

Development of Realistic Mathematics Education-Based Student Worksheets to Enhance Self-Regulated Learning in Social Arithmetic

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ABSTRACT

This study aims to design and develop student worksheets based on the Realistic Mathematics Education (RME) approach to enhance students' self-regulated learning (SRL), specifically in the context of social arithmetic. A research and development design was employed using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The study involved 48 grade VII students from two schools: MTs Muslimat NU and SMP Muhammadiyah Palangkaraya. Instruments included RME-based worksheets and an SRL questionnaire. Effectiveness was analyzed using a one-sample t-test with IBM SPSS 21. The worksheet was validated by experts and achieved a score of 94 out of 100, categorized as "very valid." Practicality results showed high usability: teachers rated it 31.5/35 ("very practical") and students 44.95/60 ("practical"). After implementation, students' SRL improved from 44.44% to 83.33%, an increase of 38.89%. The one-sample t-test showed a significance value of 0.001 (< 0.05), indicating the worksheet's effectiveness. The mean student questionnaire score was 65.16, classified as "effective." The developed RME-based worksheets are valid, practical, and effective in supporting students' independent learning. They promote meaningful engagement with mathematical content, improve comprehension of social arithmetic, and help students monitor their own progress. These results highlight the potential of RME in fostering student-centered mathematics learning.

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1. INTRODUCTION

Worksheets are widely recognized as effective learning tools that facilitate structured and independent learning. According to Bartoňová and Kričfaluši (2021), a worksheet is defined as a systematically organized set of tasks, exercises, and teaching materials designed to guide students and foster learning independence. Choo, Rotgans, Yew, and Schmidt (2011) describe worksheets as instructional tools in the form of questions and information that help students understand complex concepts through a step-by-step approach. Beyond procedural knowledge, worksheets also serve as

platforms for developing higher-order thinking. Chappell, Craft, and Susantini, as cited in Utami, Sumarmi, Ruja, and Utaya (2016), emphasize that worksheets can promote critical thinking, stimulate student inquiry, and aid teachers in evaluating learning progress. Similarly, Celik, Baki, and Isik (2022) argue that worksheets play a crucial role in constructing knowledge, encouraging engagement, and developing students' reasoning skills—making them an indispensable part of instructional design, especially in varied classroom settings.

In mathematics education, such tools are even more critical, given the subject's reputation for being challenging. This is especially relevant in the Indonesian context, where national and international assessments consistently highlight low student performance in mathematics. According to the Programme for International Student Assessment (PISA), Indonesian students scored an average of 379 in mathematics in 2018—ranking seventh lowest among 79 participating countries (OECD, 2019). These results underline a pressing need for innovative instructional strategies and tools that not only build cognitive skills but also nurture student autonomy in learning.

One of the key competencies needed to address these challenges is self-regulated learning (SRL). SRL involves students' ability to plan, monitor, and evaluate their own learning processes. Sagita and Mahmud (2019) emphasize that students with strong SRL skills can take control of their learning by setting goals, adopting effective strategies, and reflecting on outcomes. Montalvo and Torres (2004) further explain that SRL enhances academic achievement by supporting self-awareness and goal orientation. Similarly, Linda (2013) notes that SRL contributes to improved focus, reasoning, achievement, and self-reflection. Given these advantages, SRL is a critical element that should be integrated into mathematics learning alongside cognitive development.

To support SRL in mathematics, it is essential to adopt pedagogical approaches that align with students' real-world experiences. One such approach is Realistic Mathematics Education (RME), which views mathematics as a human activity and encourages students to rediscover concepts through meaningful contexts. RME, originally developed by Hans Freudenthal in the Netherlands, focuses on contextual learning, progressive mathematization, and active student involvement. Freudenthal emphasized that mathematics is not a fixed body of knowledge but a dynamic activity rooted in real-life experiences. Van den Heuvel-Panhuizen (1996) expanded this perspective by asserting that “realistic” does not only imply tangible objects but also includes imaginable and relatable contexts.

