JURNAL ABSIS
Jurnal Pendidikan Matematika dan Matematika
Vol. 7 No. 1, August 2024

DEVELOPMENT OF SOCIAL ARITHMETIC TEACHING MATERIALS BASED ON REALISTIC MATHEMATICS EDUCATION TO FACILITATE MATHEMATICAL REASONING SKILLS

Desi Kurnia Wati[1], *Sehatta Saragih[2], Elfis Suanto[3]
[1,2,3] Universitas Riau, Indonesia
sehatta.saragih@lecturer.unri.ac.id

ABSTRACT The Ministry of Education and Culture emphasizes the importance of mathematical reasoning; however, current student abilities in this area remain low due to limited independent learning, insufficient resources, and varied teaching approaches. To address these challenges, strategies such as Realistic Mathematics Education (RME) are crucial, necessitating the development of appropriate teaching materials. This research aimed to develop RME-based social arithmetic teaching materials using the 4-D model, which includes the stages of Define, Design, Development, and Dissemination. In the Define stage, researchers analyzed learner needs, learning outcomes, and relevant concepts, establishing clear learning objectives. The Design stage involved creating teaching materials through the compilation of tests, selection of media, formatting, and content design. During the Development stage, a formative evaluation was conducted, including expert assessments, one-on-one evaluations, and trials. The materials were validated with a score of 86.40%, classified as very valid. In limited trials, they received an average rating of 85.92%, classified as very practical, and in field trials, an average of 82.81%, classified as practical. In the Dissemination stage, the teaching materials were distributed to participating schools. The study concludes that RME-based social arithmetic materials effectively support the development of students' mathematical reasoning skills, meeting the criteria of validity and practicality.

Keywords: realistic mathematics education, mathematical reasoning skills, teaching material, social arithmetic.

ABSTRAK Kementerian Pendidikan dan Kebudayaan menekankan pentingnya penalaran matematis; namun, kemampuan siswa dalam hal ini masih rendah karena keterbatasan pembelajaran mandiri, kurangnya sumber daya, dan pendekatan pengajaran yang bervariasi. Untuk mengatasi tantangan ini, strategi seperti Pendidikan Matematika Realistik (RME) sangat penting, yang memerlukan pengembangan bahan ajar yang sesuai. Penelitian ini bertujuan untuk mengembangkan bahan ajar aritmetika sosial berbasis RME menggunakan model 4-D, yang mencakup tahapan Define, Design, Development, dan Dissemination. Pada

tahap Define, peneliti menganalisis kebutuhan belajar siswa, hasil belajar, dan konsep yang relevan, serta menetapkan tujuan pembelajaran yang jelas. Tahap Design melibatkan pembuatan bahan ajar melalui kompilasi tes, pemilihan media, pemformatan, dan perancangan konten. Selama tahap Development, evaluasi formatif dilakukan, termasuk penilaian ahli, evaluasi satu lawan satu, dan uji coba. Bahan ajar divalidasi dengan skor 86,40%, yang diklasifikasikan sebagai sangat valid. Dalam uji coba terbatas, bahan ajar ini mendapat rata-rata nilai 85,92%, yang dikategorikan sangat praktis, dan dalam uji coba lapangan, rata-rata 82,81%, yang dikategorikan praktis. Pada tahap Dissemination, bahan ajar didistribusikan ke sekolah-sekolah yang berpartisipasi. Studi ini menyimpulkan bahwa bahan ajar aritmetika sosial berbasis RME secara efektif mendukung pengembangan kemampuan penalaran matematis siswa, memenuhi kriteria validitas dan kepraktisan.

Keywords: RME, penalaran matematis, aritmatika sosial, bahan ajar.

INTRODUCTION

Kemendikbud (2022) emphasizes five elements of mathematical ability that are essential for students, one of which is Mathematical Reasoning Ability. Baroody (Hendriana et al., 2018) revealed that mastering this ability does not only involve memorizing mathematical facts and rules, but also involves deep thinking and using experience to make predictions. NCTM also emphasizes the importance of mathematical reasoning ability in its mathematical ability standards. (maulyda, 2020). This thinking process helps learners reach conclusions and solve mathematical problems, opening the door to hypothesis generation, proof building, and proper mathematical problem solving. (Astuti & Ristontowi, 2022; Sumartini, 2015). Fajriyah & Zanthy (2019) dan Wahyuni et al. (2019) highlighted the importance of applying matematical reasoning ability for a more effective understanding of mathematical concepts, helping students become more skilled in solving math problems. Therefore, the maximum development of mathematical Reasoning Ability is the main key in providing a strong thinking foundation for students in understanding and mastering mathematics.

