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Enhancing Students Lower Mathematics Cognitive Ability Using Multi-Representation Discursive Model Assisted by Realistic Mathematics Education Approach in Elementary School

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Abstract

This research addresses the problem of low cognitive mathematics ability of grade 5 students, especially on the topic of geometry. The solution is done by implementing the Multi Representation Discourse model (MRD) assisted by the Realistic Mathematics Education approach (RME). This study used a quasi-experimental design using a pretest-posttest control group framework. The study population consisted of 107 students in the Klaten coordination area, with a random sample of 44 participants. A 7-item essay-based test was used as the research instrument to measure cognitive ability. Hypothesis testing showed a significance value of 0.047 and a gain score of 62.01%, indicating the effectiveness of MRD with the RME approach in improving mathematics cognitive ability. In addition, the mean difference of 32.28 between the pretest and posttest scores indicated a substantial improvement in students' cognitive abilities after the MRD model with the RME approach was applied.

Keywords: *mathematic's cognitive ability, multi-representant discursive model, rme approach.*

Abstrak

Penelitian ini membahas masalah rendahnya kemampuan kognitif matematika pada siswa kelas 5 sekolah dasar, khususnya pada topik bangun ruang. Solusi yang dilakukan dengan mengimplementasikan model Multi Representasi Diskursi (MRD) berbantuan pendekatan matematika secara realistik (RME). Penelitian ini menggunakan desain kuasi-eksperimental dengan menggunakan kerangka kerja kelompok kontrol pretest-posttest. Populasi penelitian terdiri atas 107 siswa di wilayah Kabupaten Klaten, Jawa Tengah dengan sampel acak sebanyak 44 peserta. Tes berbasis esai sebanyak 7 soal digunakan sebagai instrumen penelitian untuk mengukur kemampuan kognitif. Pengujian hipotesis menunjukkan nilai signifikansi sebesar 0,047 dan gain score sebesar 62,01%, yang mengindikasikan keefektifan

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MRD dengan pendekatan RME dalam meningkatkan kemampuan kognitif matematika. Selain itu, perbedaan rata-rata sebesar 32,28 antara nilai pretest dan posttest menunjukkan peningkatan yang substansial dalam kemampuan kognitif siswa setelah diberlakukan model MRD dengan pendekatan RME.

Kata kunci: *kemampuan kognitif matematika, model diskursif multi-representatif, RME.*

INTRODUCTION

In today's rapidly advancing technological era, mathematics plays a crucial role in fostering essential cognitive abilities in elementary school students (Hibi, 2024). Mathematics education not only nurtures creative and innovative thinking but also builds the foundational skills necessary for developing competent individuals who can contribute to a nation's progress (Ulia, Hariyono, Kusmaryono, & Kusumadewi, 2022). According to Adhikari & Shrestha (2023); Uralovich et al., (2023) the progress of a nation, it can be seen from the public awareness of education. A structured and effective learning process, particularly in mathematics, is essential to equip students with the cognitive tools required for problem-solving and critical thinking, which are indispensable in shaping a prosperous future (Diputra, Suryadi, Herman, & Jupri, 2023; Ergashevich, 2024).

Mathematics as the mother of knowledge will certainly give a role to various disciplines about how to think (Hasratuddin & Hia, 2024). The contribution of mathematics that must be considered today is not only related to students' ability to solve problems, but the ability to represent things in their own way so that they are easily remembered and understood in the long term (Holmlund, 2024). The ability of students to represent a concept in mathematics is not only through formulas, but can be with relevant tables, symbols, diagrams (Agustin et al.,2024; Kusmaryono et al., 2024). If representing a concept becomes an obstacle, then the knowledge that students should gain will be difficult (Jannah, Nusantara, Yulianto & Amiruddin, 2019).

The preliminary study Sarifah et al (2024) states that the mathematical representation skills of Indonesian students are in the low category. Supporting this statement Suparman & Aini (2019) and stating that the inhibition of students in developing thinking skills will hinder students' ability to communicate and represent mathematical ideas on concepts that students have learned. As a result of students' difficulties in representing a concept/idea, students' mathematical cognitive abilities are also low (Darmayanti, Syaifuddin, Rizki, Sugianto, & Hasanah, 2022). Referring to the implementation of mathematics learning on the material of the volume of space in class V State Elementary School (SDN) 1 Kradenan, it was seen that it was difficult to give the right answer when given a problem/ question. After tracing this is the effect of students' low ability to represent mathematical concepts making the material difficult and even students think that math is a super boring lesson. Based on the statement Mariani et al (2024) that the material of the volume operation of building space is true is a lesson that is difficult for students to understand. As a preventive effort, it is necessary to implement a learning model that can improve students' mathematical cognitive abilities for the better. Based on research by Armilah & Wandini (2023) that the multi-representation discursive (MRD) learning model is successful in improving students' mathematical cognitive abilities.