In practice, RME enables students to build understanding through guided reinvention and classroom dialogue. Prahmana, Zulkardi, and Hartono (2012) argue that students should be given opportunities to reconstruct mathematical ideas with teacher guidance, which helps foster deeper conceptual understanding. In topics like social arithmetic—a branch of mathematics that relates closely to daily financial and commercial transactions—students often face both verbal and conceptual challenges (Lestari, Suryadi, & Suryadi, 2019). RME, with its focus on contextualization and problem-solving, offers a solution by enabling learners to make sense of abstract concepts through familiar experiences. Gravemeijer, as cited in Risnawati (2016), identifies three principles central to RME: (1) guided reinvention and progressive mathematization, where students rediscover mathematics through scaffolded activities; (2) didactical phenomenology, which uses rich contextual problems to drive conceptual understanding; and (3) emergent modeling, where learners move from informal to formal representations through self-developed models.

Recent empirical studies have supported the positive influence of RME on SRL. Khairani, Sugianto, and Ildiyanita (2022) found that using RME in a blended learning environment improved student SRL by 7.69%, with notable gains in thought management, behavioral regulation, and responsibility. Another study by Jumri, Risnanosanti, Ramadianti, and Syofiana (2023) found that 98.18% of students responded positively to RME-based learning, recognizing it as a contextual and effective strategy for enhancing SRL in mathematics. These findings indicate that RME not only strengthens students' conceptual understanding but also supports the development of autonomous learning behaviors.

Given the effectiveness of both worksheets and RME in supporting learning autonomy, this study seeks to develop a student worksheet that integrates the principles of RME to enhance self-regulated learning in social arithmetic. By combining structured instructional tools with a realistic, student-

centered approach, the worksheet aims to serve as a practical and effective medium for improving both cognitive outcomes and learner independence in mathematics.

2. METHODS

This study is categorized as Research and Development (R&D). R&D refers to a type of developmental research. The purpose of this developmental research is to design and develop learning materials based on the Realistic Mathematics Education (RME) approach, oriented toward enhancing students' self-regulated learning skills. The research model employed in this study is the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

2.1 Sample and Data Collection

The subjects of this study consisted of two classes from different schools, namely SMP Muhammadiyah Palangka Raya and MTs Muslimat NU Palangka Raya, with a total sample of 48 students.

Table 1. Respondent Demographics

Demographics aspect	Number of Students
Gander :	
Female	36
Male	12
Total	48
mathematical ability:	
High	11
Medium	28
Low	9

2.2 Analysis

The analysis phase includes needs analysis, materials analysis, and student characteristics analysis. The needs analysis was conducted through classroom observations and teacher interviews to identify mathematics material that frequently causes difficulties. Material analysis was conducted by reviewing previous test results and discussing them with the mathematics teacher, ultimately selecting the topic of social arithmetic, which was then examined based on indicators and core competencies. Meanwhile, the student characteristics analysis aimed to understand students' conditions in learning the selected material. To this end, researchers gathered information through interviews with students and teachers to obtain an overview of their cognitive development.

2.3 Design

The design stage is the phase in which researchers design the product to be developed. In this study, the product designed was a worksheet with a realistic mathematics education approach. At this stage, researchers developed instruments in the form of a realistic mathematics education-based worksheet and a self-regulated learning questionnaire to assess the quality of the resulting product.

2.4 Development

At this stage, the researchers developed a worksheet based on the Realistic Mathematics Education (RME) approach, equipped with features designed to support students' self-regulated learning. In addition, a questionnaire was constructed to assess validity, practicality, and the level of self-regulated learning. The product was then validated by two experts, namely a media expert and a subject-matter expert. Based on the feedback and suggestions from the validators, revisions were made to produce the initial draft of the RME-based worksheet oriented toward enhancing students' self-regulated learning skills, hereafter referred to as Draft 1.

2.5 Implementation

The implementation stage refers to the classroom trial conducted to examine the effectiveness and practicality of the developed worksheet. At the beginning of the lesson, the teacher introduced the worksheet by providing a brief explanation of its instructions and the material to be studied. Subsequently, students were divided into groups of four to five members. During the learning process, the teacher facilitated and provided assistance when necessary. Students were given the opportunity to engage in group discussions and later present their findings by answering the questions provided in the worksheet. The learning activities were observed using an observation sheet, while at the end of the session, the researchers distributed questionnaires and conducted interviews to gather students' feedback on the use of the worksheet. The teacher, as the practitioner, was also asked to evaluate the product. Upon completion of the implementation, the researchers analyzed the students' self-regulated learning questionnaire scores to assess the quality of the worksheet in terms of effectiveness.