Based on the PISA 2022 results, the students' mathematical ability score is 366, below the average score of 472 (OECD, 2023). One of the abilities that is an aspect of assessment in PISA in the field of mathematics is mathematical reasoning ability (Asdarina & Ridha, 2020). So, the focus of the PISA assessment on Mathematical Reasoning Ability shows the low achievement of students in this regard. The results of Asdarina & Ridha (2020) research stated that the matematical reasoning ability of students was still low overall, with an average of 21.68%. This low ability also occurs in social arithmetic material, where students have difficulty in structured solution steps and understanding concepts.

The application of appropriate learning strategies is one of the steps that can be taken by educators to improve mathematical reasoning ability. Previous studies have revealed that the application of RME in mathematics learning can have a positive impact on mathematical reasoning ability. (Siregar & Lubis, 2022; Fendrik, 2021; Amir

https://doi.org/10.30606/absis.v7i1.2528

& Nora, 2021; Gusnarsi et al., 2017). RME focuses on the application of mathematical concepts in real-life contexts, and involves learners in mathematical modeling activities. By introducing mathematical problems to real-life situations, RME helps learners understand the material more meaningfully, overcome difficulties in understanding abstract mathematical concepts, and develop a comprehensive understanding of mathematical concepts. The implications of learning using RME involve learners in modeling activities, analyzing data, and formulating problem-solving strategies, thus supporting the development of KEM. problem-solving strategies, thus supporting the development of students' mathematical reasoning ability. (Amir & Nora, 2021; Gusnarsi et al., 2017).

The habituation of students to learn using the RME stages must be facilitated by appropriate teaching materials. Mulbasari & Surmilasari (2018) stated that one of the keys to improving students' mathematical thinking ability is the use of appropriate teaching materials. Nurhidayati et al. (2017) stated that teaching materials that emphasize problem solving and the use of real contexts can help learners understand, analyze, formulate strategies, evaluate results, and make decisions based on relevant data which will contribute to the development of broader mathematical reasoning abilities. So, as educators, we should familiarize students to learn with RME-based teaching materials which is an approach that is recommended because it can improve mathematical reasoning ability (Indriani, 2020). In this study, teaching materials integrate mathematical concepts into real-life contexts, these teaching materials allow students to understand the material more deeply and meaningfully. In addition, the RME approach used will involve students in mathematical modeling activities, data analysis, and formulation of problem-solving strategies, so that they can overcome difficulties in understanding abstract concepts. This teaching material is designed in accordance with the standards of validity and practicality, ensuring its effectiveness in supporting the improvement of mathematical reasoning ability.

METHODS

This study employed the Research and Development (R&D) method using the 4-D model developed by Thiagarajan et al. (1974), which consists of four stages: Define, Design, Development, and Dissemination. In the Define stage, researchers conducted an initial-final analysis, learner analysis, task analysis, concept analysis, and specified learning objectives. During the Design stage, the researchers compiled tests, selected media, chose formats, and created the initial design of the teaching materials. In the Development stage, a formative evaluation was carried out, which involved four steps: expert assessment by three mathematics education lecturers, one-on-one evaluations with three students, a limited trial with 12 students, and a field trial involving 33 seventh-grade students at SMP Negeri 8 Pekanbaru. In the Dissemination stage, the researchers distributed the finalized teaching materials.

The research utilized both qualitative and quantitative data. Qualitative data were gathered from related problems and solutions, as well as feedback from experts and learners on the teaching materials. Quantitative data were obtained through validation sheets and learner response questionnaires. Data collection techniques included interviews, which provided insights into the learning references used, and questionnaires, which collected evaluations from validators and student responses to the teaching materials. The data collection instruments consisted of validation sheets and learner response questionnaires. The information gathered was processed through an analysis of the validity and practicality of the teaching materials, following predetermined standards. The components of the validity assessment included aspects such as content, presentation, language, graphics, the RME approach, and mathematical thinking ability. The practicality assessment focused on the ease of use of the teaching materials, understanding of the content, the suitability of the RME approach, and the alignment of the teaching materials with the needs, interests, and conditions of the students.

FINDING AND DISCUSSION

In line with the adopted research design, the 4D model consists of four stages, namely the define, design, develop, and dessiminate stages. The results of the research described in each phase will be presented below.

Define

The Define stage includes beginning-end analysis, learner analysis, task analysis, concept analysis, and specification of learning objectives. At the beginning-end analysis stage, researchers analyzed teaching materials at school and collected data from various sources. Based on interviews with math teachers, it was found that students are constrained in solving problems that require reasoning. They have difficulty associating mathematical concepts with everyday life and lack training in compiling evidence and developing problem-solving strategies. During learning, students tend to be less active in solving mathematical problems. Sukmawati et al. (2023), Fajriyah & Zanthy (2019), dan Putri & Yuliani (2019) also stated that low matematical reasoning ability is reflected in a lack of accuracy, weak ability to think logically, and difficulty providing conclusions or ideas that support, so that the results of students' work are not supported by adequate reasons. The lattice of interview guidelines for mathematics teachers and participants can be seen in Table 1 below.

