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Tiara Az zahra, Redi Hermanto, Dedi Nurjamil

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Development of Realistic Mathematics Education (RME) Based Student Worksheets to Facilitate Junior High School Students' Mathematical Reasoning Ability

Tiara Az zahra[1], Redi Hermanto[1*], Dedi Nurjamil[1]

[1]Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Siliwangi

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ABSTRACT

Junior high school students' mathematical reasoning ability still needs improvement, particularly in presenting mathematical information, formulating conjectures, applying concepts logically, evaluating the validity of arguments, and drawing conclusions. Therefore, this study aimed to develop a Realistic Mathematics Education (RME)-based Student Worksheet (SW) on statistics for eighth-grade junior high school students that is valid, practical, and limitedly effective in facilitating students' mathematical reasoning ability. This study employed a Research and Development (R&D) method using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The research participants included two material experts, two media experts, 10 students in a small-group trial, and 25 eighth-grade students of SMP Negeri 13 Tasikmalaya in a field trial. Data were collected through interviews, validation sheets, student response questionnaires, and mathematical reasoning ability tests. The data were analyzed using descriptive quantitative and qualitative techniques. The results showed that the developed worksheet achieved a validity score of 88% from material experts and 95% from media experts, both categorized as highly valid. The practicality test indicated a student response rate of 91.5%, categorized as highly practical. The product's effectiveness was evaluated on a limited basis through a mathematical reasoning ability test, which showed a classical mastery level of 80%. These findings indicate that the RME-based Student Worksheet can facilitate students' mathematical reasoning ability in learning statistics. Therefore, the developed worksheet is feasible to be used as an alternative teaching material that supports contextual and student-centered mathematics learning.

Corresponding Author:

Redi Hermanto,
Mathematics Education Study Program,
Faculty of Teacher Training and Education,
Universitas Siliwangi
Siliwangi Street No. 24, Kahuripan, Tasikmalaya City 46115, West Java, Indonesia
✉ redihermanto@unsil.ac.id

Introduction

Mathematics is one of the subjects that plays an important role in developing students' logical, critical, systematic, and creative thinking skills. In mathematics learning, mathematical reasoning is considered an essential competency because it is closely related to students' ability to formulate conjectures, construct arguments, verify the validity of statements, and draw logical conclusions (NCTM, 2000; Sumarmo, 2013). Mathematical reasoning also supports deeper conceptual understanding, enabling students not only to memorize procedures but also to understand relationships among mathematical concepts and apply them in various situations (Lithner, 2008). At the junior high school level, mathematical reasoning is particularly important in statistics learning, where students are required to read, interpret, analyze, and draw conclusions from information presented in the form of tables, graphs, and contextual data (OECD, 2023). Therefore, mathematics instruction should be designed to provide students with opportunities to develop their mathematical reasoning abilities optimally.

However, numerous studies have indicated that Indonesian students' mathematical reasoning abilities remain relatively low. The results of the 2022 Programme for International Student Assessment (PISA) revealed that Indonesian students' mathematical literacy performance was still below the average of OECD member countries, particularly in reasoning, mathematical modeling, and solving non-routine problems (OECD, 2023). Isnaeni et al. (2018) found that students experienced difficulties in constructing mathematical arguments and providing justifications for their solution strategies. Similar findings were reported by Hendriana et al. (2021) who stated that students' abilities to present logical reasoning and draw mathematical conclusions still require improvement. In statistics learning, students often encounter difficulties in interpreting data, identifying patterns, and drawing conclusions based on available information. These findings indicate that students' mathematical reasoning abilities require greater attention in mathematics instruction. Furthermore, several studies have shown that junior high school students' mathematical reasoning abilities generally fall within the low to moderate categories, particularly regarding indicators such as providing logical justification, constructing mathematical arguments, and drawing conclusions from available information. As a result, students often struggle to solve non-routine problems and connect mathematical concepts with real-life situations (Fitriani & Maulana, 2021).