2.6 Evaluation

The product that had been validated by experts was subsequently tested in classroom learning. This study involved two classes from different schools, namely Class VII B of SMP Muhammadiyah Palangka Raya and Class VII C of MTs Muslimat NU Palangka Raya, with a total sample of 48 students. The focus of the study was to describe the quality of the worksheet developed using the Realistic Mathematics Education (RME) approach. For this purpose, five types of questionnaires were employed: material validation and media validation questionnaires to assess the validity of the product, teacher and student response questionnaires to measure practicality, and a self-regulated learning questionnaire to evaluate effectiveness. These questionnaires were first tested for validity and reliability to ensure their ability to accurately measure students' self-regulated learning.

2.6.1 Instrument Validity

Validity testing is used to assess the accuracy of the measured data. An instrument is considered valid if $r_{\text{count}} > r_{\text{table}}$. Content validity testing is conducted through assessments by two lecturers from the Mathematics Education Department. The assessments consist of scores calculated by looking at the average using Microsoft Excel software, along with recommendations to determine whether the instrument is feasible, inadequate, or feasible with revisions.

2.6.2 Instrument Reliability

In this study, researchers used the Cronbach's alpha reliability formula to determine the reliability of the instruments used. The instruments used were descriptive tests and questionnaires.

The reliability coefficient categories for questionnaires and test items consist of five categories: very low, low, moderately high, high, and very high, with r values ranging from 0.00 to 1.00. Further explanation can be found in Appendix Table 2. The trial was conducted in Class VII D at MTs Muslimat NU with a total of 29 students. The class selected for the trial differed from the classes used as the research subjects. The reliability calculation of the instruments was assisted by Microsoft Excel software. This study adapted the conversion formula according to Widoyoko (2009: 239), as presented in Appendix Table 3, which consists of five qualitative criteria: very good, good, fairly good, low, and very low.

From Table 1, the researcher first recorded the maximum and minimum scores to obtain the ideal mean score and the ideal standard deviation for assessing the validity and practicality of the developed learning materials. The data recording referred to the validation sheets. From the results of the recording and calculation, the categories of validity and practicality of the worksheets were obtained, which are further explained in Appendix Table 4. Furthermore, to measure the effectiveness of using worksheets on students' self-regulated learning, a questionnaire was distributed. The results of the self-regulated learning questionnaire were then summarized by converting the actual scores obtained into qualitative assessment categories on a scale of 1–5. Further explanation is provided in Appendix Table 5, with criteria of very ineffective, ineffective, moderately

effective, effective, and very effective. Subsequently, a normality test was conducted using IBM SPSS 21 software to examine whether the data were normally distributed. The hypotheses used were as follows:

H_0 : The data follows a normal distribution

H_1 : The data does not follow a normal distribution

The significance level for the data is $\alpha = 0.05$, where the decision criterion is to reject H_0 if the significance value is less than $\alpha = 0.05$.

After conducting the normality test, hypothesis testing was performed using a one-sample t-test to assess the effectiveness of the developed Student Worksheet. The hypotheses are as follows:

a) If the value of $H_0 \leq 60$, it means that the learning tools with the realistic mathematics education approach are not effective for students' SRL.

b) If the value of $H_a > 60$, it means that the learning tools with the realistic mathematics education approach are effective for students' SRL.

The statistical test specified is as follows:

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

t : t-test value

\bar{x} : Average SRL test score of students

n : Number of students in the field trial class

s : Standard deviation

μ : Average value of students who achieve SRL with good criteria

The decision criterion is as follows:

H_0 is rejected if $t > 0$, and the value $\frac{\text{sig (2-tailed)}}{2} > \alpha$ with a significance level of $\alpha = 0,05$.

