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Development of geometry teaching materials based on RME in the context of the *perahu baganduang* tradition

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Abstract

This research aims to improve the mathematical communication skills of grade V elementary school students in mathematics subjects through geometry teaching materials based on Realistic Mathematics Education (RME) with the context of *perahu baganduang*. This teaching material was developed on building flat and curved side spaces by emphasizing the relationship of mathematical concepts with daily life, so that abstract ideas are easier to understand. The research uses the Plomp model development method, which consists of three stages, namely preliminary research, prototyping phase, and assessment phase. In the initial stage, literature studies, curriculum analysis, and student needs are identified. Furthermore, the prototype of teaching materials that includes teacher books and student books is validated by three validators, then tested through one-to-one, small groups, and revisions according to field input. The final stage is in the form of a large group trial to assess the practicality and effectiveness of the teaching materials. The validation results show an average score of 0.89 (very valid). The practicality test obtained a score of 94.22% from students and 98.13% from teachers in small groups, as well as 95.8% from students and 99.16% from teachers in large groups (very practical). Effectiveness was shown through the N-Gain test of 0.8 (high category) with a percentage of 82.6% (effective). The score of mathematical communication ability increased from 45.6 (pretest) to 88.3 (posttest) with an average increase of 42.78 (sufficient category). Thus, RME-based geometry teaching materials in the context of baganduang boats have proven to be valid, practical, and effective in improving mathematical communication of elementary school students.

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1. Introduction

Geometry is one of the branches of mathematics related to shapes, sizes, and positioning (Damayanti & Sukmawarti, 2022; Sriwanti & Sukmawarti, 2022). Geometry is a branch of mathematics that studies shapes, sizes, structures, and spaces, including points, lines, planes, angles, and various other geometric objects along with their relationships and properties, which is basically the study of the relationships and properties of shapes, spaces, and sizes as described in the theory of the level of understanding of geometry (Kurniasih, 2017; Nur'aini et al., 2017). In the context of elementary school, geometry education aims to help students understand the physical world around them, develop spatial thinking skills, and introduce basic mathematical concepts

Geometry learning in elementary schools is not merely about memorizing formulas and theories, but also about building a solid understanding of geometric concepts and applying them in various contexts. Preliminary studies indicate that there are challenges in teaching geometry to elementary students. Learners tend to be introduced directly to the use of formulas without engaging in the discovery of the concepts themselves, and instruction is often detached from students' everyday experiences (Amaliyah et al., 2022). In addition, the content presented is generally abstract and not connected to students' real-life contexts, let alone their local culture.

Geometry learning is considered one of the most difficult areas of mathematics for students to understand. It is not easy to master, and many students struggle to grasp geometric concepts, theorems, and the ability to solve geometry word problems (Budiarto & Artiono, 2019). Several factors contribute to these difficulties. One of the main causes is that geometry instruction still tends to focus on memorizing facts and concepts, practicing computational aspects, and applying formulas (Fauzan et al., 2013; Hermita et al., 2022) . This occurs because the learning designs created by teachers often fail to take into account students' abilities, the content of the material, students' cognitive processes, as well as the methods and learning resources used (Alim et al., 2020; de Vink et al., 2023).

In school learning, particularly in elementary geometry instruction, teachers often rely heavily on textbooks. However, textbooks frequently provide limited support in helping students construct their own understanding of geometric concepts. The quality of textbooks significantly affects student learning outcomes, Achievement, and teaching effectiveness (Ozturk et al., 2023; Ulusoy & Turuş, 2022), as they play a crucial role in both students' learning and teachers' instruction (Alim et al., 2021). Nevertheless, teachers tend to depend on mathematics textbooks when designing classroom instruction (Yunianta et al., 2023), which may limit opportunities for students to engage in active and meaningful learning.

To overcome these limitations and support students in developing conceptual understanding, one promising approach is Realistic Mathematics Education (RME). Developed by the Freudenthal Institute at Utrecht University in the Netherlands since 1971, RME is based on Hans Freudenthal's view that mathematics is a human activity (Afsari et al., 2021; Bakker, 2004). As a human activity, mathematics learning involves identifying problems, organizing relevant materials, constructing mathematical models, solving problems, and generating new ideas within meaningful contexts (Alim et al., 2020; Gravemeijer, 1994; Prahmana et al., 2020). Through this approach, the mathematics classroom becomes a space where students rediscover mathematical ideas and concepts by exploring real-world problems rather than merely receiving information from the teacher.

In implementing RME effectively, the role of teachers is essential. Teacher performance greatly influences student achievement (Sanberk & Bağiş, 2016), and the quality of education is strongly shaped by teacher-related factors(Bertram & Pascal, 2016; Sun et al., 2015). Teachers must therefore be able to design and facilitate meaningful mathematical learning experiences, particularly in the early years of schooling (MacDonald et al., 2016), since high-quality instruction contributes positively to students' academic Achievement, behavior, and motivation to learn (Salminen et al., 2012).