Table 1. Lattice of Teacher and Learner Interview Guidelines

No	Indicator
1	Exploring information on mathematics teaching materials used by students
2	Exploring information on the use of teaching materials that have integrated RME

https://doi.org/10.30606/absis.v7i1.2528

No	Indicator
3	Exploring information on students' understanding of Social Arithmetic material
4	Exploring information on students' mathematical reasoning ability
5	Exploring information about the characteristics of learners

Previous studies have also revealed that the application of RME in mathematics learning can have a positive impact on mathematical reasoning ability (Siregar & Lubis, 2022; Fendrik, 2021; Amir & Nora, 2021; Gusnarsi et al., 2017). This approach helps learners understand mathematics by linking mathematical concepts to real situations, supporting the development of deep knowledge of mathematical concepts, and connecting them to the real world. The habituation of students to learn using the RME stages must be facilitated by appropriate teaching materials. Mulbasari & Surmilasari (2018) stated that one of the keys to improving students' mathematical thinking ability is the use of appropriate teaching materials. Based on the results of interviews with mathematics teachers, it was conveyed that there were no teaching materials based on RME and learning resources that specifically supported the development of students' mathematical reasoning skills. Students and teachers also expressed the need for RME-based teaching materials as additional learning resources in the learning process to improve students' mathematical reasoning skills. This is due to the limited access of students to a variety of materials, where the use of package books is the only available learning resource. Therefore, efforts are needed to provide RME-based teaching materials to provide a variety of materials and support the improvement of students' mathematical reasoning skills in the teaching and learning process.

At the learner analysis stage, researchers conducted interviews about the characteristics of students. The teaching materials were designed for grade VII SMP/MTs aged 12-14 years, following the principles of cognitive development according to Piaget's theory (Zulkarnain & Heleni, 2014). The theory emphasizes the formal operational stage at the age of 11-15 years, where the ability to think abstractly, think deductively, and reason has developed. Nonetheless, this transitional phase requires an introduction to abstract concepts through concrete illustrations, given that some learners may have difficulty understanding them. The importance of concrete illustrations is in line with the interest of learners at that age in teaching materials equipped with attractive illustrations, as stated by Muhtar et al. (2020) dan Magdalena et al. (2021). Good illustrations not only increase learners' appeal but also help visualize abstract concepts, creating an enjoyable learning experience. Therefore, teaching materials that combine text and interesting illustrations, as well as utilize pictures, diagrams, or graphs, are expected to increase learners' active participation in learning mathematics.

At the task analysis stage, researchers analyzed the Learning Outcomes (CP) of the Merdeka Phase D Curriculum on social arithmetic material, namely "At the end of phase D, students can apply arithmetic operations on real numbers, and provide estimates/estimates in solving problems (including those related to financial literacy)." Task analysis is carried out by compiling the details of the tasks that learners must understand, namely:

1. Able to use arithmetic operations on real numbers and provide estimation/estimation in solving problems related to profit and loss.
2. Able to use arithmetic operations on real numbers and provide estimates in solving problems related to the percentage of profit and loss.
3. Able to use arithmetic operations on real numbers and give estimation/estimation in solving problems related to discounts.
4. Able to use arithmetic operations on real numbers and provide estimation/estimation in solving problems related to gross, tare and net.
5. Able to use arithmetic operations on real numbers and give estimation/estimation in solving problems related to single interest.

At the concept analysis stage, researchers determine, describe, and structurally design teaching materials. The elaboration of material into teaching materials refers to the CP of the Merdeka Phase D Curriculum on social arithmetic material. Based on the results of CP analysis, researchers made a concept map regarding the elaboration of social arithmetic material. At the learning objective specification stage, researchers identify the objectives to be achieved in learning which are adjusted to task analysis and concept analysis, which will later be integrated with the preparation of teaching materials to be developed. The specification of learning objectives is formulated based on the results of task analysis and the results of concept analysis. The specifications of the learning objectives obtained are as follows: a) Able to explain the concept of purchase price and selling price; b) Able to determine purchase price and selling price; c) Able to solve contextual problems related to selling price and purchase price; d) Able to explain the concept of profit and loss; e) Able to determine profit and loss; f) Able to solve contextual problems related to profit and loss; g) Able to determine the percentage of profit and percentage of loss; h) Able to solve contextual problems related to the percentage of profit and percentage of loss; i) Able to explain the concept of discount in buying and selling activities; j) Able to determine discount; k) Able to solve contextual problems related to discounts; l) Able to explain the concepts of gross, net, and tare; m) Able to determine gross, net, and tare; n) Able to solve contextual problems related to gross, net, and tare.