The multi-representation discursive learning model accommodates students into several groups and facilitates students in developing students' cognitive abilities through the representation power possessed by students (Novita, 2022). Although in one group they have different representational power, this can be a beneficial alternative because students can exchange knowledge that students get from various sources. Basically, the multi-representation discursive model emphasizes the understanding and use of various forms of representation that can be used by students in understanding mathematics (Adnyana, Suarsana, & Suharta, 2021). When students are faced with a mathematical problem, try to solve the problem using a variety of existing methods and not always have to be driven by the formula but understand the problem first. When students understand the problem, they are facilitated to be able to find the right way or answer by creating their own problem representation model either with the help of objects, symbols, and so on. Of course, this model varies depending on the creativity of students in developing problem representations. Therefore, mathematics learning should provide flexibility for students to think, practice and develop their mathematical representation skills so that students' mathematical cognitive abilities reach a better level (Muskens, Frankenhuis, & Borghans, 2024; Nufus et al., 2024). In line with the research Fathonah et al (2024) that the multi-representation discourse model in addition to being able to develop students' mathematical cognitive abilities, it is also able to revive students' reasoning power in solving problems.

The mathematical cognitive abilities of each student are different (Azzahra, 2022). However, overall, when observations were carried out, the results of students' cognitive abilities averaged 53.19 and were in the low category. Students' low mathematical cognitive abilities are actually caused by many factors, one of which is the way students solve the problems given, especially in the material of building space, which is more focused on memorizing formulas. Whereas students' mathematical cognitive abilities consist of the ability to think inductively and deductively, think according to rules, analyze patterns such as pictures, graphs and tables and be able to solve problems (Noto, Amiruddin, Maemunah, Bakar, & Sumarni, 2023; Novaliyosi, Tola, & Rahayu, 2019).

Based on the existing findings, the mathematics learning that was carried out focused too much on the ability to remember formulas and was quite abstract in presenting the material taught. This is of course constrained if students have poor logic and forget the formula to be used. Therefore, as an initiation to make it easier for students to remember, learning needs to be correlated with students' experiences through the realistic mathematics education (RME) approach. This RME approach makes it easy for students to be able to understand and solve problems in mathematics, because it is related to students' daily lives (Febriana, 2021; Gistituati & Atikah, 2022). This will make students able to develop the concept of the solution that students want to use and minimize bias when solving problems (Son & Ditasona, 2020; Sukri & Widjajanti, 2015).

Previous studies have explored the Multi-Representation Discursive (MRD) model in various educational contexts. However, there is a distinct research gap in the integration of the MRD model with the Realistic Mathematics Education (RME) approach. Several journal sources that have been explored, there is no research that specifically examines this combination in addressing mathematical cognitive abilities, especially in the context of building spaces for grade 5 students. Although there are studies focussed on improving students' cognitive ability, differences in subject matter and target implementation of this model in order to understand the effective potential in the implemented model. This study aims to fill the gap by providing empirical evidence on how the MRD model, when combined with the RME approach, improves students' mathematical cognitive ability in a structured and contextually relevant way.

METHODS

This research uses a quasi-experimental research type with a pretest-post test control group design. This study consists of 2 types of groups, namely experimental and control groups. The experimental class will be given a treatment in the form of implementing a multi-representation discursive (MRD) model with the help of the RME approach, while the control class uses a learning model that is often used by students. An overview of the research design, as follows:

Tabel 1. Pretest-Posttest Control Group Design

Class	Pre assesment	Action	Post assesment
Experiment group (EG)	O_1	X	O_2
Control group (CG)	O_3	-	O_4

Description: (O_1) is a pretest that will be given to the experimental group (EG), (X) is the treatment in the form of MRD model implementation with the help of the RME approach, and (O_2) is a posttest that will given to the experimental group (EG). While, in control group (CG) only given a pretest symbolised by (O_3) and a posttest symbolised by (O_4) . The control group used the default model that is often implemented by teachers in the control class.

The population in this study amounted to 107 students from 5 schools in cluster IV, Klaten. The determination of the research sample was carried out through simple random sampling technique and obtained SDN Kradenan as an experimental class of 24 students and SDN 1 Karang Patel as a control class with the research subject being grade V. The total number of samples in this study was 44 students.

The research instrument used a mathematical cognitive ability test with a total of 7 questions with essay type. The questions created were correlated with students' daily lives and the questions were as follows: 1) Andika has a cube-shaped box to store toys. If the side length of the box is 12 cm, what is the surface area of the box?; 2) Mr Ali made a block-shaped aquarium with a length of 50 cm, a width of 30 cm and a height of 40 cm. How many litres of water are needed to fill the aquarium to the brim? (Note: 1 litre = 1,000 cm^3); 3) Toni has a cardboard box with a length of 25 cm, a width of 20 cm and a height of 15 cm. The cardboard will be covered with wrapping paper. How much wrapping paper is needed to cover the cardboard?; 4) Andi throws a dice that has a side length of 5 cm. If the dice is painted all over its surface, what is the total area painted?; 5) Andi has a block-shaped shelf with a length of 80 cm, a width of 30 cm, and a height of 50 cm. He wants to put books in it. What is the maximum volume of the shelf to hold the books?; 6) A cube made of wood with sides of 10 cm will be cut into small cubes with sides of 2 cm. How many small cubes can be made?; and 7) Ms. Rahayu bought a block-shaped cardboard box to store cakes with a length of 40 cm, a width of 25 cm, and a height of 20 cm. The box will be covered with clear plastic. How much area is needed to cover the whole box?.