Realistic Mathematics Education (RME) is an approach to learning mathematics that has been developed since 1971 by a group of mathematicians from the Freudenthal Institute, Utrecht University in the Netherlands. This approach is grounded in Hans Freudenthal's view that mathematics is a human activity (Afsari et al., 2021). According to this perspective, the mathematics classroom is not merely a place where knowledge is transferred from teacher to student, but rather a space where students rediscover mathematical ideas and concepts through the exploration of real-world problems.

Realistic Mathematics Education (RME) is an approach that views mathematics as a human activity, where learning starts from contextual problems that are close to real life (Ericko & Musdi, 2018; Muchtar et al., 2020; Putri & Saino, 2020). Through a progressive mathematicization process, students are directed from concrete situations to formal concepts by emphasizing the use of meaningful contexts, self-models, interactions, and interconnectedness between concepts to build a deep and enjoyable understanding of mathematics. Numerous studies on realistic mathematics have been conducted, yielding encouraging results. Previous research has concluded that students' mathematical abilities improve significantly when taught using the realistic mathematics approach (Alim et al., 2019; Ericko & Musdi, 2018). Based on these findings, it can be inferred that realistic mathematics learning is highly appropriate for enhancing students' mathematical competence. Furthermore, when realistic learning is integrated with cultural contexts, it becomes an engaging means of fostering students' understanding of cultural values within the framework of mathematics itself (Andriani et al., 2023; Rezeki et al., 2021).

Based on the problems identified, the development of geometry teaching materials based on Realistic Mathematics Education (RME) with the context of the *Perahu Baganduang* tradition offers a potential solution. The design of these teaching materials integrates RME with local wisdom content by incorporating the *Perahu Baganduang* tradition as a context that reflects real-life phenomena or situations that can be simulated by students. This approach provides opportunities for students to rediscover mathematical concepts by engaging them in a variety of activities guided by the teacher. Students are also encouraged to exercise creativity in developing mathematical models to solve the problems they encounter. Each principle of this approach is embodied through the integration of local cultural content, specifically the *Perahu Baganduang* tradition, into every learning activity.

2. Method

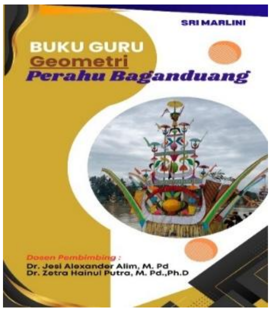
The method employed in this study is the research and development (R&D) approach. Tjeerd Plomp, an expert in educational and instructional technology development, developed this method. The Plomp model consists of three main phases: the Preliminary Investigation phase, the Prototype phase, and the Assessment phase. This study was conducted at SDN 007 Kampung Baru, Gunung Toar District, Kuantan Singingi Regency, during the odd semester of the 2024/2025 academic year. Data collection techniques included observation and interviews. The research instruments comprised interview guidelines, validation sheets for instruments and products, observation sheets for model implementation, questionnaires, and students' mathematical concept comprehension tests. To examine the validity of the Geometry Teaching Materials Based on RME in the Context of the *Perahu Baganduang* Tradition for Improving Mathematical Communication, expert judgment was used. To analyze the effectiveness of the developed RME-based teaching materials, a pretest-posttest was conducted to measure students' mathematical communication skills, and N-gain was calculated to determine the level of improvement in students' skills compared to their scores before the treatment.

3. Results

This study aims to develop geometry teaching materials based on Realistic Mathematics Education (RME) in the context of the *Perahu Baganduang* tradition, in the form of a teacher's book and a student's book. These teaching materials were designed in accordance with the geometry curriculum for fifth-grade students in elementary schools. The use of RME-based geometry teaching materials in the *Perahu Baganduang* context, consisting of both the teacher's and students' books, serves as an effort to enhance students' mathematical communication skills in geometry. The development process follows the Plomp model, beginning with the preliminary research phase. This phase serves as the foundation for designing the learning trajectory in this study. At this stage, various relevant and necessary information was collected to support the development of the teaching materials. The information gathered was then further analyzed. The analysis encompassed several aspects related to development needs. This stage of analysis was divided into three components: curriculum analysis, needs analysis, and learner analysis.

From the analysis of curriculum documents, teachers' books, and students' books, it was found that the relevant learning outcomes in this context include students' ability to present, interpret, and analyze data. This study adopted part of these outcomes and integrated them into the learning objectives formulated in the teachers' and students' books based on the RME approach. The needs analysis was conducted to obtain an overview of classroom conditions. Based on the findings, the development of geometry teaching materials using the RME approach in the *Perahu Baganduang* context enables teachers to design a sequence of learning activities aligned with students' ways of thinking and cognitive development levels, to anticipate strategies and misconceptions that may arise, and to provide intervention scenarios to guide students' understanding gradually. Consequently, geometry learning becomes more meaningful, enjoyable, and encourages active student engagement in studying geometric concepts.

The learner analysis was conducted at the initial stage of planning for the development of geometry teaching materials in the *Perahu Baganduang* context. According to Piaget's theory, fifth-grade students are in the concrete operational stage. At this stage, students begin to demonstrate the ability to think logically, but they still require support to understand abstract concepts. Therefore, embedding contextual learning based on real-life experiences is considered more effective in facilitating the learning process. The next stage is the Prototyping Phase. At this stage, the design and development of the teaching material products were carried out, consisting of the Teacher's Book and the Student's Book, both based on the RME approach in the *Perahu Baganduang* context for fifth-grade elementary students. The design process included preparing the learning activity scripts, incorporating contextual problems, and developing the visual layout of the books. The following presents the results of the teacher's book and the student's book that were developed.