One factor that may contribute to students' low mathematical reasoning ability is the teaching materials used in the learning process. Based on classroom observations and interviews with an eighth-grade mathematics teacher at SMP Negeri 13 Tasikmalaya, the student worksheets currently used are dominated by routine exercises that emphasize formulas and procedural solution methods. In addition, interviews with several students revealed that they tend to focus on obtaining answers directly without explaining the reasoning behind their solution processes or drawing conclusions from the results obtained. This condition indicates that learning activities facilitated through the existing worksheets have not provided sufficient opportunities for students to develop the ability to formulate conjectures, construct arguments, verify solutions, and draw conclusions independently. Consequently, students tend to rely heavily on examples provided by teachers and encounter difficulties when faced with problems requiring mathematical reasoning. This finding is consistent with Prastowo, (2019) who argued that effective teaching materials should provide opportunities for students to explore, reflect, and construct knowledge independently. Therefore, there is a need to develop student worksheets that not only focus on procedural problem-solving but also facilitate students' mathematical reasoning processes. Developing worksheets that encourage students to provide explanations, formulate conjectures, and draw conclusions is essential because these activities

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constitute integral components of mathematical reasoning. Contextual and student-centered worksheets can provide broader opportunities for students to actively construct their own knowledge (Gea et al., 2025).

One instructional approach considered suitable for facilitating students' mathematical reasoning ability is Realistic Mathematics Education (RME). Freudenthal, (1991) viewed mathematics as a human activity; therefore, mathematics instruction should begin with problems closely related to students' daily lives. Within the RME approach, students are encouraged to engage in mathematization processes through exploration, modeling, discussion, and reflection, enabling mathematical concepts to be discovered and constructed meaningfully (Gravemeijer, 1994). These characteristics align closely with the indicators of mathematical reasoning because students are trained to formulate conjectures, provide justifications, evaluate arguments, and draw conclusions based on their analyses. Previous studies have demonstrated that the implementation of RME can improve mathematical thinking, problem-solving skills, and mathematical reasoning through contextual and student-centered learning experiences (Wijaya, 2012; Prahmana, 2017; Gravemeijer, 2020). Therefore, integrating RME principles into student worksheets has the potential to create more contextual, active, and meaningful mathematics learning. Recent studies have also shown that student worksheets developed using the realistic mathematics approach can support students in developing mathematical reasoning abilities through contextual activities closely related to everyday life (Nazwani et al. 2025).

Numerous studies have developed RME-based student worksheets in mathematics education and reported positive impacts on learning quality. However, most of these studies have focused on improving learning outcomes, conceptual understanding, or mathematical problem-solving abilities (Wandari et al., 2018; Zulkardi & Putri, 2019; Meika et al., 2023). Research on worksheet development specifically oriented toward mathematical reasoning ability remains limited, and further studies are needed to explicitly integrate mathematical reasoning indicators into RME-based worksheets for statistics learning (Wati et al., 2024). Studies specifically developing RME-based student worksheets to facilitate junior high school students' mathematical reasoning abilities in statistics are still relatively scarce. Moreover, few studies have systematically integrated mathematical reasoning indicators into worksheet activities involving realistic contexts, exploration, discussion, and student reflection. Based on these conditions, the novelty of this study lies in the development of an RME-based Student Worksheet specifically designed to facilitate junior high school students' mathematical reasoning abilities in statistics learning. This study aims to produce a Student Worksheet that is valid, practical, and effective, thereby providing an alternative teaching material that supports meaningful mathematics learning and promotes the development of students' mathematical reasoning abilities.

Method

Research Design and Participants

This study employed a Research and Development (R&D) approach aimed at developing a Realistic Mathematics Education (RME)-based Student Worksheet (SW) to facilitate students' mathematical reasoning ability and to evaluate the feasibility of the developed product. The development process followed the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation (Lee & Owens, 2004). During the analysis stage, observations, interviews, and a preliminary study were conducted to identify learning needs and existing problems in mathematics instruction. The design stage involved designing the RME-based Student Worksheet and developing the research instruments. In the development stage, the product was created and subsequently validated by subject matter

experts and media experts. The implementation stage consisted of small-group and field trials, while the evaluation stage involved revising the product based on feedback obtained from the validation process and field implementation.