Before being given to the research subjects, this research instrument will be tested on students outside the research sample to see the validity and reliability of the items. A total of 30 students were given questions that had been made with the criteria if the item scored more than 0.361 (t table) then the instrument was declared valid. Then, proceed with the reliability test with the minimum requirement of significance obtained from the reliability test results which is 0.7 so that it can be said to be reliable. Based on the results of the validity and reliability tests, the entire instrument was declared valid with the significance received on each item more than 0.361 and with the reliability criteria which is very reliable because it obtained a significance of 0.811.

In analysing the data of the research results using 2 techniques, namely descriptive and inferential analysis. Descriptive data analysis is intended to be able to know how much improvement in students' mathematical cognitive abilities by using the MRD model assisted by the RME approach by looking at the average value, standard deviation and variance to determine the distribution of the data obtained. Inferential analysis was conducted to test the hypothesis whether or not the MRD model had an effect on students' mathematical cognitive abilities. In the inferential analysis, the prerequisite test was first carried out by looking at the normality of the data and the homogeneity of the data. If, the significance of the data obtained is at least 0.05 then the data is declared normally distributed data and homogeneous data variance and can be continued with hypothesis testing. The research hypothesis test uses an independent test with the condition that if the significance value is less than 5%, then the MRD model with the RME approach has a significant effect on the students' mathematical cognitive abilities. In order to be able to determine the level of effectiveness of the MRD model with the RME approach, the ngain score test was carried out by looking at the average percentage of gain score results with a minimum range of between 56% – 75%, then it was declared to have effectiveness with moderately effective criteria.

RESULTS AND DISCUSSION

Preliminary interpretation to show the mathematical cognitive ability between the experimental group and the control group through descriptive analysis results are shown in table 2.

Tabel 2. Mathematical Cognitive Ability Results

Data	Means	Deviation Standart	Varians
EG-Pretest	46,77	11,122	123,708
EG-Post test	79,05	8,121	65,950
CG-Pretest	53,23	7,571	57,327
CG-Post test	74,05	8,068	65,093

Referring to the results shown in table 2, there was an increase in students' mathematical cognitive abilities in both the experimental and control groups. In the experimental group (EG) with an average of 46.77 obtained during the pretest increased by 32.28 to 79.05 during the post test. The acquisition of standard deviation and variance in the experimental group when given a pretest and post test gets a high range difference, therefore it can be concluded that the resulting data has a very wide range. The increase in mathematical cognitive abilities is not only found in the experimental group (EG), but also in the control group (CG). Evidenced by the acquisition of 53.23 during the pretest and increased to 74.05 during the post test with an increase of 20.82. Looking at the results of the standard deviation and variance of the data obtained by the control group (CG) shows that the range of values obtained is quite high but still better when implemented in the experimental group. Based on the results of this calculation, it can be concluded that the experimental group (EG) with the multi-representation discursive (MRD) model assisted by the RME approach is more significant in improving mathematical cognitive abilities than the control group (CG). Followed by inferential analysis to test the hypothesis, then before that the prerequisite test was carried out, namely normality test and homogeneity test. The results are shown in table 3.

Tabel 3. Normality Test Result

Data	**Significance**
EG-Pretest	0,940
EG-Post test	0,483
CG-Pretest	0,752
CG-Post test	0,434

Table 3 displays the results of the normality test with different significance obtained. Both the experimental and control groups in the pretest and post test obtained a significance of more than 5% (0.05), so it can be concluded that the data generated is normally distributed. After that, proceed with the homogeneity test with the results displayed in table 4.

Tabel 4. Homogeneity test result

Data	**Significance**
Based on trimmed means	0,236

The results of the homogeneity test referring to table 4 with a significance value of 0.236 indicate that the resulting data has a homogeneous data variance. Because it has fulfilled the prerequisite test, then to see whether or not the multi-representation discursive (MRD) model with the RME approach has an effect, the independence test is conducted. The results are shown in table 5.

Table 5. Independent test result

$\mathbf{T_{count}}$	**df**	**Sig. 2-tailed**
2.049	42	0,047

The results displayed on the acquisition of independent tests in table 5, namely with a degree of freddom of 42, t count 2.049, and 2-tailed significance of 0.047 stated that the multi-representation discursive (MRD) model with RME approach affects the mathematical cognitive abilities of students in material of building space in class V. To be able to determine the level of effectiveness of the MRD model with the RME approach, the effectiveness test was carried out by looking at the N-gain score. The results are shown in table 6.

Tabel 6. N-gain score result

Data	**Means**	**Minimum**	**Maximum**
N-gainscore (%)	62,01	50	93,94

The percentage of gain score obtained by students referring to table 6 is 62.01% with a minimum value of 50% and a maximum of 93.94%. These results indicate that the multi-representation discursive model with the RME approach is quite effective in improving students' mathematical cognitive abilities.