3. FINDINGS AND DISCUSSION

3.1 Analysis

3.1.1 Needs analysis

In the needs analysis stage, the researcher conducted interviews and classroom observations. This stage aimed to identify problems and factual conditions occurring in the school. The interview results revealed that teachers had never used worksheets as a learning medium. Teachers tended to rely on outdated teaching materials that had not been updated in accordance with students' needs, particularly in social arithmetic, where relevant real-life examples were still limited. The observation results indicated that learning remained teacher-centered, with no use of worksheets to guide students in becoming active participants during the learning process.

3.1.2 Material Analysis

In the material analysis stage, the researcher conducted an analysis of the subject matter based on the curriculum implemented at the research site, namely the 2013 Curriculum. The material analyzed was social arithmetic, with reference to the following basic competencies: (1) recognizing and analyzing various situations related to social arithmetic (sales, purchases, discounts, profit, loss, simple interest, percentage, gross, tare, and net weight); and (2) solving problems related to social arithmetic (sales, purchases, discounts, profit, loss, simple interest, percentage, gross, tare, and net weight). Subsequently, the analysis was extended to the characteristics of social arithmetic, which include the nature of the objects studied, truth based on logic, gradual and continuous learning, interrelation among different topics, the use of symbolic language, and duplication across other fields of study.

3.1.3 Analysis of Student Characteristics

The analysis of student characteristics was carried out through interviews and observations during the learning process. The interviews involved one teacher from each school that served as the research site. The results indicated that many students did not complete their assignments due to difficulties in understanding the material. The teachers further noted that the main obstacle lay in the use of abstract symbols, which were not familiar to the students. In addition, the limited availability of interactive learning tools—such as worksheets that provide simple and comprehensible examples—also contributed to the low level of interest in learning mathematics. The researcher’s observations revealed that classroom activities remained teacher-centered, while students tended to be passive and were not supported by appropriate learning tools. Even when teachers posed questions, most students still struggled to provide accurate answers.

3.2 Design

In the process of designing the worksheet, the researcher first analyzed the curriculum used by the school, namely the 2013 Curriculum, with a focus on the core material. Following this analysis, the researcher developed a map of student needs regarding the worksheet and created a worksheet framework that outlined the sequence of components, which included several core activities: “Let’s Understand,” “Let’s Reason,” and “Let’s Practice.” Furthermore, in compiling and designing the worksheet, several stages were undertaken to construct the concept of the worksheet using the realistic mathematics education approach. These stages included: (1) identifying reference books that could serve as sources for preparing the social arithmetic material. In this study, the researcher used several references, namely: a) Mathematics Textbook for the 2013 Curriculum, Revised Edition 2017, Semester 2. b) Module 6: Social Arithmetic, published by the Ministry of Education and Culture in 2020. c) Components of the worksheet (cover, introduction, learning instructions, main content, and conclusion).

3.3 Development

Development is the stage in which the designed worksheet is further developed. The worksheet that has been previously designed is refined and organized with reference to the characteristics of Realistic Mathematics Education (RME). It is also developed to provide facilities that enable students to engage in independent learning, through the inclusion of clear and comprehensible instructions. The worksheet incorporates several characteristics that reflect the principles of Realistic Mathematics Education, including the following:

3.3.1 Integrated

Integrated Learning refers to an instructional approach that connects the material to be studied with prerequisite or previously learned material. Through integrated learning, students are expected to understand the new content more effectively by reinforcing their prior knowledge.