Design

At the Design stage, researchers designed the initial design of teaching materials by compiling tests, selecting media, determining the format, and designing the content of teaching materials. At the stage of compiling tests, researchers used validity

https://doi.org/10.30606/absis.v7i1.2528

sheets and practicality sheets as instruments to assess teaching materials with a Likert scale as a means of assessing the level of suitability and usability by students.

At the media selection stage, researchers decided to use visual media in the form of illustrations and teaching materials in printed form. Visual media was chosen because of its ability to convey concepts visually, supporting students' understanding of concept abstraction through illustrations, as stated by Nurfadhillah et al. (2021). Teaching materials in printed form were chosen to increase accessibility, minimize access barriers, and provide flexibility of use inside and outside the classroom. In its format, teaching materials have an organized structure, including various elements, such as preface, table of contents, instructions for use, CP, concept map, RME-based learning activities, sample problems and solutions, formative tests, material summary, answer key, and bibliography. The RME-based learning activities are directed at solving contextual problems by utilizing models as a solution strategy. The focus is on modeling and expressing mathematical thinking. Learners are invited to make conjectures, develop general models of solutions, compile evidence, provide reasons for solutions, draw conclusions, and check the validity of arguments. During the initial design stage, researchers began developing teaching materials according to the plan that had been made. The following is the initial design of the teaching materials developed.

Figure 1. Cover Page

Figure 2. Introductory Material

Figure 1 shows that the cover page includes several important elements, namely the title of the teaching material, the author's name, supporting illustrations, class, and education unit. The title of the teaching materials listed provides a brief description of the content of the material presented. Figure 2 shows that the introductory material in teaching materials acts as a gateway that opens a window to understanding the material. As an introduction, this material provides an overview, as well as an introduction to the concepts discussed.

Figure 3. Using Context

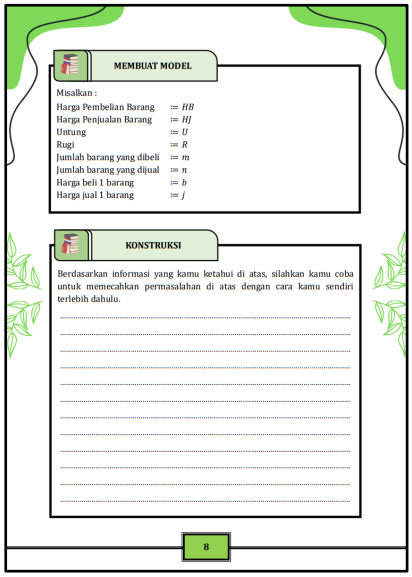

Figure 4. Modeling and Construction

Figure 3 shows that in the section using context, learners are given contextual problems that can be imagined by students related to learning materials. Learners carefully pay attention, understand, and know what information is given in the problem. Figure 4 shows that in the section using models, teaching materials present mathematical modeling to help learners in realistically describing complex processes or ideas. Learners are invited to face contextual problems formulated in mathematical models, to apply mathematical knowledge practically in solving everyday problems. Learners process the information that has been collected and face the problem using the knowledge and understanding they have gained after going through the steps of understanding the problem and making a model.

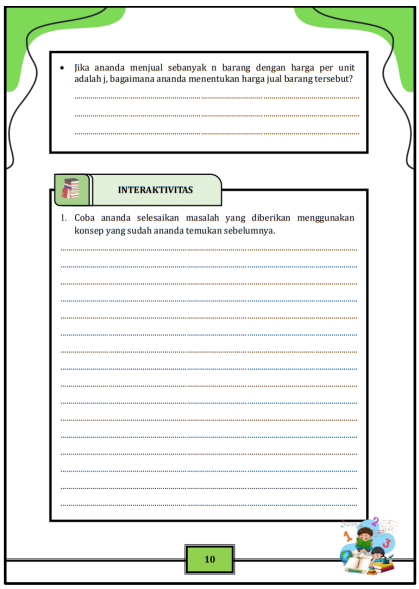

Figure 5. Interactivity

Figure 6. Linkage

https://doi.org/10.30606/absis.v7i1.2528

Figure 5 shows that in the interactivity section, learners make conclusions about the learning material and solve the problems given using the concepts that have been found before. Figure 6 shows that in the linkage section, learners apply previously learned mathematical facts, concepts, and procedures to solve problems. They use previously acquired knowledge related to the material being studied.

Development

At this stage, a formative evaluation of the initial design is carried out which consists of four stages, namely expert assessment, one-on-one evaluation, limited trial, and field trial.