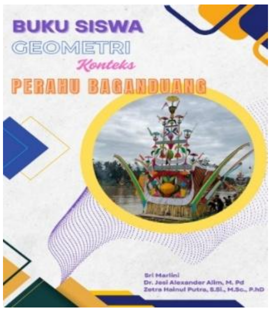


Figure 1. *Perahu baganduang*-based teaching materials: teacher's book and student's book

The initial prototype produced represented the first product of the design process. Subsequently, this prototype was tested through a formative evaluation stage with the aim of obtaining constructive feedback from experts for product refinement. The formative evaluation process was carried out in several steps, namely self-evaluation, expert review, one-to-one evaluation, and small group evaluation. At the self-evaluation stage, a screening process was conducted on Prototype 1 that had been developed. The researcher re-examined the design with the purpose of identifying and correcting errors, both technical and non-technical, before proceeding to the next evaluation stage. This screening activity involved two elementary school teachers as peer reviewers. The focus of the review included the accuracy of writing (including typos), the appropriateness of terminology used, the correctness of the content presented in the geometry teaching materials based on RME with the *Perahu Baganduang* context, and the quality of the visual presentation. The feedback obtained from this stage served as an important basis for revising Prototype 1 before moving on to the expert review stage.

Once the product had been designed and passed the self-evaluation stage, the next step was expert review to assess the feasibility of the product before its use by Grade V elementary school students. In this process, three validators were involved to determine the validity of the RME-based geometry teaching materials in the *Perahu Baganduang* context, both in the teacher's book and the student's book. Based on the validation questionnaires collected from the media expert, material expert, and language expert, it can be concluded that the RME-based geometry teaching materials in the *Perahu Baganduang* context met the validity criteria. The results of the expert validation are presented in Table 1.

Table 1. Validation result

No	Aspects	Validator Assessment		Category
		Teacher's Book	Student's Book	
1.	Content	0.82	0.85	Very Valid
2.	Language	0.92	0.77	Very Valid
3.	Didactics/Presentation	0.93	0.92	Very Valid
4.	Graphics/Visual Design	0.90	0.85	Very Valid
	Average	0.89	0.84	Very Valid
	Overall average	**0.86**		**Very Valid**

Based on the validation results, the teacher's book obtained an average validity score of 0.89, which falls into the "very valid" category. Meanwhile, the student's book achieved an average validity score of 0.84, which is also categorized as "very valid." When averaged across all aspects, the developed product reached a validity score of 0.86. Thus, it can be concluded that the teaching materials fall into the "very valid" category and are feasible to be tested with students. The next stage was the One-to-One trial, which was conducted after the product was declared valid based on the validators' assessments. This trial involved three fifth-grade elementary school students selected purposively to represent varying levels of mathematical ability: high, medium, and low. The evaluation process was carried out by providing open-ended questions directly to each student in order to explore their responses regarding the use of the teaching material.

The trial results indicated that all students (A, B, and C) were attracted to the appearance of the student book, particularly due to the integration of visuals, mathematical content, and contextual activities. They found the book more engaging compared to regular textbooks, as the material was presented by linking mathematical concepts to real-life situations closely related to their daily experiences, namely the Baganduang boat tradition. This approach facilitated a better understanding of the concepts being studied. Following the One-to-One trial, a small-scale trial was conducted at SDN 007 Kampung Baru, Gunung Toar District, Kuantan Singingi Regency. In this small group setting, the sample consisted of five fifth-grade students and two teachers. The purpose of this activity was to collect feedback from both students and teachers regarding the implementation of the RME-based geometry teaching materials in the context of the Baganduang boat tradition, as well as to evaluate the practicality of using the teachers' and students' books. The results of the small group trial are presented in Table 2.

Table 2. Results of small group trial students

No	Student	Student Book	
		Persentase (%)	**Category**
1.	Student 1	100	Very Practical
2.	Student 2	91.1	Very Practical
3.	Student 3	80	Very Practical
4.	Student 4	100	Very Practical
5.	Student 5	100	Very Practical
	Average	94.22	Very Practical

Based on the results of the practicality test of the student book and the implementation of the RME-based geometry teaching material within the context of the *Perahu Baganduang* tradition in the learning process, it can be concluded that both the use of the student book and the application of the teaching material fall into the "Practical" category in the small-group student trial. A practicality response questionnaire was also administered to elementary school teachers. Table 3 presents the results of the teacher practicality test.

Table 3. Results of small group trial

No.	Aspect	Teacher Books (%)	
		Persentase (%)	**Category**
1.	Attractiveness	96.88	Very Practical
2.	Ease of Use	100	Very Practical
3.	Usefulness	97.50	Very Practical
	Average	**98.13**	**Very Practical**

Based on the results of the practicality test regarding the use of the teacher and student books, as well as the implementation of the RME-based geometry teaching material within the context of the *Perahu Baganduang* tradition, it can be concluded that the media as a whole falls into the "Highly Practical" category according to teacher responses. In line with this, teachers' comments on the practicality questionnaire indicated that the use of RME-based teaching materials contextualized with the *Perahu Baganduang* tradition can serve as a strategy for teachers to design more engaging and effective mathematics instruction.

