords in the literature related to the Discourse Multi-Representation (DMR) learning model in the context of solving mathematical problems at the elementary school level. The yellow color indicates the area with the highest frequency, while the green and blue colors indicate lower frequencies. From this visualization, the keywords *speech* and *model* appear to be the most dominant and are located in the center of the network with a bright yellow color. This reflects that verbal discourse (*speech*) and the use of learning models are the main foundations in the study of DMR. Both keywords illustrate the essential characteristics of the DMR approach that emphasizes verbal representation and conceptual models in mathematics learning.

The keywords *effect*, *data*, *system*, and *application* also occupy strategic positions with medium to high density levels. This indicates that many studies have explored the influence of the DMR model on student learning outcomes, as well as its integration with application systems and data technology in supporting the learning process. The presence of the words *artificial intelligence*, *speech recognition*, and *deep learning* indicate the direction of DMR development which is increasingly connected to technology-based approaches and artificial intelligence in education. Meanwhile, keywords such as *mathematical representation*, *visual representation*, and *math problem* appear in a fairly dense green zone, showing a strong focus on the multi-modal representation aspect in helping students solve mathematical problems. This is in line with the main principle of DMR which integrates various forms of representation (visual, symbolic, verbal) in the learning process. The presence of the words *elementary school*, *grade*, and *group* indicates that the context of DMR application is still focused on the elementary school environment and is designed for collaborative learning groups. Interestingly, the emergence of the words *communication*, *collaborative problem*, and *gesture* suggests the importance of social interaction and non-verbal communication as part of the DMR approach in building mathematical understanding.

Overall, this density visualization shows a high concentration of research on verbal, representational, and technology integration aspects in the application of the DMR model. This indicates that this approach is not only effective in improving mathematical problem solving, but also adaptive to technological developments and the needs of 21st century learning.

### Main Focus or Thematic Clusters in DMR Study on Mathematics Problem Solving in Elementary School



**Figure 4 .** Network Visualization

The results of bibliometric visualization with the network visualization approach through VOSviewer software show five main clusters that indicate thematic focus in the study of the Multi-Representation Discourse Learning Model (DMR) on solving mathematical problems in elementary schools. In general, the prominent keywords are speech, model, and effect, which represent the main dimensions in related studies, namely the aspect of verbal communication, the use of learning models, and the influence or impact of DMR implementation in the context of mathematics education.

The first cluster (in red) represents the social and communication dimensions of learning, which include keywords such as communication, assessment, collaborative problem, and inquiry. This reflects that the DMR approach is positioned as a learning strategy that supports students' social engagement through discourse, reflection, and collaboration in solving mathematical problems. This cluster emphasizes the importance of verbal and non-verbal interactions, such as gestures and visual representations in the formation of mathematical understanding. The second cluster (in yellow) focuses on the effectiveness and application of learning models, characterized by keywords such as effect, system, task, and opportunity. This cluster indicates that DMR is understood as a systematic framework that not only functions as an instructional method, but also as a means to evaluate the effectiveness of learning and provide opportunities for the development of problem-solving skills.

The third cluster (in green) draws attention to the context of elementary education, particularly the relationship between the application of DMR and mathematics learning at the elementary school level. Keywords such as elementary school, math problem, group, and paper indicate that most of the research was conducted in elementary education settings with a group learning approach and literature studies that emphasize mathematical problem solving. The fourth cluster (in purple) contains keywords that reflect mathematical representation such as visual representation, mathematical representation, and function. This cluster strengthens the argument that DMR relies heavily on students' ability to transform abstract concepts into various forms of representation, including symbols, images, and verbal narratives. The fifth cluster (in blue) shows the technological dimension in the DMR approach, especially in the context of contemporary research. Keywords such as artificial intelligence, speech recognition, deep learning, and application indicate the integration of advanced technology in supporting discourse-based learning and multimodal representation.

Overall, the results of this analysis indicate that the DMR learning model has a broad scope, not only in terms of strengthening students' mathematical understanding through multimodal representation, but also in the context of technology integration, increasing social interaction, and optimizing critical and reflective thinking processes at the elementary education level. These findings provide a strong basis for further development in the implementation of DMR as an innovative pedagogical approach in mathematics learning a.

## **DISCUSSION**

The results of bibliometric analysis through network, overlay, and density visualization of literature on Multi-Representation Discourse (DMR) in solving mathematical problems in elementary schools reveal a complex and dynamic thematic landscape. The five main clusters identified show a diversity of research focuses, ranging from aspects of verbal communication, effectiveness of learning models, elementary education, mathematical representation, to integration of artificial intelligence-based technology. The consistent emergence of keywords such as speech, model, and effect in the three forms of visualization shows that the DMR discourse focuses heavily on the combination of verbal and visual representations in supporting mathematical understanding.