The implementation of the multi-representation discursive model carried out during learning in the experimental class, students do not receive material explicitly but the teacher demands students by providing stimulus to be able to be active and innovative during activities so as to find the meaning of the problems given by the teacher in the problem. By providing stimulus continuously during learning when answering questions, students get used to answering the available questions even though they are of different types. This had an effect when the descriptive analysis test was carried out which confirmed that students' mathematical cognitive abilities increased after the implementation of the multi-representation discursive model. In fact, the multi-representation discursive model not only has a good effect on students' mathematical cognitive abilities but also in other learning area. Reffering on the research by Nur & Azmi (2019) that when the multi-representation discursive model is implemented, the activity process in the classroom becomes more lively, students become active in expressing ideas which have an effect on improving concept understanding and student learning achievement in islamic religious education. Then, research conducted by Sunyono & Meristin (2018) The multi-representation discursive model increases students' activeness in exploring knowledge so that students' understanding of chemical bonding concepts is more qualified.

Continuously, this model indicates that learning by providing students with comprehensive space to explore knowledge and discover spatial concepts in order to reconstruct students' knowledge, is very feasible to apply. During the learning process using the multi-representational discourse (MRD) model, the teacher acts as a facilitator and learning mediator through a learning approach, namely the RME approach. This RME approach ensures that students as a whole understand the concept of building space which will be solved by students in the form of questions through stimuli that are correlated with students' daily lives. This will create a meaningful experience for students because students know directly the concept of building space itself without being given it directly by the teacher. Therefore, learning using a multi-representational discourse model with an RME approach which is carried out collaboratively and interestingly is able to help students in solving problems in mathematics, especially the concept of space itself. This is supported by Cheng et al (2021) the existence of collaborative learning can increase students' enthusiasm to study harder. The MRD model is effective in optimizing students' ability to imagine, so that students' higher-order thinking and reasoning skills in solving problems increase (Yuanita & Ibrahim, 2015).

Referring to the opinion Rostika & Junita (2017) there are 5 stages in implementing this MRD model, namely the preparation, introduction, development, implementation and closing stages. Starting with the preparation stage, there are 2 types of preparation carried out by the teacher, namely (1) preparation for learning materials and (2) preparation when managing learning in the classroom. In point (1); Teachers must be able to understand in depth each stage of the MRD model of learning. Because mathematics is said to be a very difficult lesson, teachers must be initiative and innovative in finding concise ways to provide stimulus to students when learning. This is useful so that students are able to understand mathematical concepts related to geometric figures easily. Abstract explanations will make it difficult for students to understand something (Li & Schoenfeld, 2019). Apart from that, innovation is needed in explaining learning in a fun way so that students' minds regarding mathematics is a scary and annoying learning that can be distracted. What the teacher does is use the RME approach so that students can directly experience the benefits of learning because it is based on students' real lives. Apart from that, teachers also prepare simplified student worksheets to make it easier for students to learn. In point (2): The teacher begins to form students into several groups with different (heterogeneous) student characteristics. This aims to ensure that students are able to exchange information with other students, are able to learn from each other and teach students who still don't understand, and provide emotional closeness between students that learning is a very important thing (Aluvalu et al., 2024). Students who are in heterogeneous ability groups have better attitudes toward one another and their schoolwork, a stronger sense of community inside the classroom, and invaluable intellectual and social lessons (Loureiro & Rodrigues, 2024).

Followed by the introduction stage, the teacher began to provide apperception to students by linking previous learning materials with students' experiences while learning and stimulating students with questions related to the shapes of objects around students. Questions during the apperception given by the teacher such as "Have you ever gone to the library?", "What do you think is in the library?", "If you are in a place and the place is filled with many items, what is it called?". The teacher continues to provide stimulus to students until students know about the things to be learned. After several questions were given, students were finally able to answer that the place the teacher meant was a room. After that, the teacher conveys that the focus of learning that will be learned is related to building space and stimulates students to return what is a building space? The answers given by students certainly vary and in summary the definition of building space according to students is "a building that has contents (volume)". This apperception turned out to be useful where students became more enthusiastic in answering questions (Musthofa & Sujadi, 2020).

This is supported by Puteri (2018) that apperception and stimulus that continues to be given by the teacher will have a positive impact on students' concept understanding and encourage students to be able to remember continuously. After knowing the definition of the shape of the space itself, the teacher again provides a stimulus in the form of questions related to the shape of objects around the students. Questions related to the shape of the object are indicated so that students are able to know about the concept of building spaces, namely cubes and blocks. This is the main point of learning, namely students know the concept of space, know the concept of why space is called a cube and know why space is said to be a block. Every student gives an answer even though there is an answer that is less precise, the teacher does not blame the student but rather provides support to the student to find a more precise answer. This form of positive support has an effect on students' confidence to be able to express their opinions in public, class activeness, and a sense of wanting to find answers in order to get attention from the teacher (Daulay, Hasibuan, Ibrahim, & Kasih, 2023; Samodra & Faridi, 2021).