Expert Assessment

Based on the validation results, quantitative data consisting of validity scores and qualitative data consisting of comments and suggestions for improvement were obtained. The results of teaching material validation are presented in Table 2.

Table 1. Teaching Material Validation Results

Assessed Aspect	Average Validator Assessment of Teaching Materials (%)					Average (%)	Category
	1	2	3	4	5		
Graphics	88,10	88,10	88,10	88,10	88,10	88,10	Very Valid
Contents	86,11	87,50	87,50	86,11	86,11	86,67	Very Valid
Presentation	89,58	89,58	89,58	89,58	89,58	89,58	Very Valid
Language	86,11	86,11	86,11	86,11	86,11	86,11	Very Valid
RME	81,67	81,67	85,00	81,67	83,33	82,67	Very Valid
Mathematical Reasoning Ability	83,33	83,33	84,72	83,33	81,94	83,33	Valid
Average (%)	**86,18**	**86,40**	**87,06**	**86,18**	**86,18**	**86,40**	**Very Valid**

Expert assessment involved discussions with the supervisor and validation by three mathematics education lecturers, focusing on aspects of graphics, content, presentation, language, RME, and Mathematical Reasoning Ability. The validity of teaching materials reached 86.40%, classified as very valid. In line with Akbar (2017) regarding the achievement of product validity in the range of 70-85%. The aspects of graphics, content, presentation, and language received an average score of very valid, respectively 88.10%, 86.11%, 89.58%, and 86.11%. Similarly, the RME aspect and matematical reasoning ability with the vali category, namely 82.67% and 83.33%. Validators provided constructive suggestions, such as the addition of acknowledgments, changing the term “5 teaching materials” to “5 learning activities”, adjusting illustrations to maintain privacy, adding educational images, adding captions to illustrations, communicative improvements to the introductory editorial, adding instructions to the test, and presenting more comprehensive

apperceptions. It is also suggested to update the editorial to be more contextualized according to current conditions. All of these suggestions aim to improve the quality and attractiveness of teaching materials, especially for junior high school students.

One-on-one evaluation

At the one-on-one evaluation stage, the researcher engaged three learners to obtain focused information on readability, attractiveness, and identification of shortcomings. Direct interaction with learners provided detailed insights into the teaching materials. Learners provided constructive feedback, including the correction of word errors in learning objective B1, consistency between question descriptions and illustrations, the addition of icons on subtitles for a more attractive appearance, and the improvement of question wording to make it clearer. A typing error was also found in formative test 1, and learners recommended clarifying the illustration for question number 2 of formative test - 2 to make it more focused and concrete. This input is used as the basis for researchers to improve teaching materials.

Limited trial

After going through the validation and one-on-one evaluation stages, the researchers conducted limited group trials to observe the practicality of the teaching materials. The results of the student response questionnaire in the limited trial can be seen in Table 3.

Table 2. Limited Trial Questionnaire Results for Teaching Materials

Assessed Aspect	Results of Student Response Questionnaires to Teaching Materials – (%)					Average (%)	Category
	1	2	3	4	5		
Ease of use of teaching materials	85,00	86,25	86,25	85,00	84,58	85,42	Very Practical
Understanding of teaching materials	86,98	88,28	86,72	85,94	86,98	86,98	Very Practical
Suitability of teaching materials to the needs, interests and conditions of students	85,42	86,01	85,42	86,31	87,50	86,13	Very Practical
Suitability of the RME approach to teaching materials	84,17	85,42	85,00	84,17	83,33	84,42	Practical
Average (%)	**85,58**	**86,67**	**85,92**	**85,50**	**85,92**	**85,92**	**Very Practical**

https://doi.org/10.30606/absis.v7i1.2528

At the limited testing stage, researchers observed the practicality of the designed teaching materials. Students' responses to the ease of use of learning materials were very positive and gave high assessments (85.42%), understanding of the material (86.98%), suitability to needs and interests (86.13%), and application of the RME (84.42%). The questionnaire shows that the teaching materials are very practical with an average score of 85.92%. Students provide suggestions for adding examples in the introductory material, adjusting the purchase price of the hijab, and improving the editorial in the introductory material for learning activities – 5.

Field trials

This research conducted a field trial to measure the level of practicality of mathematics teaching materials in class VII.I of SMP Negeri 8 Pekanbaru, totaling 33 students. The learning process follows a limited trial pattern, starting with apperception, motivation, and independent learning activities. The results of the student response questionnaire in the field trial can be seen in Table 4.