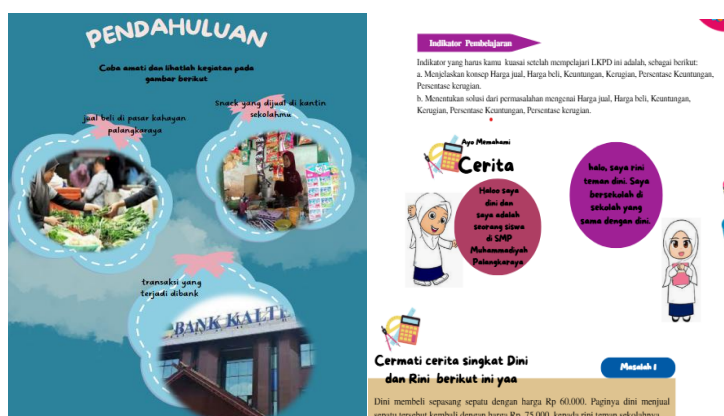


Figure 1. Integrated learning

3.3.2 Use of Context

The use of context in Realistic Mathematics Education (RME) refers to the deliberate integration of real-life activities, events, and situations into the process of learning mathematics. Rather than presenting mathematics as a set of abstract symbols and procedures, RME situates mathematical ideas within scenarios that are familiar and meaningful to students, allowing them to draw upon their prior knowledge and everyday experiences. Such contexts may include social interactions, household activities, or community events that students routinely encounter, which are then transformed into learning situations where mathematical reasoning is required. By embedding mathematical content into authentic and relatable experiences, students are encouraged to perceive mathematics as a human activity that naturally emerges from problem-solving in real-world settings.

In this study, the worksheet designed by the researcher incorporates contextual elements through the use of carefully constructed illustrations in the form of dialogues. These dialogues depict everyday conversations and activities that directly align with the topic of social arithmetic, such as buying and selling goods, calculating discounts, or determining profit and loss. This design choice not only makes the mathematical problems more engaging and accessible but also fosters a deeper level of comprehension, as students can more easily connect abstract concepts with concrete examples from their daily environment. Moreover, contextualization in the worksheet functions as a bridge that guides students from intuitive, experience-based reasoning toward more formal mathematical understanding. It also supports the development of self-regulated learning, as students are provided with opportunities to take ownership of their learning process, apply strategies independently, and reflect on the relevance of mathematics in their own lives. Thus, the incorporation of context within RME is not merely a teaching aid but a pedagogical strategy that enriches the learning experience, strengthens conceptual understanding, and enhances student motivation in learning mathematics.



Figure 2. Use of context

3.3.3 The process of mathematization and construction

The process of mathematization refers to the progression of mathematics from an informal stage to a formal one. In this activity, informal mathematics is introduced through illustrative examples that depict events related to students' everyday lives.



Figure 3. The process of mathematization and construction

In this activity, illustrations in the form of pictures and dialogues are no longer used, as the learning process has progressed to the stage of abstraction. At this stage, students are required to understand a problem by examining a given narrative and then connecting it to the mathematical content being studied.



Figure 4. Core activity “let’s practice”

The mathematization activities in the worksheet begin with informal mathematics, characterized by the use of illustrations in the form of dialogues and contexts related to students’ everyday experiences. Students are then guided toward formal mathematics, where they are able to solve more abstract problems by applying the formulas they have acquired. This process also indirectly facilitates the construction of knowledge.

3.3.4 Interactivity

The worksheet was developed and designed in such a way that can be completed by students either independently or individually. In the implementation of this study, the researcher employed the cooperative learning method. Cooperative learning provides opportunities for students to engage in discussion and collaboratively solve the problems presented in the worksheet.

3.4 Validation and Revision

3.4.1 Validation

Before being implemented in the classroom, the worksheet underwent a process of validation and revision. The validation was carried out by two expert lecturers from the Mathematics Education Study Program at Yogyakarta State University. Three aspects were assessed: content/material feasibility (10 sub-aspects), presentation appropriateness (7 sub-aspects), and language appropriateness (3 sub-aspects). Each sub-aspect was rated on a scale from 1 (minimum) to 5 (maximum), as further detailed in Appendix Table 6. The maximum total score was 100, and the validation results a total of 94, consisting of 48 for content/material feasibility, 33 for presentation appropriateness, and 13 for language appropriateness. Based on the categorization in Table 4, it can be concluded that the

worksheet falls into the “very good” category, within the interval of 83–99.4, indicating that the worksheet is highly valid and therefore suitable for trial implementation.

3.4.2 Revision

In the validation process, the validators provided suggestions and comments on the developed product. To improve its quality, the researcher carried out revisions based on the feedback given by the validators. After the revision stage, the product was subsequently tested in the classroom learning process, as presented in Table 7 below.