Overall, the media is categorized as "Highly Practical" for trials involving both teachers and small groups. The teachers' assessments demonstrate that the RME-based geometry teaching material within the context of the *Perahu Baganduang* tradition possesses an appeal that stimulates student interest in learning. Furthermore, the material is considered easy to use and beneficial for both students and teachers. Its integration of real-life contexts provides an innovative learning experience, particularly in mathematics instruction, and supports the development of students' mathematical communication skills in geometry. After completing the small-group trial, the next step was to conduct a larger-scale trial, referred to as the large-group trial. This trial was carried out at SDN 007 Kampung Baru, Gunung Toar District, Kuantan Singingi Regency. Participants in the large-group trial consisted of nine fifth-grade students and four fifth-grade teachers. The detailed results of students' initial ability measurements in the geometry topic are presented in the recapitulation Table 4 below.

Table 4. Pretest result

Classification	Pretest
Sample	9
Maximum score	55
Minimum score	30
Average	**45.6**

The results of the pretest data analysis presented in Table 4 indicate that students' initial abilities in geometry were still at a low level. This is reflected in the average score obtained, which was 45.6, with a maximum score of 55 and a minimum score of 30. These findings suggest that the majority of students did not yet possess an adequate understanding of geometric concepts. After obtaining the initial data on students' mathematical communication skills, the implementation of the RME-based teaching material within the context of the *Perahu Baganduang* tradition was carried out. The implementation took place over four sessions. During the process, the researcher applied the learning design in accordance with the sequence outlined in the RME-based teaching material, supported by the teacher's book, while students engaged in learning activities using the students' book developed within the same context. Throughout the learning sessions, three teachers were involved in monitoring the activities and evaluating the alignment of the teacher's book with the RME-based teaching material in the context of the *Perahu Baganduang* tradition. In addition, during the large-group trial, data on practicality were also collected through student and teacher response questionnaires. The results of the large-group trial are presented in the following Table 5.

Table 5. The results of the large-group trial of students

No	Student	Student Book	
		Persentase (%)	**Category**
1.	Student 1	100	Very Practical
2.	Student 2	91.1	Very Practical
3.	Student 3	80	Very Practical
4.	Student 4	100	Very Practical
5.	Student 5	100	Very Practical
6.	Student 6	100	Very Practical
7.	Student 7	97.8	Very Practical
8.	Student 8	93.3	Very Practical
9.	Student 9	100	Very Practical
	Average	**95.8**	**Very Practical**

Based on the results of the practicality test regarding the use of the student book and the implementation of the RME-based geometry teaching material in the context of the *Perahu Baganduang* tradition during the large-group trial, it can be concluded that both the use of the student book and the application of the teaching materials fall into the "Practical" category. A practicality response questionnaire was also administered to elementary school teachers. Table 5 presents the results of the teacher practicality assessment.

Tabel 6. Large-Group trial results teachers

No.	Aspect	Student and Teacher Books (%)	Category
1.	Attractiveness	98.43	Very Practical
2.	Ease of Use	97.50	Very Practical
3.	Usefulness	100	Very Practical
	Average	**99.16**	**Very Practical**

Based on the results of the practicality assessment regarding the use of the teacher and student books, as well as the implementation of the RME-based geometry teaching materials within the context of the *Perahu Baganduang* tradition, it can be concluded that the media as a whole falls into the "Very Practical" category according to teacher responses. In line with this, teachers' comments on the practicality questionnaire indicated that using RME-based teaching materials contextualized with the *Perahu Baganduang* tradition can serve as a strategy for designing more engaging and effective mathematics instruction. Overall, the media is classified as "Very Practical" for trials involving teachers and small groups. Teachers' evaluations show that the RME-based geometry teaching materials in the context of the *Perahu Baganduang* tradition have an appeal that stimulates students' interest in learning. Moreover, the materials are considered easy to use and beneficial for both students and teachers. The integration of real-life contexts also provides an innovative learning experience, particularly in mathematics instruction, and supports the development of students' mathematical communication skills in geometry.

Subsequently, after the learning process was completed, a posttest was administered to assess students' final abilities following the implementation of the RME-based teaching materials in the context of the *Perahu Baganduang* tradition. At the end of the learning activities, students were given five individual enrichment exercises in the form of essay questions as a review of the learning that had been conducted. These enrichment exercises included questions related to geometry, specifically on plane shapes and curved-surface solid figures. Following this, students were given a posttest to evaluate their final mathematical communication skills. The statistical summary of the posttest results is presented below.