This finding strengthens the results of the study by Arti et al., who emphasized the role of multiple representations in improving students' conceptual understanding, especially in abstract topics (Arti et al., 2025). Stated that the use of symbolic, verbal, and visual representations contributes to students' construction of meaning and mathematical reasoning (Mardiani et al.,

2024). In particular, the cluster emphasizing communication and social interaction strengthens the view that representation in mathematics is not only cognitive, but also social. This idea is in line with the thinking as communicating framework proposed by Rusmilah et al. (Rusmilah et al., 2022), as well as Abidin's research which shows that teacher-facilitated mathematical dialogue can strengthen students' problem-solving strategies (Abidin, 2020).

DMR not only functions as a learning approach but also as a diagnostic tool to map students' misconceptions. This can be seen from the cluster that highlights the evaluative function of DMR in recognizing conceptual errors. Tima and Sutrisno explain that multiple representations can complement each other, compare information between forms, and deepen conceptual understanding (Tima & Sutrisno, 2020). Agustiningtyas et al.'s study supports this finding, by showing that students who are able to move between representations have a higher tendency to solve complex mathematical problems. (Agustiningtyas et al., 2023). Overlay visualization reveals a temporal shift in research focus. Initial themes centered on communication and social interaction shift toward exploring technologies such as speech recognition, augmented reality, and artificial intelligence. This development marks a paradigm shift in research from traditional pedagogical approaches to more personalized and adaptive use of digital technologies. On the other hand, density visualization shows a high intensity on topics such as model, speech, and application, indicating that the development of DMR-based learning models is a prominent focus in the literature.

Another interesting aspect is the consistency of keywords such as elementary school, student, and group, which shows that DMR is most widely studied in the context of elementary education and cooperative learning. Mawaddah and Safitri showed that exploratory talk in small groups plays an important role in the development of students' logical reasoning and argumentation (Mawaddah & Safitri, 2024). Oktaya's findings also emphasize the importance of discursive norms in the classroom in shaping mathematical thinking structures through active participation (Oktaya, 2022). This shows that DMR not only functions as a strategy for presenting information, but also as a dialogical medium that allows understanding to be formed through social interaction.

Within the framework of social constructivism, these findings are in line with Vygotsky's thinking in Etnawati who views language and social interaction as the core of cognitive development (Etnawati, 2021). DMR in this context can be understood as a means to connect the zone of proximal development with more concrete and meaningful learning experiences. Therefore, representation is not only seen as a visual aid, but as an integral part of a learning

discourse that is oriented towards developing students' mathematical understanding and reasoning as a whole.

## **CONCLUSION**

From the overall analysis, it can be concluded that the discourse of multiple representations (DMR) is developing as a learning approach that is not only relevant in the context of modern mathematics education, but also adaptive to the challenges and opportunities of future technology. Visual, narrative, and symbolic literacy contained in DMR are important foundations in the development of critical thinking skills, conceptual understanding, and social collaboration in 21st-century mathematics learning. This study has limitations because it only relies on bibliometric analysis of publications indexed in Google Scholar. Therefore, the scope of the literature analyzed does not necessarily represent the entirety of the available studies. In addition, the absence of qualitative analysis of article content is a drawback, because bibliometrics only provide a general overview of research trends and networks without evaluating the methodology, findings, or quality of the studies in depth. Reliance on a single database can also lead to bias in the representation of the available literature.

## **RECOMMENDATION**

Based on the results of the bibliometric analysis conducted, there are several recommendations for further development in the field of Multi-Representational Discourse (DMR) in mathematics learning. First, it is recommended to expand the scope of data sources used in the analysis, including local journals, open repositories, and sources that are not indexed in international databases. This will provide a more comprehensive picture of the development of DMR research. In addition, although the quantity of publications is important, the main focus should be given to improving the quality of research. Researchers are expected to develop a more in-depth methodology to examine the direct impact of DMR in the context of mathematics education, including through empirical research that can confirm existing theories. Furthermore, collaboration between researchers, educational institutions, and technology developers needs to be improved. This collaboration can produce innovative and applicable approaches in integrating DMR with existing learning technologies. Further research should also include a qualitative dimension, where case studies or interviews with teachers and students can dig deeper into the challenges and opportunities for implementing DMR in the classroom. Finally, it is important to develop and evaluate tools or platforms that can support

the effective implementation of DMR in mathematics learning, in order to improve the quality of learning and the results achieved.

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