When it is indicated that students already know the concept of geometric shapes, especially cubes and blocks, the teacher then provides several example questions with answers and several practice questions. At this stage, the teacher gives students the flexibility to explore various sources of knowledge, both from the internet and print media. This aims to be a stage in developing students' knowledge to become more competent in solving problems and helping students develop their reasoning abilities (Sari & Darhim, 2020). This stage of knowledge development provides students with the opportunity not only to seek sources of knowledge from books, but also to exchange information with friends in groups. This certainly requires attention from the teacher, because if there are errors in the explanation given by colleagues, it will have a negative impact on students' understanding of the material.

According to the Arefaine et al (2022) stages of development, the multi-representational discursive model is able to accommodate various levels of student knowledge from less to students who have more knowledge. During the knowledge exploration process, the teacher will go around each group to ask to what extent the students have conceptualized problem solving. Each student is allowed to represent anything related to the problem in the question, whether in the form of language in conveying it or using mathematical symbols.

The interesting thing during this activity was that when asked questions related to the height of the block, where the volume of the block, length and width were known using mathematical language, there were students who carried out the simulation using their own language and mathematical symbols such as vb (volume of the block), pb (length of the block).), lb (beam width) and so on. In fact, the example questions given by the teacher did not include this. After being asked, students get this concept when asking group members. Indirectly, through group activities there is a conceptual shift, procedural understanding and knowledge of objects in a better direction (Orillo & Mistades, 2024). Based on this, it can be said that the ability to think abstractly by associating the language used, the symbols created by students themselves when learning mathematics is starting to form as a result of the implementation of the MRD model with the RME approach (Adnyana et al., 2021). After the students have found the answers, the teacher collects the answer papers and then discusses them with the students.

At the implementation stage, the teacher gives students the opportunity to present the results of the exploration of knowledge obtained by each group. This stage is an open discussion, so that colleagues from other groups can provide input or questions regarding the answers submitted. By having open discussions, students will indirectly learn to express opinions, ask questions, and make the class more active (Sofyan & Haryanto, 2023). This open discussion will present various answers from each student because they have gained knowledge from various sources, of course each source is different between groups (Dobusch, Dobusch, & Müller-Seitz, 2019). This will also increase students' knowledge of something that students do not yet know when carrying out exploration or knowledge development activities. This is where the teacher's job is as a mediator who will provide views and opinions regarding students' mathematical cognitive understanding of spatial construction material.

Based on the presentations that have been carried out, it turns out that each group has its own style in representing meaning and providing solutions to problems given by the teacher. The main aim of this activity is not to find out who is most correct, but rather to strengthen students' mathematical cognitive abilities through open discussion activities At the end of the lesson, the teacher reflects back on the learning that has been carried out. Reflection activities are carried out to briefly review about building space and check students' understanding (Turns, Shroyer, Lovins, & Atman, 2017). After that, the teacher gives test questions to students that must be done personally by students as a form of learning evaluation.

On the basis of research that has been done that the multi-representation discursive model is able to effectively influence students' mathematical cognitive abilities. This is evidenced by the acquisition of 2-tailed significance of 0.247 with a gain score obtained of 62.01%. Based on research by Rizal (2021) the multi-representation discursive model is able to present students with fun learning so that it makes it easier for students to remember longer. In addition, Supriadi et al (2020) it is argued that the multi-representation discursive model also affects the ability to understand concepts and solve mathematical problems in algebra material with a significance obtained of 0.000 from the MANOVA test results. Pratiwi & Selvianti (2023), the multi-representation discursive model not only has a significant effect on concept understanding in various other disciplines, but also on students' self-efficacy. Based on the research that has been carried out, students' mathematical cognitive abilities become better as a result of the implementation of the multi-representation discursive model with the RME approach.

CONCLUSION

The implementation of the Multi-Representation Discursive (MRD) model assisted by the RME approach shows significant potential in improving students' learning experience. In addition to improving mathematical cognitive ability, this model also promotes group discussion skills, conceptual understanding, active participation, and the ability to express mathematical concepts in students' language. However, further exploration is needed to strengthen these findings and refine the application of this model. Integrating technology, such as smartphones or tablets, can enhance learning by providing wider access to information and diverse perspectives. In addition, involving observers, including model experts, will ensure more accurate feedback and assessment during implementation. Future research should also investigate the impact of this model on other mathematical skills, such as mathematical literacy, to provide a comprehensive understanding of its effectiveness. In addition, external influences, such as maths courses or parental guidance, should be recognised as contributing factors to student learning outcomes. While this study highlights the potential of combining the MRD model with the RME approach, further research is urgently needed to address these considerations and validate its effectiveness in varied educational contexts.