Tabel 7. The result postest

Classification	**Posttest**
Sample	9
Maximum score	100
Minimum score	45
Average	**88.3**

The posttest results presented in Table 7 indicate a significant improvement in students' abilities after participating in learning using Realistic Mathematics Education (RME)-based teaching materials within the context of the *Perahu Baganduang* tradition. The average student score increased to 88.3, with the highest score reaching 100 and the lowest score reaching 45. These results suggest that the instructional intervention contributed positively to students' understanding of geometry. Furthermore, the use of local cultural context in the learning process enabled students to more easily connect mathematical concepts with real-life phenomena, resulting in optimal learning outcomes.

Based on the study, data were obtained regarding the improvement of students' mathematical communication skills through context-based learning. This data includes several indicators of mathematical communication, such as reflecting real objects or diagrams into mathematical ideas, creating models of situations from a problem, expressing daily events in mathematical language or symbols, comprehending representations, as well as making conjectures, constructing arguments, and generalizing. The percentages of pretest and posttest results, as well as the percentage increase for each indicator, are presented in the following Table 8.

Table 8. Percentage improvement of students' mathematical communication skills

No.	Mathematical Communication Indicators	Pretest (%)	Posttest (%)	Increase (%)	Category
1.	Reflecting real objects, pictures, and diagrams into mathematical ideas	58.33	88.9	30.56	Fair
2.	Creating models of situations or problems	44.44	91.7	47.22	Fair
3.	Expressing daily events in mathematical language or symbols	36.11	72.2	36.11	Fair
4.	Reading and interpreting representations	47.22	100	57.28	Good
5.	Making conjectures, constructing arguments, and generalizing	41.67	88.9	47.22	Fair
	Overall Achievement (%)	**45.56**	**88.3**	**42.78**	**Fair**

Based on the table above, it can be observed that all indicators of students' mathematical communication skills showed improvement after the intervention. The highest percentage increase was found in the indicator of reading and interpreting representations, which increased by 57.28% and was classified as "Good." Meanwhile, the indicator with the lowest improvement was reflecting real objects, pictures, and diagrams into mathematical ideas, with an increase of 30.56%, still classified as "Fair." Overall, the average improvement in students' mathematical communication skills reached 42.78%, categorized as "Fair." These results indicate that the applied learning approach was effective in enhancing students' mathematical communication skills, although some indicators still require further improvement. To further evaluate the extent of improvement in students' abilities before and after the intervention, an N-Gain analysis was conducted. The results of the N-Gain calculation are presented below.

Table 9. N-Gain calculation results

Category	Pretest	Posttest
Maximum score	55	100
Minimum score	30	45
Average N-Gain	0.8	High
Average N-Gain (%)	82.6	Effective

Based on the N-Gain calculation presented in Table 9, the average score was 0.8, equivalent to 82.6%. This value falls into the "High" category and is considered effective in enhancing students' mathematical abilities. These results indicate that the implementation of RME-based teaching materials using the *Perahu Baganduang* tradition context had a significant positive impact on students' mathematical competence, particularly in the geometry topic. Therefore, this learning strategy can be classified as an effective, contextual approach that strengthens students' mathematical communication skills in accordance with 21st-century learning demands. The summary of differences in students' mathematical communication abilities before and after the intervention in the geometry topic is presented as follows.

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Table 10. Differences in students' mathematical communication skills

Category	Average Score	Average difference
Pretest	45.6	42.7
Posttest	88.3	

Based on Table 10, the difference between the posttest and pretest average scores was 42.7, corresponding to an increase of 78,5%. Therefore, it can be concluded that students' average scores improved after receiving instruction using RME-based teaching materials within the *Perahu Baganduang* context. Students' mathematical communication skills increased by 78.5% following the implementation of these teaching materials. Overall, it can be concluded that the use of RME-based teaching materials in the *Perahu Baganduang* context for geometry topic lessons is sufficiently effective and can be applied as a learning design to strengthen students' mathematical communication skills

4. Discussion

The geometry learning materials based on *Realistic Mathematics Education* (RME) within the local cultural context of the Baganduang Boat were found to be valid, practical, and effective. However, rather than merely restating these outcomes, it is important to interpret why the learning materials achieved such high validity and effectiveness. The strong validity results are attributed to the didactic and presentational aspects that closely follow the principles of RME. These include contextualized problem situations, the use of visual and tangible models, and learning activities that encourage students' active engagement (Alim et al., 2024; Silaban et al., 2025). Such alignment with RME principles ensures that students construct mathematical understanding through meaningful experiences rather than rote procedures, consistent with Gravemeijer (1994) and Wulandari et al. (2024).

The integration of the Baganduang Boat as a local cultural context contributes significantly to this process. The boat's structural elements, such as triangular, square, and trapezoidal shapes, serve as concrete representations that facilitate both horizontal mathematization linking real-world contexts to models and vertical mathematization formalizing abstract mathematical ideas (Argareta & Simbulas, 2025). Through these culturally embedded examples, students no longer perceive geometry as an abstract domain but as an integral part of their daily life and local environment (Afriansyah, 2016). This approach enhances students' mathematical communication skills by enabling them to express real-life situations in mathematical language, represent ideas through diagrams and symbols, explain problem-solving steps, and discuss their reasoning both orally and in writing. These improvements were reflected in the N-Gain score of 0.8, indicating high effectiveness.