Table 3. Results of Teaching Material Field Trial Questionnaires

Assessed Aspect	Results of Student Response Questionnaires to Teaching Materials – (%)					Average (%)	Category
	1	2	3	4	5		
Ease of use of teaching materials	80,45	82,73	84,09	84,39	84,09	83,15	Practical
Understanding of teaching materials	81,72	82,67	85,51	84,56	84,38	83,77	Practical
Suitability of teaching materials to the needs, interests and conditions of students	80,09	81,71	84,20	82,36	83,44	82,36	Practical
Suitability of the RME approach to teaching materials	80,30	81,06	81,97	82,42	82,12	81,58	Practical
Average (%)	80,73	82,09	84,15	83,48	83,61	82,81	Practical

Student responses to the ease of use of teaching materials reached 83.15% in the practical category. Students rated the teaching materials positively and indicated that a balanced and clear color combination created an enjoyable learning experience. The content of the teaching materials is assessed as good with appropriate illustrations and pictures, helping to understand concepts. The display design is attractive and can provide motivational encouragement to students. The choice of font type and size is considered attractive and provides good readability. This finding is in line with Lasmiyati & Harta (2014) that teaching materials that are

easy to understand and fun can motivate and arouse students' enthusiasm for learning.

The aspect of understanding teaching materials also received a positive assessment with an average of 83.77% which was categorized as practical. The designed teaching materials received a positive response from students. The material presented is easy to understand. The flow of learning activities is considered very clear and provides significant assistance in understanding the concepts of learning material. The existence of teaching materials allows students to re-learn the desired material, increasing the effectiveness of learning. This finding is in line with the stand-alone concept, where teaching materials stand alone without dependence on other materials and do not require joint use with other teaching materials (Rahdiyanta, 2012). Teaching materials are considered to support students in achieving learning goals with activities that are considered effective. The presentation of material in teaching materials encourages discussion between students, creating an interactive learning atmosphere. Practice questions included in teaching materials are recognized as strengthening students' knowledge of the material being taught. The simple sentence writing style supports students' ease of understanding, fulfills user-friendly characteristics, with language that is friendly and easy to understand (Sihotang, 2020).

The aspect of suitability of teaching materials to the needs, interests and conditions of students obtained an average of 82.36% in the practical category. The use of teaching materials in mathematics learning is considered capable of making the material more enjoyable and attracting students' attention. This teaching material primarily supports mastery of material on the topic of social arithmetic, showing self-contained characteristics, where all learning material is contained in one teaching material, providing opportunities for students to understand the material comprehensively (Sirate & Ramadhana, 2017). Apart from that, teaching materials provide high motivation and have a positive effect on increasing students' mathematical reasoning ability. Students' desire to study other materials with teaching materials shows the flexibility and attractiveness of this learning. Teaching materials also fulfill the characteristics of self-instruction, facilitating students to learn autonomously without relying on external assistance (Septora, 2017).

The average assessment of the suitability aspect of RME was 81.58% in the practical category. Based on student responses, the designed teaching materials can facilitate visual understanding of mathematical problems. Activities in teaching materials support students in informal to formal modeling, while encouraging a variety of solving approaches. The problems or tasks presented create a collaborative learning atmosphere, with links to mathematical concepts and other branches of science. The overall average response from students reached 82.81%, indicating that the teaching materials were included in the practical category. Student suggestions involved detailed explanations of illustrations, additional discount images, and

https://doi.org/10.30606/absis.v7i1.2528

adjustments to the context of the questions to increase clarity and relevance in the teaching materials.

RME-based social arithmetic teaching materials are proven to be valid and practical in facilitating mathematical reasoning abilities. The validity of teaching materials reached 86.40%, classified as very valid. At the limited trial stage, the average assessment of teaching materials was 85.92% in the very practical category. At the field trial stage, the average teaching material reached 82.81%, in the practical category. In line with Agustiani (2019) research which shows that the implementation of RME-based teaching materials has a positive influence on mathematical reasoning ability. Valid and practical standards as expressed by Nieveen in Akker et al. (2010) has been fulfilled in this teaching material. Thus, it can be concluded that the social arithmetic RME teaching materials have met the valid and practical criteria in accordance with the established standards.

Disseminate

At the product Disseminate stage, according to Mulyatiningsih (2014), teaching materials are handed over to schools participating in the research and it is hoped that they can be used as learning resources and references for developing teaching materials on other materials. In addition, research results are presented through publications in accredited journals in the form of articles and disseminated through research results seminars, in accordance with the principle of effective and wide dissemination.