The study was conducted at SMP Negeri 13 Tasikmalaya, Indonesia. The participants consisted of two subject matter experts, two media experts, a mathematics teacher, and eighth-grade students. The small-group trial involved 10 students to obtain feedback regarding the usability, appearance, and readability of the worksheet. After revision, the product was implemented in a field trial involving 25 eighth-grade students. Participants were selected using purposive sampling based on the needs of the study. The research instruments included product validation sheets, instrument validation sheets, student response questionnaires, and a mathematical reasoning ability test. Instrument validation was conducted prior to data collection, while product validation was carried out to determine the feasibility of the developed worksheet. The mathematical reasoning ability test consisted of five essay questions developed based on the indicators of mathematical reasoning, namely: presenting mathematical statements, formulating conjectures, applying concepts or rules logically, evaluating the validity of arguments, and drawing conclusions or generalizations. Student responses were assessed using a scoring rubric validated by experts. Data were analyzed using descriptive quantitative techniques to determine the validity, practicality, and limited effectiveness of the developed worksheet. Validity was determined from expert evaluations, practicality was measured through student response questionnaires, and limited effectiveness was assessed based on students' mathematical reasoning achievement and classical learning mastery after using the developed worksheet.

Instruments

The instruments used in this study included interview guidelines, material expert validation sheets, media expert validation sheets, student response questionnaires, and a mathematical reasoning ability test. The interview guidelines were employed during the needs analysis stage to obtain information regarding the existing conditions of mathematics learning and the need for developing an RME-based Student Worksheet (Sugiyono, 2020).

The material expert and media expert validation sheets were used to evaluate the feasibility of the developed worksheet. Material validation focused on content quality and instructional objectives, whereas media validation emphasized instructional quality and presentation aspects (Yusoff, 2019). Student response questionnaires were administered to determine the practicality of the worksheet after its implementation in classroom learning. All validation sheets and questionnaires employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Joshi et al.,2015).The instrument specifications for expert validation and student response questionnaires are presented in Tables 1, 2, and 3.

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Table 1. Material Expert Validation Blueprint

No.	Content and Objectives Quality Criteria	Statement Indicators	Number of Items
1	Accuracy	The material is aligned with the Learning Outcomes (CP) and Learning Objectives (TP), and statistical concepts are presented correctly.	3
2	Relevance	The material supports the achievement of the learning objectives.	2
3	Completeness	The material and worksheet activities are presented comprehensively.	3
4	Balance	Balance among the material, examples, and exercises.	1
5	Interest and Attention	The material is able to attract students' attention.	1
6	Suitability to Students' Characteristics	The material is appropriate to students' characteristics and developmental level.	2
Total			12

Table 2. Media Expert Validation Blueprint

No.	Instructional Quality Criteria	Statement Indicators	Number of Items
1	Providing Learning Opportunities	The worksheet encourages students to actively learn and discover concepts.	2
2	Providing Learning Assistance	Instructions and guidance in the worksheet are easy to understand.	2
3	Motivational Quality	The appearance and activities of the worksheet enhance students' learning motivation.	2
4	Instructional Flexibility	The worksheet is easy to use in various learning situations.	3
5	Social Interaction Quality	The worksheet supports student discussion and interaction.	1
6	Assessment and Evaluation Quality	The tasks and activities are aligned with the learning objectives.	2
7	Impact on Students	The worksheet helps students understand the material and develop mathematical reasoning ability.	3
Total			15

Table 3. Student Response Questionnaire Blueprint

No.	Instructional Quality Criteria	Sample Statement	Number of Items
1	Providing Learning Opportunities	The worksheet helps me discover statistical concepts independently.	2
2	Providing Learning Assistance	The instructions in the worksheet are easy to understand.	2
3	Motivational Quality	The worksheet makes me more interested in learning mathematics.	2
4	Instructional Flexibility	The worksheet is easy to use during the learning process.	3
5	Social Interaction Quality	The worksheet helps me discuss ideas with my classmates.	1
6	Assessment and Evaluation Quality	The tasks in the worksheet are relevant to the material being studied.	2
7	Impact on Students	The worksheet helps me understand and reason about statistical concepts.	3
Total			15

The mathematical reasoning ability test was administered to determine students' achievement in mathematical reasoning after using the Realistic Mathematics Education (RME)-based Student Worksheet. The test consisted of five essay questions developed based on the indicators of mathematical reasoning ability, namely presenting mathematical statements, formulating conjectures, applying concepts or rules logically, evaluating the validity of arguments, and drawing conclusions. Prior to implementation, the test instrument was validated by two mathematics education experts and one mathematics teacher to assess content appropriateness, language clarity, and the suitability of the cognitive level for the characteristics of the students.