Furthermore, the design of these materials reflects Vygotsky's sociocultural learning theory (Utami, 2016), which emphasizes that cognitive development occurs through social interaction. Group discussions surrounding the shapes and symmetry of the Baganduang Boat foster collaborative mathematical communication (Rubi Babullah et al., 2024). This interaction supports the gradual transition from informal, context-based reasoning to formal mathematical abstraction. The materials also incorporate open-ended problems that stimulate critical and communicative thinking—an approach supported by previous studies (Lubis & Nurdin, 2023; Yuliani et al., 2020), which found that RME can improve both mathematical communication and conceptual understanding.

The exceptional practicality of the RME-based materials functions not merely as a logistical advantage but as a pedagogical enabler for mathematical communication. When teacher guides and student books are designed with clarity, coherence, and exploration-rich tasks, teachers are freed from procedural burdens and can direct their attention toward fostering dialogue, argumentation, and representation among students. This structural "ease of use" aligns with the RME principle of interactivity, where learners articulate, question, and reason about mathematics in meaningful contexts (Siswantari et al., 2025). Furthermore, context-rich materials that invite student exploration support horizontal and vertical mathematization, enabling learners to shift from real-world phenomena to mathematical models and formalization, thus providing rich opportunities for students to express ideas, represent them symbolically, and justify their reasoning (Andika et al., 2025). In short, the practicality of these materials effectively scaffolds the communicative dimension of mathematics learning: by removing implementation barriers, students can engage more fully in discussing, representing, and reflecting on mathematical ideas, thereby enhancing their mathematical communication competence (Rahmawati, 2020).

The effectiveness of the learning materials is evident from the results of student tests and mathematical communication questionnaires, which indicate an improvement in mathematical communication skills at a high level. Students were able to express mathematical ideas both orally and in writing, explain problem-solving strategies, and engage in discussions to find solutions. This effectiveness is closely related to the principles of RME, which emphasize guided reinvention and interaction, whereby students are directed to rediscover geometric concepts through learning experiences grounded in local cultural contexts (Melisawati, Nur Izzati, n.d.). These findings reinforce previous studies (Holdia Melsita , Rhomiy Handican, 2025., Melisawati, Nur Izzati, n.d.), which concluded that culture-based RME can enhance learning outcomes while fostering students' appreciation for local wisdom.

Thus, based on validity, practicality, and effectiveness testing, it can be concluded that RME-based geometry learning materials with the Baganduang Boat tradition context represent an innovation worthy of implementation in elementary school education. The implications of this study highlight the necessity for teachers to utilize local culture as a learning resource, enabling students to comprehend abstract concepts more easily (Matondang, 2020), in line with the Merdeka Curriculum's emphasis on experiential learning and the development of communication competencies. Integrating local culture into mathematics learning not only preserves local wisdom but also enriches students' learning experiences while enhancing their mathematical thinking and communication skills (Edi Susanto, Rusdi, 2021).

5. Conclusion and Implications

This study produced geometry learning materials based on *Realistic Mathematics Education* (RME) within the local cultural context of the Baganduang Boat, developed using the Plomp model. The results showed that the developed learning materials were valid**,** practical**,** and effective**.** The validity was demonstrated by an average validity score of 0.86, categorized as *very valid*. Practicality was evidenced by trial results indicating positive responses from teachers and students and a high level of implementation**.** The effectiveness of the materials was reflected in the improvement of students' mathematical communication skills, with an N-Gain score of 0.8**,** classified as *high effectiveness*. Therefore, these learning materials are feasible to be used as an alternative resource for teaching geometry in elementary schools.

The implications of this study suggest that developing learning materials based on local cultural contexts can strengthen the connection between mathematics and students' real-life experiences, while also fostering appreciation for regional cultural values. Teachers are encouraged to utilize local cultural potentials in learning activities, aligning with the principles of the *Merdeka Curriculum*, which emphasizes contextual and student-centered learning. Such an approach has the potential not only to enhance students' understanding of mathematical concepts but also to cultivate their character and cultural identity.

Credit authorship contribution statement

Sri Marlini: Methodology, Formal analysis, Data curation, Conceptualization. **Jesi Alexander Alim**: Resources, Project Administration, Methodology. **Zetra Hainul Putra**: Funding acquisition, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Declaration

All participants provided informed consent prior to their involvement in the study. They were informed about the study's purpose, procedures, and their right to withdraw at any time without consequence.

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References

Afriansyah, E. A. (2016). Makna realistic dalam RME dan PMRI. *Lemma : Letters of Mathematics Education*, *2*(2), 96–104.

Afsari, S., Safitri, I., Harahap, S. K., & Munthe, L. S. (2021). Systematic Literature Review: Efektivitas Pendekatan Pendidikan Matematika Realistik Pada Pembelajaran Matematika. *Indonesian Journal of Intellectual Publication*, *1*(3), 189–197.

Alim, J. A., Asih, S. R., & Putra, Z. H. (2024). *Primary : Jurnal Pendidikan Guru Sekolah Dasar*. *13*(6), 242–251.

Alim, J. A., Fauzan, A., Arwana, I. M., & Musdi, E. (2019). Interactive Multimedia in Learning 2-Dimensional Gemoetric Shapes in Elementary School. *Prosiding CELSciTech*, *4*, 51–53.