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REFERENCES

Adhikari, D. R., & Shrestha, P. (2023). Knowledge management initiatives for achieving sustainable development goal 4.7: higher education institutions’ stakeholder perspectives. *Journal of Knowledge Management*, *27*(4). https://doi.org/https://doi.org/10.1108/JKM-03-2022-0172

Adnyana, W. G. ., Suarsana, M. ., & Suharta, P. G. . (2021). Multi-Representation Discourse Model and Math Problem Solving Skills of High School Students. *Journal of Learning Improvement and Lesson Study*, *1*(1), 40–48. https://doi.org/10.24036/jlils.v1i1.8

Agustin, R. D. A., Sa’dijah, C., Susiswo, S., & Sukoriyanto, S. (2024). Mathematical Semantics Representation Obstacles Of Preservice Mathematics Teachers. *Pegem Journal of Education and Instruction,* *14*(3), 376–392. https://doi.org/10.47750/pegegog.14.03.35

Aluvalu, R., Anil, G. R., & Raisinghani, M. S. (2024). Learner-Centric Education in Heterogeneous Learning Environments: Key Insights for Optimal Learning. *International Journal of Online Pedagogy and Course Design (IJOPCD)*, *14*(1), 1–13. https://doi.org/10.4018/IJOPCD.335950

Arefaine, N., Michael, K., & Assefa, S. (2022). Effect of Multiple Representations on Students’ Performance on Interpretations and Techniques of Representation in

Calculus. *Jurnal Pendidikan Matematika*, *16*(3), 351–372. https://doi.org/10.22342/jpm.16.3.18291.351-372

Armilah, A., & Wandini, R. R. (2023). The Use of Mathematical Representation by Elementary School Students in Mathematics Learning. *TSAQOFAH*, *4*(2), 971–977. https://doi.org/10.58578/tsaqofah.v4i2.2435

Azzahra, N. (2022). Cognitive ability characteristic and learning motivation on slow learners student in solving mathematics problem. *AIP Conference Proceedings*, 2468. AIP Publishing. https://doi.org/https://doi.org/10.1063/5.0102735

Cheng, F. F., Wu, C. S., & Su, P. C. (2021). The Impact of Collaborative Learning and Personality on Satisfaction in Innovative Teaching Context. *Frontiers in Psychology*, *12*(September). https://doi.org/10.3389/fpsyg.2021.713497

Darmayanti, R., Syaifuddin, M., Rizki, N., Sugianto, R., & Hasanah, N. (2022). High school students' mathematical representation ability: Evaluation of disposition based on mastery learning assessment model (MLAM). *Journal of Advanced Sciences and Mathematics Education*, *2*(1), 1–15. https://doi.org/10.58524/jasme.v2i1.93

Daulay, A. R., Hasibuan, S., Ibrahim, I., & Kasih, I. (2023). The Effect of Strengthening (Reinforcement) and Confidence on the Skills of Passing Techniques in Volleyball Games at SMA Negeri 6 Padangsidimpuan City. *Randwick International of Social Science Journal*, *4*(2), 367–375. https://doi.org/10.47175/rissj.v4i2.677

Diputra, K. S., Suryadi, D., Herman, T., & Jupri, A. (2023). Analysis of the Elementary School Students' Learning Obstacles: A Case Study on the Concept of Fractions. *Al Ibtida: Jurnal Pendidikan Guru MI*, *10*(1), 13. https://doi.org/10.24235/al.ibtida.snj.v10i1.13078

Dobusch, L., Dobusch, L., & Müller-Seitz, G. (2019). Closing for the Benefit of Openness? The case of Wikimedia's open strategy process. *Organization Studies*, *40*(3), 343–370. https://doi.org/10.1177/0170840617736930

Ergashevich, E. A. (2024). THE ROLE OF BLOOM'S TAXONOMY IN DETERMINING PEDAGOGICAL OBJECTIVES IN THE PROCESS OF EDUCATIONAL LESSONS. *American Journal of Language, Literacy and Learning in STEM Education*, *02*(01), 264–270. Retrieved from https://grnjournal.us/index.php/STEM/article/view/2684/2313

Fathonah, S., Cahyono, E., Haryani, S., Sarwi, S., & Lestari, N. H. (2024). Application of Multirepresentation-Based Creative Problem-Solving Learning Models to Improve Critical and Creative Thinking Skills for Students. *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE)*, *12*(1), 185–200. https://doi.org/https://doi.org/10.23947/2334-8496-2024-12-1-185-200

Febriana, R. (2021). Application of the RME Approach to Improve Students' Mathematical Concepts Understanding. *Tarbawi : Jurnal Ilmu Pendidikan*, *17*(2), 118–125. https://doi.org/10.32939/tarbawi.v17i2.1006

Gistituati, N., & Atikah, N. (2022). E-Module Based on RME Approach in Improving the Mathematical Communication Skills of Elementary Students. *Jurnal Ilmiah Sekolah Dasar*, *6*(1), 106–115. https://doi.org/10.23887/jisd.v6i1.42314

Hasratuddin, H., & Hia, Y. (2024). Adversity quotient-based mathematical reasoning ability in geometry learning through virtual realistic approaches. *N AIP Conference Proceedings*, *2662*, 1. AIP Publishing. https://doi.org/https://doi.org/10.1063/5.0133469

Hibi, W. (2024). Using Smart Applications to Develop Mathematical Concepts among Fourth Grade Students with Arithmetic Learning Difficulties. *International Journal of Science, Mathematics and Technology Learning*, *32*(1), 1–28. https://doi.org/10.18848/2327-7971/CGP/v32i01/1-28

Holmlund, A. (2024). How numbers influence students when solving linear equations.