Table 4. Mathematical Reasoning Ability Test Blueprint

No.	Mathematical Reasoning Indicator	Learning Objective	Item Type
1	Presenting mathematical statements	Representing a problem in the form of a table or mathematical representation.	Essay
2	Formulating conjectures	Making conjectures based on the available information.	Essay
3	Applying concepts or rules logically	Determining the mean value and performing calculations accurately.	Essay
4	Evaluating the validity of arguments	Assessing the correctness of solution procedures and obtained results.	Essay
5	Drawing conclusions or generalizations	Drawing conclusions based on data analysis results.	Essay

Student responses were assessed using an analytic scoring rubric with a score range of 0–4 for each indicator. A score of 0 was assigned when a student provided no relevant response, whereas a score of 4 was assigned when the student provided a correct, complete, and logical response in accordance with the measured indicator. Since the test consisted of five essay items, the maximum possible score was 20. The obtained scores were then converted to a scale of 0–100 using the following formula:

$$Score = \frac{Obtained\ Score}{20} \times 100$$

Data Collection

Data were collected through interviews, product validation, student response questionnaires, and a mathematical reasoning ability test. Interviews were conducted during the needs analysis stage with an eighth-grade mathematics teacher at SMP Negeri 13 Tasikmalaya to obtain information regarding the current conditions of mathematics learning, the teaching materials used, students' mathematical reasoning abilities, and challenges encountered during the learning process. The interview results served as the basis for developing the Realistic Mathematics Education (RME)-based Student Worksheet.

Product validation was conducted to determine the feasibility of the worksheet before it was implemented with students. The validation process involved material experts and media experts who assessed the product using validation questionnaires. Material validation focused on content appropriateness, learning objectives, and the alignment of the material with mathematical reasoning indicators. Meanwhile, media validation emphasized aspects of visual appearance, readability, ease of use, and worksheet presentation. The validation results were used as the basis for revising and improving the developed product. In addition, student response questionnaires were administered to determine the practicality of the worksheet after

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its implementation in classroom learning. The questionnaires were distributed after the implementation stage and evaluated several aspects, including ease of use, learning motivation, support in understanding the material, learning interaction, and the benefits of the worksheet for students' learning processes.

The mathematical reasoning ability test was administered to evaluate the effectiveness of the RME-based Student Worksheet in facilitating students' mathematical reasoning abilities. The test was conducted after students completed learning activities using the developed worksheet. It consisted of essay questions designed based on the indicators of mathematical reasoning, namely presenting mathematical statements, formulating conjectures, applying concepts logically, evaluating the validity of arguments, and drawing conclusions. The test results were analyzed based on students' classical learning mastery.

Data Analysis

Data analysis was conducted to determine the validity, practicality, and effectiveness of the developed Realistic Mathematics Education (RME)-based Student Worksheet. The research data were obtained from material expert validation, media expert validation, student response questionnaires, and mathematical reasoning ability tests. The data obtained from expert validation and student response questionnaires were analyzed quantitatively using the following percentage formula:

$$NP = \frac{R}{SM}\ x\ 100\%$$

Notes:

NP = Percentage Score

R = Total Score obtained

SM = Maximun Possible Score

The resulting percentages were then interpreted according to the validity and practicality criteria adapted from Rahman et al. (2019). Student response questionnaire data were analyzed using a Likert scale to determine the practicality level of the RME-based Student Worksheet.

Table 5. Validity and Practicality Criteria of the Student Worksheet

Percentage	Validity Interpretation	Practicality Interpretation
80% < x ≤ 100%	Highly Valid	Highly Practical
60% < x ≤ 80%	Valid	Practical
40% < x ≤ 60%	Moderately Valid	Moderately Practical
20% < x ≤ 40%	Less Valid	Impractical
0% < x ≤ 20%	Very Less Valid	Highly Impractical

The effectiveness of the worksheet was evaluated based on students' mathematical reasoning ability test results using the classical mastery percentage. Students were considered to have achieved mastery if they obtained a score of at least 75. The percentage of classical mastery was calculated using the following formula:

$$\text{CM} = \frac{Number\ of\ Students\ Achieving\ Mastery}{Total\ Number\ of\ Students} \times 100\%$$

Notes:
CM : Classical Mastery Percentage
The developed product was considered effective if at least 75% of students achieved learning mastery.