Table 2. Revisions Made to Improve the Student Worksheet Based on Realistic Mathematics Education Principles

No	Before Revision	After Revision
1.	The illustrative examples provided still do not contain a realistic context.	Changing the examples in the illustrations with familiar stories that often happen to students in their daily lives.
2.	Review the story problems in the student worksheet again so that the numbers are not too complicated.	Analyze and change the numbers in the story problems into whole numbers that are easy to calculate.
3.	The stages that are in accordance with the characteristics of Realistic Mathematics Education are further clarified.	Clarifying the stages, starting from situations, model of, model for, formal.

3.5 Results of Instrument Validity and Reliability Tests

The instruments used in this study must meet validity and reliability criteria. Validity was assessed based on validation scores by two mathematics education lecturers. Reliability was assessed by conducting a pilot test in a different class from the one used as the research subjects. The pilot test was grade VII D of Mts Muslimat NU, with a total of 29 students. Furthermore, the following is a presentation of the validity and reliability test results: The questionnaire consisted of 28 questions, consisting of both positive and negative statements. The instrument was considered valid if $r_{count} > r_{table}$. The validity test for the self-regulated learning questionnaire, consisting of descriptive questions, yielded 28 valid items and one item, number 29, was invalid.

After conducting the validity test on the questions and questionnaire, the researchers then conducted a reliability test to determine the level of reliability of the instrument. A reliability test conducted using Microsoft Excel software using the Cronbach's alpha formula yielded a total of 28 items, 35,372 item variances, and 2,458 total variances, with $r_{11} = 2.6611$, categorized as very high. Based on the coefficient category table, r_{11} was 0.982367, falling within the range of >1.000 , indicating very high. Based on these values, the self-regulated learning questionnaire is reliable and can be used for research trials. After the questionnaire was tested for reliability, the instrument was tested.

3.6 Implementation

In this study, the developed product was tested in two schools, namely MTs Muslimat NU Palangkaraya and SMP Muhammadiyah Palangkaraya. The data obtained from the implementation consisted of students' questionnaire responses to the worksheet. There were four learning themes covered across five sessions. The researcher also conducted classroom observations, and overall, more than 85% of the learning process was successfully implemented.

3.7 Evaluation

The evaluation stage was carried out to determine the practicality and effectiveness of the developed student worksheet. This process involved distributing a practicality response questionnaire to both students and mathematics teachers, with all collected data analyzed to assess whether the product met the established criteria for practicality and effectiveness.

The practicality questionnaires were administered in two schools—SMP Muhammadiyah Palangkaraya and MTs Muslimat NU Palangkaraya—with students serving as the primary respondents. The analysis of student responses yielded an average score of 45.083, which falls within the "good" category, indicating that the worksheet is practical and suitable for use in classroom learning. Additionally, the questionnaire was distributed to two mathematics teachers from the respective schools involved in the study. The teachers' responses produced an average score exceeding 29.4006, categorized as "very good," reinforcing the conclusion that the worksheet is highly practical for classroom implementation.

To evaluate the effectiveness of the worksheet in supporting students' self-regulated learning, a separate questionnaire was administered. This questionnaire included 28 items, consisting of 12 positive and 16 negative statements, across seven categories. The overall mean score from student responses was 65.16, and from 48 student participants, the average score reached 65.475, placing it within the "effective" category.

Further statistical analysis was conducted using a one-sample t-test to confirm these findings. A preliminary normality test indicated a significance value of 0.70, suggesting the data were normally distributed ($p > 0.05$). The subsequent t-test yielded a significance value of 0.001 ($p < 0.05$), leading to the rejection of the null hypothesis (H_0). This result supports the conclusion that the worksheet developed using the Realistic Mathematics Education approach is effective in enhancing students' self-regulated learning.

Discussion

This study aimed to develop a student worksheet grounded in the Realistic Mathematics Education (RME) approach, oriented toward fostering students' self-regulated learning, while meeting the criteria of being valid, practical, and effective. According to Plomp and Nieveen (2013), a valid learning device must contain consistently interconnected and current materials, while Nieveen (1999) emphasized that validity also entails a sound theoretical foundation. The results of the validation process in this study indicated that the worksheet achieved a high level of validity, with an average score of 83.994 across content, media, and language dimensions. These findings place the worksheet in the "very good" category, signifying that it has a strong foundation for supporting meaningful learning. However, several aspects required improvement, such as the contextualization of illustrations and the clarity of RME stages—including the transitions from situational problems to formal mathematical thinking. These weaknesses suggest that although the product is theoretically sound, iterative revisions are essential before broader implementation, particularly to enhance its connection to students' real-world experiences and improve the scaffolding of mathematical reasoning through the RME stages of "situation," "model of," "model for," and "formal."