Alim, J. A., Fauzan, A., Arwana, I. M., & Musdi, E. (2020). Model of Geometry Realistic Learning Development with Interactive Multimedia Assistance in Elementary School. *Journal of Physics: Conference Series*, *1471*(1), 012053. https://doi.org/10.1088/1742-6596/1471/1/012053

Amaliyah, A., Uyun, N., Deka Fitri, R., & Rahmawati, S. (2022). Analisis Kesulitan Belajar Siswa Pada Materi Geometri. *Jurnal Sosial Teknologi*, *2*(7), 659–654.

Andika, R., Rani, M. M., Syam, S. S., & Firdaus, A. (2025). *Analysis of Students ' Mathematics Communication Ability Through the Realistic Mathematics Education*. *5*(1), 247–257. https://doi.org/10.58737/jpled.v5i1.402

Andriani, D., Sahono, B., Badeni, B., & Haji, S. (2023). Proceedings of the 3rd International Conference on Educational Science and Teacher Profession (ICETeP 2021). In *Proceedings of the 3rd International Conference on Educational Science and Teacher Profession (ICETeP 2021)* (Vol. 1). Atlantis Press SARL. https://doi.org/10.2991/978-2-494069-19-0

Argareta, F. M., & Simbulas, L. J. C. (2025). Development of desmos application integrated ethnomathematics on geometry for grade IV UPT SDN 101826 Tuntungan. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *14*(4), 485–498.

Bakker. (2004). *Design research in statistics education On symbolizing and computer tools*. Wilco, Amersfoort/Freundhental Institute.

Bertram, T., & Pascal, C. (2016). *Early Childhood Policies and Systems in Eight Countries*. Springer International Publishing. https://doi.org/10.1007/978-3-319-39847-1

Budiarto, M. T., & Artiono, R. (2019). Geometri Dan Permasalahan Dalam Pembelajarannya (Suatu Penelitian Meta Analisis). *JUMADIKA : Jurnal Magister Pendidikan Matematika*, *1*(1), 9–18. https://doi.org/10.30598/jumadikavol1iss1year2019page9-18

Damayanti, A., & Sukmawarti, S. (2022). Pengembangan Bahan Ajar Geometri SD Berbasis Jajanan Pasar. *Indonesian Research Journal On Education*, *3*(1), 382–388.

de Vink, I. C., Willemsen, R. H., Keijzer, R., Lazonder, A. W., & Kroesbergen, E. H. (2023). Supporting creative problem solving in primary geometry education. *Thinking Skills and Creativity*, *48*, 101307.

Edi Susanto, Rusdi, A. S. (2021). *Pembelajaran Matematika Realistik Berbasis Budaya Masyarakat Bengkulu dalam meningkatkan Komunikasi Matematis Mahasiswa*. *06*(01), 39–49.

Ericko, R., & Musdi, E. (2018). Pengaruh Pendekatan Realistic Mathematics Education (RME) Terhadap Kemampuan Pemahaman Konsep Matematika Peserta Didik. *Jurnal Edukasi Dan Penelitian Matematika Hal*, *7*(4), 134–139.

Fauzan, A., Plomp, T., & Gravemeijer, K. (2013). The development of an RME-based geometry course for Indonesian primary schools. In *Educational Design Research – Part B: Illustrative Cases*.

Gravemeijer. (1994). Developing Realistic Mathematics Education. In *Utrecht university*.

Hermita, N., Putra, Z. H., Alim, J. A., Fitriani, M., Nasien, D., & Mahbubah, K. (2022). Analysis of the Among System-Based Discovery and Inquiry Learning Models. *JOURNAL OF TEACHING AND LEARNING IN ELEMENTARY EDUCATION (JTLEE)*, *5*(2), 216–224.

Holdia Melsita , Rhomiy Handican, R. D. (2025). *Jurnal Pendidikan MIPA*. *15*, 250–264.

Kurniasih, R. (2017). Penerapan Strategi Pembelajaran Fase Belajar Model Van Hiele Pada Materi Bangun Ruang Sisi Datar. *JURNAL SILOGISME : Kajian Ilmu Matematika Dan Pembelajarannya*, *2*(2), 61. https://doi.org/10.24269/js.v2i2.626

Lubis, F. F., & Nurdin, E. (2023). *Pembelajaran Ethno-RME Meningkatkan Keterampilan Berpikir Kritis Matematis Siswa*. *6*(3), 277–284.

MacDonald, A., Goff, W., Dockett, S., & Perry, B. (2016). Mathematics education in the early years. *Research in Mathematics Education in Australasia 2012-2015*, *10*(2), 165–186.

Matondang, A. R. (2020). *Issn 2087-8249 e-issn 2580-0450*. *09*(1), 26–34.

Melisawati, Nur Izzati, D. R. (n.d.). *Pengaruh Pendekatan Realistic Mathematics Education dengan Konteks Budaya Melayu Kepulauan Riau Terhadap Hasil Belajar Siswa*. 84–92.