Table 6. Classical Mastery Criteria

Percentage	Interpretation
≥ 75%	Effective
< 75%	Not Effective

Research Findings

This study produced a Realistic Mathematics Education (RME)-based Student Worksheet (SW) on statistics for eighth-grade junior high school students to facilitate their mathematical reasoning ability. The worksheet was developed using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The developed product incorporates contextual learning activities that are aligned with students' characteristics, enabling them to develop a more meaningful understanding of mathematical concepts. During the analysis stage, interviews were conducted with an eighth-grade mathematics teacher at SMP Negeri 13 Tasikmalaya. The interview results revealed that mathematics instruction still relied primarily on conventional teaching materials and had not optimally facilitated students' mathematical reasoning abilities. Students experienced difficulties in understanding statistical concepts and solving problems that required mathematical reasoning. Most students tended to solve problems by imitating examples provided by the teacher without understanding the underlying concepts or the rationale for using particular formulas. Therefore, an RME-based Student Worksheet was developed to support students in learning statistics through contextual problems closely related to their daily lives.

The design stage involved developing the structure of the Student Worksheet, which consisted of a cover page, learning outcomes, learning objectives, usage instructions, contextual learning activities, practice exercises, and self-reflection sections. The worksheet was designed according to the principles of Realistic Mathematics Education, including the use of realistic contexts, mathematical models, student contributions, interaction, and the interconnection of mathematical concepts. The worksheet layout was designed using attractive color combinations, illustrations, and a systematic organization to enhance students' learning motivation. Furthermore, each activity in the worksheet was designed to promote indicators of mathematical reasoning ability. Students were encouraged to represent data in tables and graphs, formulate conjectures based on available information, and draw conclusions from data analysis. In the self-reflection section, students recorded their learning experiences and difficulties encountered during the learning process, enabling teachers to gain deeper insights into students' conceptual understanding.

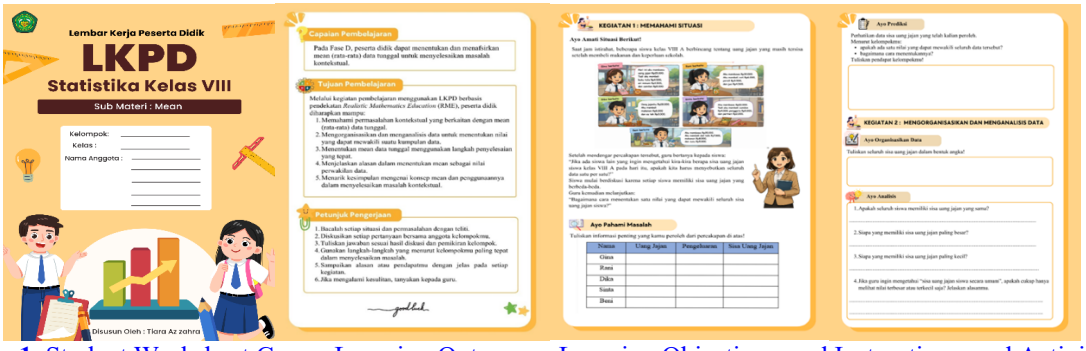

Figure 1. Student Worksheet Cover, Learning Outcomes, Learning Objectives, and Instructions, and Activity

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At the development stage, the completed worksheet was validated by material experts and media experts to determine its feasibility before implementation. The validation results indicated that the RME-based Student Worksheet was categorized as highly valid.

Table 7. Results of Material and Media Expert Validation

Aspect	Percentage (%)	Category
Material Expert	88	Highly Valid
Media Expert	95	Highly Valid
Average	91.5	Highly Valid

As shown in Table 7, the validation results demonstrated that the worksheet met the criteria of content appropriateness, presentation quality, readability, and media design. The material experts confirmed that the worksheet content was aligned with the learning outcomes and indicators of mathematical reasoning ability. Meanwhile, the media experts stated that the worksheet was visually appealing, easy to use, and systematically organized. Several suggestions were provided, including improving the layout design, simplifying language usage, and refining contextual illustrations to make them more accessible to students. Revisions were made accordingly before the implementation stage.

The implementation stage consisted of a small-group trial and a field trial involving eighth-grade students. The small-group trial was conducted to obtain students' initial responses to the developed worksheet, whereas the field trial aimed to evaluate its practicality in classroom learning. The results indicated that the worksheet was categorized as highly practical.