CONCLUSIONS AND RECOMMENDATIONS

Based on the procedures carried out, the researcher concludes that the final outcome of this study is the successful development of RME-based social arithmetic teaching materials, which have demonstrated a high level of validity and practicality, making them well-suited to effectively support the learning process. These materials have been designed to align with the principles of Realistic Mathematics Education, fostering a more engaging and contextually relevant learning environment for students. Several important recommendations arise from this research: 1) It is recommended that teachers incorporate more questions that encourage students to engage in mathematical reasoning, which is crucial for improving their overall mathematical abilities and critical thinking skills; and 2) While the teaching materials are effective, the adaptive characteristics—particularly regarding the integration of technology—are not yet fully realized. The current use of technology in these materials has not been optimized to achieve the desired level of adaptability, limiting their potential responsiveness to changes in science and technology. To enhance the effectiveness and relevance of these teaching materials, it is essential to improve and more effectively integrate technological elements, ensuring that the materials can dynamically adapt to ongoing advancements and better meet the evolving needs of both teachers and students.

REFERENCES

Agustiani, S. (2019). Penerapan bahan ajar matematika berbasis rme terhadap kemampuan penalaran matematis siswa. *Jurnal Peka*, 2(2), 65–72. https://doi.org/10.37150/jp.v2i2.1118

Akbar, S. (2017). *Instrumen Perangkat Pembelajaran*. PT Remaja Rosdakarya.

van den Akker, J., Bannan, B., Kelly, A. E., Nieveen, N., & Plomp, T. (2010). *An introduction to educational design research*. SLO Netherlands Institute for Curriculum Development.

Amir, A., & Nora, N. (2021). Kemampuan penalaran matematis siswa melalui pendekatan realistic mathematics education di SMP Negeri 5 Padangsidimpuan. *Logaritma : Jurnal Ilmu-Ilmu Pendidikan dan Sains*, 9(01), 15–32.

Asdarina, O., & Ridha, M. (2020). Analisis kemampuan penalaran matematis siswa dalam menyelesaikan soal setara PISA konten geometri. *Numeracy*, 7(2), 192–206. https://doi.org/10.46244/numeracy.v7i2.1167

Astuti, Y., & Ristontowi. (2022). Pengembangan soal kemampuan penalaran matematis untuk siswa SMA. *Jurnal Math-UMB.EDU*, 9(2), 94–100. https://doi.org/10.36085/mathumbedu.v9i2.2508

Fajriyah, L., & Zanthy, L. S. (2019). Penerapan pendekatan kontekstual terhadap kemampuan pemahaman dan komunikasi matematis siswa SMP. *Journal on Education*, 1(3), 211–216. https://jonedu.org/index.php/joe/article/view/140

Fendrik, M. (2021). Pengaruh pendekatan realistic mathematics education terhadap kemampuan penalaran matematis siswa SD ditinjau dari kemampuan siswa dan level sekolah. *Numeracy*, 8(2), 102–112. https://doi.org/10.46244/numeracy.v8i2.1611

Fuada, S. (2015). Pengujian validitas alat peraga pembangkit sinyal (oscillator) untuk pembelajaran workshop instrumentasi industri. *Prosiding Seminar Nasional Pendidikan : Inovasi Pembelajaran Untuk Pendidikan Berkemajuan*, 854-861. https://seminar.umpo.ac.id/index.php/semnasdik2015/article/view/308/0

Gusnarsi, D., Utami, C., & Wahyuni, R. (2017). Pengaruh model pembelajaran realistic mathematics education (RME) terhadap kemampuan penalaran matematis siswa pada materi lingkaran kelas VIII. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, 2(1), 32–36. http://dx.doi.org/10.26737/jpmi.v2i1.207

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2018). *Hard skills dan soft skills matematik siswa*. Bandung: PT Refika Aditama.

Indriani, D. (2020). Penerapan bahan ajar matematika berbasis rme terhadap kemampuan komunikasi dan penalaran matematis. *Jurnal Peka*, 3(2), 49–54. https://www.jurnal.ummi.ac.id/index.php/peka/article/view/786

https://doi.org/10.30606/absis.v7i1.2528

Kemendikbud. (2022). Keputusan Nomor 033/H/KR/2022.

Lasmiyati, & Harta, I. (2014). Pengembangan Modul Pembelajaran untuk Meningkatkan Pemahaman Konsep dan Minat SMP. *Pytagoras: Jurnal Pendidikan Matematika*, 9(2), 161–174. https://doi.org/10.21831/pg.v9i2.9077

Magdalena, I., Roshita, Pratiwi, S., Pertiwi, A., & Damayanti, A. P. (2021). Penggunaan Media Gambar dalam Meningkatkan Minat Belajar Siswa Kelas IV di SD Negeri 3 Kamal Pagi. *Pensa : Jurnal Pendidikan dan Ilmu Sosial*, 3(2), 334–346. https://ejournal.stitpn.ac.id/index.php/pensa/article/view/1374

Maulyda, M. A. (2020). *Paradigma pembelajaran matematika berbasis NCTM*. Malang: CV IRDH.