Muchtar, I. S. M., Hendriani, A., & Fitriani, A. D. (2020). Penerapan Pendekatan RME untuk Meningkatkan Pemahaman. *Jurnal Pendidikan Guru Sekolah Dasar*, *5*, 108–119.

Nur'aini, I. L., Harahap, E., Badruzzaman, F. H., & Darmawan, D. (2017). Pembelajaran Matematika Geometri Secara Realistis Dengan GeoGebra. *Matematika*, *16*(2), 1–6.

Ozturk, A., Schramm, L., Milligan, M., Canning, M., Rapol, M., & Wilson, S. (2023). Examining Textbooks to Support Prospective Teachers' Pedagogical Content Knowledge of Geometry. *Ohio Journal of School Mathematics*, *94*, 13–20.

Prahmana, R. C. I., Sagita, L., Hidayat, W., & Utami, N. W. (2020). Two Decades of Realistic Mathematics Education Research in Indonesia: a Survey. *Infinity Journal*, *9*(2), 223–246. https://doi.org/10.22460/infinity.v9i2.p223-246

Putri, N. M., & Saino. (2020). Pengembangan Booklet Sebagai Media Pembelajaran Pada Mata Pelajaran Pengelolaan Bisnis Ritel Materi Perlindungan Konsumen Kelas Xi Bdp Di Smkn Mojoagung. *Jurnal Pendidikan Tata Niaga (JPTN)*, *8*(3), 925–931.

Rahmawati, L. H. (2020). *Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Berbasis Scientific Approach Pada Mata Pelajaran Administrasi Umum Semester Genap Kelas X OTKP di SMK Negeri 1 Jombang Pengembangan Lembar Kegiatan Peserta Didik (LKPD) ....* *8*, 504–515.

Rezeki, S., Andrian, D., & Safitri, Y. (2021). Mathematics and cultures: A new concept in maintaining cultures through the development of learning devices. *International Journal of Instruction*, *14*(3), 375–392.

Rubi Babullah, Siti Qomariyah, Neneng Neneng, Ujang Natadireja, & Siti Nurafifah. (2024). Kolaborasi Metode Diskusi Kelompok Dengan Problem Solving Learning Untuk Meningkatkan Keterampilan Pemecahan Masalah Siswa Pada Materi Aqidah Akhlak. *Jurnal Budi Pekerti Agama Islam*, *2*(2), 65–84. https://doi.org/10.61132/jbpai.v2i2.132

Salminen, J., Lerkkanen, M. K., Poikkeus, A. M., Pakarinen, E., Siekkinen, M., Hännikäinen, M., Poikonen, P. L., & Rasku-Puttonen, H. (2012). Observed Classroom Quality Profiles of Kindergarten Classrooms in Finland. *Early Education and Development*, *23*(5), 654–677. https://doi.org/10.1080/10409289.2011.574267

Sanberk, İ., & Bağiş, S. (2016). How do third-grade students and their teachers construe each other? *International Electronic Journal of Elementary Education*, *8*(4), 559–572.

Silaban, P. J., Sitepu, A., & Sitepu, I. (2025). *Primary : Jurnal Pendidikan Guru Sekolah Dasar*. *14*(5), 780–796.

Siswantari, Sabon, S. S., Listiawati, N., Wirda, Y., Zulkardi, & Riyanto, B. (2025). Bridging mathematics and communication: Implementing realistic mathematics education principles for skill development. *Journal on Mathematics Education*, *16*(1).

Sriwanti, P. U., & Sukmawarti, S. (2022). Pengembangan Modul Geometri Sd Berbasis Etnomatematika. *Pedagogi: Jurnal Ilmiah Pendidikan*, *8*(1), 31–38.

Sun, J., Rao, N., & Pearson, E. (2015). Policies and Strategies to Enhance the Quality of Early Childhood. *Education for All 2000-2015: Achievements and Challenges Policies*.

Ulusoy, F., & Turuş, İ. B. (2022). The mathematical and technological nature of tasks containing the use of dynamic geometry software in middle and secondary school mathematics textbooks. *Education and Information Technologies*, *27*(8), 11089–11113.

Utami, I. G. A. L. P. (2016). Teori Konstruktivisme dan Teori Sosiokultural: Aplikasi dalam Pengajaran Bahasa Inggris. *Prasi*, *11*(01), 4–11.

Wulandari, R., Charlina, C., & Septyanti, E. (2024). Validitas Pengembangan Bahan Ajar Teks Anekdot Berbasis Kearifan Lokal Siswa Kelas X Sman 15 Pekanbaru. *Jurnal Basataka (JBT)*, *7*(2), 795–804. https://doi.org/10.36277/basataka.v7i2.552

Yuliani, D., Andriani, L., & Fitri, I. (2020). Pengaruh Penerapan Pendekatan RME (Realistic Mathematic Education) Terhadap Kemampuan Komunikasi Matematis. *JURING (Journal for Research in Mathematics Learning)*, *3*(3), 193–200.

Yunianta, T. N. H., Suryadi, D., Dasari, D., & Herman, T. (2023). Textbook praxeological-didactical analysis: Lessons learned from the Indonesian mathematics textbook. *Journal on Mathematics Education*, *14*(3), 503–524.