Table 8. Trial Results

Trial Stage	Percentage (%)	Category
Small-Group Trial	96	Highly Practical
Field Trial	83	Highly Practical

Based on Table 8, students responded positively to the use of the RME-based Student Worksheet in mathematics learning. Students reported that the worksheet helped them understand statistical concepts through contextual problems related to their daily experiences. In addition, the learning activities encouraged students to engage actively in discussions, formulate conjectures, organize data, and draw conclusions. During the learning process, students appeared more active in expressing their ideas and collaborating with peers. They were able to represent data accurately in tables and graphs and provide logical justifications for their solutions. Several students were also able to explain the problem-solving process using their own words when presenting the results of group discussions.

The self-reflection responses further indicated that most students found mathematics learning easier to understand because the problems were connected to real-life situations. Students also reported increased interest and motivation in learning mathematics due to the attractive design and varied activities provided in the worksheet. The effectiveness of the worksheet was evaluated through students' mathematical reasoning ability test administered after the implementation of the RME-based Student Worksheet. The results showed that most students achieved the minimum mastery criterion (score ≥ 75), indicating that the worksheet was effective in facilitating students' mathematical reasoning ability.

Table 9. Mathematical Reasoning Ability Test Results

Criteria	Results
Number of Students Achieving Mastery	20
Mastery Percentage (%)	80
Category	Effective

As presented in Table 9, students demonstrated the ability to present mathematical statements, formulate conjectures, apply concepts logically, evaluate the validity of arguments, and draw conclusions in accordance with the indicators of mathematical reasoning ability. Students were able to connect statistical data with relevant concepts to solve problems accurately. Furthermore, students' written work indicated that most students were capable of providing logical explanations for their answers and describing their solution processes systematically. Rather than merely presenting final answers, students demonstrated the steps involved in solving problems and justified the formulas they used. These findings suggest that the implementation of the RME-based Student Worksheet helped students develop a more meaningful understanding of mathematical concepts through contextual and interactive learning activities. Overall, the findings indicate that the developed Realistic Mathematics Education (RME)-based Student Worksheet met the criteria of validity, practicality, and effectiveness. Therefore, it is feasible to be used as an alternative teaching material for statistics learning to facilitate junior high school students' mathematical reasoning ability.

Discussion

The findings of this study indicate that the developed Realistic Mathematics Education (RME)-based Student Worksheet met the criteria of validity, practicality, and limited effectiveness in facilitating students' mathematical reasoning ability. The high level of validity suggests that the worksheet is appropriate in terms of content, presentation, language, and media design. The validators confirmed that the material was aligned with the learning outcomes, students' characteristics, and the indicators of mathematical reasoning ability. Furthermore, the use of realistic contexts in the worksheet helped students develop a more meaningful understanding of statistical concepts because the learning activities were connected to situations encountered in everyday life. This finding is consistent with the principles of Realistic Mathematics Education proposed by Gravemeijer, (2020) which emphasize that mathematics learning should begin with realistic contexts that enable students to construct mathematical concepts through a process of mathematization from informal situations to formal mathematical ideas.

The practicality of the worksheet was demonstrated by students' responses, which fell within the highly practical category. During the learning process, students actively participated in discussions, expressed their ideas, and solved contextual problems presented in the worksheet. These activities are consistent with the characteristics of the RME approach, which positions students as active participants in constructing their own knowledge. The findings of this study support those of Fitriani & Maulana, (2021), who reported that RME-based worksheets could enhance students' engagement in mathematics learning. However, unlike previous studies, the present study specifically focused on developing a worksheet for statistics learning that was intentionally designed to facilitate the indicators of mathematical reasoning ability.

The results of the mathematical reasoning ability test showed that students achieved a classical mastery level of 80%. This result indicates that most students were able to successfully complete mathematical reasoning tasks after using the RME-based Student Worksheet. An analysis of students' responses revealed that the most noticeable improvements occurred in their ability to present mathematical statements, formulate conjectures, apply concepts logically, evaluate the validity of arguments, and draw conclusions. Through contextual learning activities, students were able to transform contextual information into structured data, make predictions based on available information, calculate the mean systematically, evaluate the consistency of their results with their initial conjectures, and draw conclusions from the

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analyzed data. These findings suggest that the activities provided in the worksheet offered students opportunities to engage in various aspects of mathematical reasoning throughout the learning process.