Mathematical Thinking and Learning, *00*(00), 1–18. https://doi.org/10.1080/10986065.2024.2314067

Jannah, U. R., Nusantara, T., Yulianto, F. E., & Amiruddin, M. (2019). Student's learning obstacles on mathematical understanding of a function: A case study in Indonesia higher education. *TEM Journal*, *8*(4), 1409–1417. https://doi.org/10.18421/TEM84-44

Kusmaryono, I., Aminudin, M., Ubaidah, N., & Chamalah, E. (2024). the Bridging Understanding of Language and Mathematical Symbols Between Teachers and Students: an Effort To Increase Mathematical Literacy. *Infinity Journal*, *13*(1), 251–270. https://doi.org/10.22460/infinity.v13i1.p251-270

Li, Y., & Schoenfeld, A. . (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-019-0197-9

Loureiro, A., & Rodrigues, M. de O. (2024). Student Grouping: Investigating a Socio-Educational Practice in a Public School in Portugal. *Social Sciences*, *13*(3). https://doi.org/10.3390/socsci13030141

Mariani, S., Nurasiah, I., & Nurmeta, I. K. (2024). Improving Critical Thinking Skills of Class VI Students Building Space Materials through the RME Learning Model. *JUPE: Jurnal Pendidikan Mandala*, *9*(1), 103–110. Retrieved from https://ejournal.mandalanursa.org/index.php/JUPE/article/view/6737%0Ahttps://ejournal.mandalanursa.org/index.php/JUPE/article/download/6737/4791

Minarni, A., Napitupulu, E. E., & Husein, R. (2016). Mathematical understanding and representation ability of public junior high school in North Sumatra. *Journal on Mathematics Education*, *7*(1), 43–56. https://doi.org/10.22342/jme.7.1.2816.43-56

Muskens, M., Frankenhuis, W. E., & Borghans, L. (2024). Math items about real-world content lower test-scores of students from families with low socioeconomic status. *Npj Science of Learning*, *9*(1). https://doi.org/10.1038/s41539-024-00228-8

Musthofa, P. R., & Sujadi, I. (2020). The students' perception of the teacher's apperception and its influence on students' initial knowledge. *In Journal of Physics: Conference Series*, *1465*, 012063. IOP Publishing.

Noto, M. S., Amiruddin, M. H., Maemunah, S., Bakar, M. T., & Sumarni, P. (2023). Students' Mathematical Logical Thinking in Terms of Learning Style. *Rangkiang Mathematics Journal*, *2*(1), 9–17. https://doi.org/10.24036/rmj.v2i1.24

Novaliyosi, Tola, B., & Rahayu, W. (2019). Trends of Mathematical Logical Thinking Ability Through the Cra (Concrete-Representational-Abstract) Approach With Portfolio Assessment. *IJER: Indonesian Journal of Educationa; Review*, *6*(2), 98–112. Retrieved from http://pps.unj.ac.id/journal/ijer

Novita, F. A. (2022). Pengaruh Model Pembelajaran Kooperatif Tipe Diskursus Multy Reprecentacy (DMR) dengan Berbantuan Media Wall Chart terhadap Keaktifan Belajar Siswa Pada Mata Pelajaran Sejarah Kelas X IIS MAN Aceh Barat Daya. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, *7*(4), 259–266. https://doi.org/10.24815/jimps.v7i4.22543

Nufus, H., Muhandaz, R., Hasanuddin, Nurdin, E., Ariawan, R., Fineldi, R. J., … Situmorang, D. D. B. (2024). Analyzing the students' mathematical creative thinking ability in terms of self-regulated learning: How do we find what we are looking for? *Heliyon*, *10*(3), e24871. https://doi.org/10.1016/j.heliyon.2024.e24871

Nur, M. A., & Azmi, F. (2019). Penerapan Model Pembelajaran Diskursus Multy Reprecentacy (DMR) untuk Meningkatkan Pemahaman dan Prestasi Belajar Siswa. *As-Syar'i: Jurnal Bimbingan & Konseling Keluarga*, *1*(1), 105–112. https://doi.org/10.47476/as.v1i1.91

Orillo, M. J. F., & Mistades, V. M. (2024). Effects of Multiple Representation in Student's Conceptual Understanding and Metacognitive Awareness in Mechanics. *KnE Social*

Sciences, *2024*, 862–868. https://doi.org/10.18502/kss.v9i13.16011

Pratiwi, D. D., & Selvianti, D. (2023). The effect of DMR on students' mathematical problem solving ability and self efficacy. *Journal of Learning Improvement and Lesson Study*, *3*(1), 50–57. https://doi.org/10.24036/jlils.v3i1.53