Muhtar, N. A., Nugraha, A., & Giyartini, R. (2020). Pengembangan media pembelajaran IPA berbasis information communication and technology (ICT). *Pedadidaktika: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 7(4), 20–31. https://doi.org/10.17509/pedadidaktika.v7i4.26455

Mulbasari, A. S., & Surmilasari, N. (2018). Pengaruh bahan ajar berbasis contextual teaching and learning (CTL) terhadap kemampuan penalaran matematis siswa SMA. *Jurnal Elemen*, 4(2), 197–203. https://doi.org/10.29408/jel.v4i2.719

Mulyatiningsih, E. (2014). *Metode penelitian terapan bidang pendidikan*. Bandung: Alfabeta.

Nurfadhillah, S., Ramadhanty Wahidah, A., Rahmah, G., Ramdhan, F., & Claudia Maharani, S. (2021). Penggunaan media dalam pembelajaran matematika dan manfaatnya di sekolah dasar swasta plus ar-rahmaniyah. *Edisi : Jurnal Edukasi dan Sains*, 3(2), 289–298. https://ejournal.stitpn.ac.id/index.php/edisi/article/view/1353

Nurhidayati, S., Tayeb, T., & Baharuddin. (2017). Pengembangan bahan ajar matematika berbasis masalah untuk memfasilitasi pencapaian kemampuan penalaran pada pokok bahasan perbandingan kelas VII MTsN Model Makassar. *MaPan : Jurnal Matematika Dan Pembelajaran*, 5(2), 236–250. https://doi.org/10.24252/mapan.v5n2a6

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing

Putri, A. D., & Yuliani, A. (2019). Analisis Kemampuan Penalaran Matematis Siswa MA di Kabupaten Bandung Barat pada Materi Barisan Dan Deret. Journal On Education, 1(2), 400–409. https://jonedu.org/index.php/joe/article/view/80

Rahdiyanta, D. (2012). *Teknik Penyusunan Modul*. http://staff.uny.ac.id/sites/default/files/penelitian/dr-dwi-rahdiyanta-mpd/20-teknik-penyusunan-modul.pdf

Septora, R. (2017). Pengembangan modul dengan menggunakan pendekatan saintifik pada kelas X sekolah menengah atas. *Jurnal Lentera Pendidikan Pusat Penelitian LPPM UM METRO*, 2(1), 86–98. https://ojs.ummetro.ac.id/index.php/lentera/article/view/494

Sihotang, H. (2020). Materi pembelajaran pengembangan pembelajaran. Jakarta: UKI Press.

Sirate, S. F. S., & Ramadhana, R. (2017). Pengembangan modul pembelajaran berbasis keterampilan literasi. *Jurnal Inspiratif Pendidikan*, 6(2), 316–335. https://doi.org/10.24252/ip.v6i2.5763

Siregar, R., & Lubis, S. N. (2022). Analisis Kemampuan Penalaran Matematis Siswa dengan Pendekatan Realistic Mathematics Education pada Materi Barisan dan Deret. *Journal of Didactic Mathematics*, 3(2), 51–60. https://doi.org/10.34007/jdm.v3i2.1459

Sukmawati, Amrullah, Hikmah, N., & Soepriyanto, H. (2023). Analisis kemampuan penalaran matematika siswa ditinjau dari gaya belajar. *JCAR (Journal of Classroom Action Research)*, 5(2), 106–110. https://jppipa.unram.ac.id/index.php/jcar/article/view/3207

Sumartini, T. S. (2015). Peningkatan Kemampuan Penalaran Matematis Siswa Melalui Pembelajaran Berbasis Masalah. Mosharafa: Jurnal Pendidikan Matematika, 4(1), 1–10. https://doi.org/10.31980/mosharafa.v4i1.323

Syahmaidi, E., & Hidayat, H. (2016). Praktikalitas perancangan media e-learning berbasis video. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, 5(2), 87-97. https://doi.org/10.23887/janapati.v5i2.9858

Thiagarajan, S., Semmel, D. S., & Semmel, M. I. (1974). *Instructional development for training teachers of exceptional children: A sourcebook*. Center for Innovation in Teaching the Handicapped, Indiana University.

Wahyuni, Z., Roza, Y., & Maimunah, M. (2019). Analisis kemampuan penalaran matematika siswa kelas X pada materi dimensi tiga. *Jurnal Ilmiah Pendidikan Matematika Al Qalasadi*, 3(1), 81–92. https://doi.org/10.32505/qalasadi.v3i1.920

Zulkarnain, & Heleni, S. (2014). *Strategi pembelajaran matematika*. Pekanbaru: Cendikia Insani.

https://doi.org/10.30606/absis.v7i1.2528