In terms of practicality, the worksheet was tested in two schools and evaluated through questionnaires administered to both students and teachers. The responses demonstrated that the worksheet was easy to use and effective in facilitating student engagement, particularly when applied to the topic of social arithmetic. Teachers reported that the worksheet supported the instructional process, while students responded positively to the design and clarity of the tasks. Nonetheless, classroom observations revealed that some students still required guidance at the early stages of using the worksheet, indicating that full independence was not immediately achieved. This implies that while the worksheet is practically implementable, its success is influenced by the preparedness and pedagogical understanding of teachers, especially regarding the philosophy and facilitation strategies embedded in RME. To address this limitation, it is recommended that future implementations be

supported with a comprehensive teacher's guidebook and professional development sessions that deepen teachers' familiarity with RME principles and strategies for promoting student autonomy.

The effectiveness of the worksheet was evaluated over 7–8 instructional sessions focused on social arithmetic, using both observation and student performance data. Teachers facilitated the lessons and ensured that students were actively engaged in completing the worksheet tasks. Post-implementation analysis revealed significant improvements in students' academic performance and self-regulated learning behaviors. Prior to the intervention, many students had difficulty meeting the minimum mastery criteria and frequently failed to submit assignments on time. After using the worksheet, there was a notable increase in the number of students achieving the minimum learning standards, and assignment submission rates reached 100%. These findings indicate that the structured and contextual nature of the RME-based worksheet effectively supports students' independent learning, particularly by providing clear instructions, relatable examples, and scaffolded activities that encourage step-by-step reasoning. However, the effectiveness of the worksheet can still be enhanced by addressing the diverse learning needs of students. Future research should consider integrating a wider range of problem types with varying difficulty levels, so that low-achieving students receive adequate support while high-achieving students remain challenged and engaged.

The findings of this study are supported by similar research in the field. Siregar et al. (2023) found that students' self-regulated learning improved significantly when instruction was based on the RME approach, with 95.68% of students expressing positive responses toward the learning experience. This supports the present study's conclusion that RME-based learning tools are effective in cultivating students' ability to manage and direct their own learning. Additionally, Chandra and Hidayati (2023) developed a similar student worksheet for elementary school students using the RME approach. Their product achieved high validity (validator score: 89) and was rated as practical and effective, with a response score of 105 and an N-Gain score of 75%, categorized as "very effective." These studies collectively reinforce the argument that RME-based instructional materials, when thoughtfully designed and implemented, can substantially enhance both engagement and learning outcomes across educational levels.

In summary, this study demonstrates that student worksheets developed using the Realistic Mathematics Education approach can serve as valid, practical, and effective tools to support self-regulated learning, particularly in social arithmetic topics. While the results are promising, the success of such instructional tools depends on continuous refinement, teacher readiness, and sensitivity to student diversity. Future research should explore long-term implementation, digital adaptations, and cross-grade applicability to maximize the potential of RME-based worksheets in improving mathematics education.

4. CONCLUSION

This study successfully developed a student worksheet based on the Realistic Mathematics Education (RME) approach, designed to foster students' self-regulated learning in social arithmetic. The development process followed five key phases—Analyze, Design, Develop, Implement, and Evaluate—resulting in a worksheet that was validated as highly valid (score: 94/100), very practical by teachers (31.5/35), practical by students (44.95/60), and effective in promoting self-regulated learning (average score: 65.16/100; $p = 0.001 < 0.05$). The worksheet facilitated student engagement, conceptual understanding, and independent learning by incorporating real-life examples and clear instructions. However, the study faced limitations, including extended instructional time due to discussions and the conventional format of the worksheet, which lacked digital adaptability and required significant preparation to align with students' characteristics. Future research is recommended to explore the long-term impact of RME-based worksheets on self-regulated learning across different educational levels and to develop digital versions to support broader implementation and inclusivity in modern learning environments.

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