Puteri, L. H. (2018). The Apperception Approach for Stimulating Student Learning Motivation. *International Journal of Education, Training and Learning*, *2*(1), 7–12. https://doi.org/10.33094/6.2017.2018.21.7.12

Renaldy, Y., & Maarif, S. (2022). Analysis Study of Mathematical Representation Skills of High School Students Seen from the Perspective of Sociomathematical Norms. *Edumaspul: Jurnal Pendidikan*, *6*(2), 1856–1866. https://doi.org/10.33487/edumaspul.v6i2.3703

Rizal, A. (2021). Multi-Representation Discourse Learning Model As an Alternative Solution To Improve Student Learning Outcomes In Science Lessons. *Jurnal Sekolah Dasar*, *6*(1), 23–28. Retrieved from https://journal.ubpkarawang.ac.id/index.php/PGSD/article/view/1300/1062

Rostika, D., & Junita, H. (2017). Peningkatan Kemampuan Pemecahan Masalah Siswa Sd Dalam Pembelajaran Matematika Dengan Model Diskursus Multy Representation (Dmr). *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru*, *9*(1), 35. https://doi.org/10.17509/eh.v9i1.6176

Samodra, O. A., & Faridi, A. (2021). The Correlation of Positive Reinforcement, Self-Confidence, and Speaking Performance of English Young Learners. *English Education Journal*, *11*(3), 393–405. https://doi.org/10.15294/eej.v11i1.45463

Sari, D. P., & Darhim. (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

Sarifah, I., Kuswati, E., Suniasih, W., Fahrurrozi, F., & Susilo, G. (2024). Cognitive Test Instruments to Measure Student Mathematics Ability in Elementary School: Rasch Analysis. *Educational Administration: Theory and Practice*, *30*(4), 767–779. https://doi.org/10.53555/kuey.v30i4.1557

Sofyan, F. A., & Haryanto, H. (2023). Analysis of Students' Thinking Ability in Solving Open-Ended Problems in Mathematics Learning for Grade I of Madrasah Ibtidaiyah. *Proceedings Series on Social Sciences & Humanities*, *12*, 238–243. https://doi.org/10.30595/pssh.v12i.800

Son, A. L., & Ditasona, C. (2020). CORE RME learning model on improving students' mathematical problem-solving ability. *Journal of Physics: Conference Series*, *1657*(1). https://doi.org/10.1088/1742-6596/1657/1/012060

Sukri, Y. F., & Widjajanti, D. B. (2015). Pengaruh Pendekatan Rme Terhadap Motivasi Dan Prestasi Belajar Siswa Sd Melalui Pembelajaran Tematik-Integratif. *Jurnal Prima Edukasia*, *3*(2), 227. https://doi.org/10.21831/jpe.v3i2.6503

Sunyono, S., & Meristin, A. (2018). The effect of multiple representation-based learning (MRL) to increase students' understanding of chemical bonding concepts. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 399–406. https://doi.org/10.15294/jpii.v7i4.16219

Suparman, S., & Aini, N. (2019). Development of PISA-Like Mathematics Tasks Design of Change and Relationship Content to Measure Mathematical Representation Skills. *Asian Journal of Assessment in Teaching and Learning*, *9*(1), 28–37. https://doi.org/10.37134/ajatel.vol9.no1.3.2019

Supriadi, N., Ramadhona, K., Pratiwi, D. D., & Widyawati, S. (2020). Concept understanding skills and mathematical problem-solving skills in algebraic materials: The effect of DMR learning model assisted by dragonbox puzzle game during the Covid-19 Pandemic. *Al-Jabar: Jurnal Pendidikan Matematika*, *11*(1), 191–198. Retrieved from http://ejournal.radenintan.ac.id/index.php/al-jabar/index

Turns, J. A., Shroyer, K. E., Lovins, T. L., & Atman, C. J. (2017). Understanding reflection activities broadly. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2017-June*(June). https://doi.org/10.18260/1-2--29054

Ulia, N., Hariyono, M., Kusmaryono, I., & Kusumadewi, R. F. (2022). Developing Ancermat (Anthology of Mathematics Story) Digital Learning Media to Improve Students' Problem-Solving Ability. *Al Ibtida: Jurnal Pendidikan Guru MI*, *9*(1), 88. https://doi.org/10.24235/al.ibtida.snj.v9i1.8072

Uralovich, K. S., Toshmamatovich, T. U., Kubayevich, K. F., Sapaev, I. B., Saylaubaevna, S. S., Beknazarova, Z. F., & Khurramov, A. (2023). A primary factor in sustainable development and environmental sustainability is environmental education. *Caspian Journal of Environmental Sciences*, *21*(4), 965–975. https://doi.org/10.22124/cjes.2023.7155

Yuanita, L., & Ibrahim, M. (2015). Supporting Students in Learning with Multiple Representation to Improve Student Mental Models on Atomic Structure Concepts. *Science Education International*, *26*(2), 104–125.