The findings of this study also support those of Wandari et al. (2018) who argued that the realistic mathematics approach helps students understand mathematical concepts through meaningful and interactive learning activities. Furthermore, the results reinforce the view that the use of realistic contexts in mathematics instruction can facilitate students' mathematical reasoning abilities. In the present study, the contextual situations incorporated into the worksheet enabled students to connect statistical concepts with their everyday experiences. Consequently, the learning process focused not only on computational procedures but also on reasoning and mathematical thinking processes. Nevertheless, the findings of this study should be interpreted with caution. The effectiveness of the developed worksheet was examined on a limited basis through students' mathematical reasoning test results and classical mastery achievement after using the worksheet. The study did not employ a pretest–posttest design or a control group; therefore, it cannot provide comparative evidence regarding improvements in students' mathematical reasoning ability. In addition, the number of participants was relatively small, and the field trial was conducted in only one school, which limits the generalizability of the findings. Future studies are recommended to involve larger samples, employ experimental research designs, and conduct longitudinal evaluations to provide a more comprehensive understanding of the effects of RME-based Student Worksheets on students' mathematical reasoning ability.

Conclusion

This study developed a Realistic Mathematics Education (RME)-based Student Worksheet (SW) on statistics for eighth-grade junior high school students that met the criteria of validity, practicality, and limited effectiveness in facilitating students' mathematical reasoning ability. The expert validation results indicated that the developed worksheet was categorized as highly valid, with an average validity score of 91.5%, while students' responses demonstrated that the worksheet was highly practical. Furthermore, the results of the mathematical reasoning ability test showed a classical mastery percentage of 80%, indicating that most students were able to successfully complete mathematical reasoning tasks after using the developed worksheet. The implementation of the RME-based Student Worksheet provided students with opportunities to develop various aspects of mathematical reasoning, including presenting mathematical statements, formulating conjectures, applying concepts or rules logically, evaluating the validity of arguments, and drawing conclusions based on contextual problems. Therefore, the developed worksheet can serve as an alternative teaching material that supports more active, contextual, and student-centered mathematics learning.

Despite these promising findings, this study has several limitations. First, the product trial involved a relatively small number of participants and was conducted in only one school. Second, the study did not employ a control group or comparison class, making it difficult to compare the results with those obtained through other instructional materials. Third, the effectiveness of the worksheet was evaluated on a limited basis through students' post-test performance and classical mastery achievement; therefore, it does not provide a comprehensive measure of improvement in mathematical reasoning ability. In addition, no long-term evaluation was conducted to examine the sustainability of students' mathematical reasoning development. Based on these limitations, future research is recommended to involve larger and more diverse samples, employ a pretest–posttest design, and include a control group or comparison class to obtain stronger evidence regarding the effectiveness of RME-based Student

Worksheets. Future studies may also examine improvements in mathematical reasoning ability using N-Gain analysis or other measures of learning improvement. Furthermore, the development of RME-based Student Worksheets for different mathematics topics is recommended to provide a broader understanding of their implementation and effectiveness in mathematics education.

Conflict of Interest

The authors declares that there is no conflict of interest.

Auhor Contributions

T.A. conceived the research idea and was responsible for data collection. R.H. and D.N. made significant contributions to the development of the theoretical framework and methodology, as well as to data organization, data analysis, interpretation of findings, manuscript preparation, and final approval of the manuscript. All authors have reviewed and approved the final version of this article. The distribution of contributions to the conceptualization, writing, and revision of this study was as follows: T.A.: 60%, R.H.: 20%, and D.N.: 20%.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author, R.H., upon reasonable request.

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Authors Biography

	**Tiara Az zahra** is a student in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Siliwangi, Tasikmalaya, West Java, Indonesia. ✉ tiaraazzahra3344@gmail.com
	**Redi Hermanto** is a lecturer in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Siliwangi, Tasikmalaya, West Java, Indonesia. His teaching and research interests include mathematical thinking processes, micro teaching, mathematics computer applications, selected topics in secondary school mathematics, information technology, and mathematics learning media. ✉ redihermanto@unsil.ac.id
	**Dedi Nurjamil** is a lecturer in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Universitas Siliwangi, Tasikmalaya, West Java, Indonesia. His academic interests include educational management, philosophy and history of mathematics, number theory, mathematics lesson planning, and mathematics education seminars. ✉ dedinurjamil@unsil.ac.id