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#20103 Summary

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**Development of Flat Geometry Supplement Book
with the *Realistic Mathematics Education* Approach Based on Reog Ponorogo
Ethnomathematics to Improve Numeracy Literacy of Elementary School
Students**

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Abstract

This study aims to describe the development of supplementary books with a realistic mathematics education approach based on ethnomathematics reog Ponorogo in improving numeracy literacy. The type of research used is Research and Development with the ADDIE model (analysis, design, development, implementation, and evaluation). The instruments in this study are validation sheets consisting of validation sheets for material experts, learning experts, media experts, and linguists, practical response questionnaires, and numeracy literacy question sheets. The development results show that it is very valid to use with the results of the assessment of material experts of 89.8%, media experts 91%, learning experts 94%, and linguists 90%. The results of the practical response showed an efficient criterion with an assessment of 82.3%. Meanwhile, numeracy literacy ability is in the medium category, which is shown with an n-gain score of 0.6461 and an n-gain score of 64.61%, which means that the supplement books developed are quite effective in improving numeracy literacy.

Keywords: *Supplementary Books, Realistic Mathematics Education, Ethnomathematics, Numeracy Literacy*

Abstract

Penelitian ini bertujuan untuk mendiskripsikan pengembangan buku suplemen dengan pendekatan realistic mathematics education berbasis etnomatematika reog Ponorogo dalam meningkatkan literasi numerasi. Jenis penelitian yang digunakan adalah Research and Development dengan model ADDIE (analysis, design, development, implementation and evaluation). Instrumen dalam penelitian ini yaitu lembar validasi yang terdiri dari lembar validasi ahli materi, ahli pembelajaran, ahli media dan ahli bahasa, lembar angket respon kepraktisan dan lembar soal literasi numerasi. Hasil pengembangan menunjukkan sangat valid digunakan dengan hasil penilaian ahli materi sebesar 89,8%, ahli media 91%, ahli pembelajaran 94% dan ahli bahasa 90%. Hasil Respon kepraktisan menunjukkan kriteria sangat praktis dengan penilaian 82,3%. Sedangkan kemampuan literasi numerasi berada pada kategori sedang yang ditunjukkan dengan nilai n-gain score sebesar 0,6461 dan n-gain score persen menunjukkan nilai 64,61% yang berarti bahwa buku suplemen yang dikembangkan cukup efektif untuk meningkatkan literasi numerasi

Kata Kunci: Buku Suplemen, *Realistic Mathematics Education*, Etnomatematika, Literasi Numerasi

INTRODUCTION

Numeracy literacy is one of the literacy dimensions in the National Literacy Movement. Numeracy literacy is defined as the knowledge and skills to acquire, interpret, use, and communicate various kinds of mathematical numbers and symbols to solve practical problems in the context of daily life, and the skills to analyze information from data displays in the form of tables, graphs, and charts for decision-making from *problem-solving activities* (Atmazaki et al., 2017). Numeracy literacy skills are important for students because numeracy literacy is not just about using formulas to solve problems, but is related to the ability to implement mathematical concepts and rules in daily life (Han et al., 2017).

However, despite this, some researchers state that the achievement of numeracy literacy of Indonesian students is relatively low (Damanik & Handayani, 2023). The results of the PISA survey in 2018 on the reading ability of Indonesian students were ranked 74th out of 79 countries, ranked 73rd out of 79 countries for math skills, and ranked 71st out of 79 countries for science skills (Hewi & Shaleh, 2020) with an average score of 371 for reading, 376 for math, and 379 for science. This achievement is below the average of 79 PISA participating countries, namely the average for reading skills of 487, while for mathematics and science skills of 489 (PISA, 2017). Other data shows that 70% of Indonesian students have low literacy (OECD, 2019c) and 72% are in the category of having low math ability (OECD, 2019a). This is because most Indonesian students are not able to solve simple problems in mathematics (Putrawangsa & Hasanah, 2022). The variety of the availability of reading materials that support numeracy literacy is very minimal, and the use of teaching materials is still limited in textbooks related to mathematics learning, difficulties in solving numeracy literacy problems due to the lack of practice questions in solving problems that are closer to daily life (Ain et al., 2023a) And students still find it difficult to connect mathematical concepts to real situations because the methods used by teachers in learning are not interesting, so students lose enthusiasm when learning mathematics (Indrastuti et al., 2024).

One of them is evidenced by the data on the existence of reading materials about numeracy literacy in the Ministry of Education's repository through the web site

<https://repositori.kemdikbud.go.id>, Information was obtained that there were 644 book titles, of which of the 644 books only 10 book titles were reading books for children about numeracy. In addition, the results of interviews on the results of the minimum competency assessment (AKM) at elementary education institutions that measure reading literacy, numeracy literacy, and character show that in 2022, the national average score of numeracy skills is 1.57, with a score range of 1-3. The average value of numeracy ability in East Java province is 1.63. Meanwhile, the average result of numeracy ability in Malang City is 1.62, in Kediri Regency is 1.66, and in Ponorogo Regency is 1.69. This value shows that numeracy skills, both at the national level, and at the East Java Province level, as well as at the district level and in several cities only achieved success of 50%-60%.

Several research studies were conducted in elementary schools in North Lombok (Nurhayati et al., 2022), Tasikmalaya City (D. R. Sari & Muharram, 2022), and Malang City (Iruntyasari, 2022) also show that the numeracy literacy ability of geometry materials is relatively low, shown by students not being able to systematically reason about numeracy problems that display information in the form of spatial buildings or flat buildings.

Based on this, to improve numeracy literacy, it is necessary to have teaching materials in the form of supplementary books, especially geometry, with an approach that is oriented to problems in daily life, one of which is the realistic mathematics education approach. According to Arif and Rukmi (2020), supplement books are supporting books that can be used by teachers and students as complementary books or enrichment books used in the teaching and learning process (Fatianti et al., 2024). Dwi stated that supplementary books are companion books to complement the main book, not mandatory for students and teachers, but can help expand knowledge from the main book (Putri et al., 2020). The *Realistic Mathematics Education approach* according to Sari et al. (R. M. Sari et al., 2017) It is a learning approach where learning activities emphasize the active role of students so that concepts can be learned by students. This approach has a great influence on mathematics learning, including in terms of creative thinking ability and motivation to learn mathematics, mathematical reasoning skills, mathematical problem-solving skills, mathematical literacy and disposition skills, and spatial reasoning skills (Rismaratri & Nuryadi, 2018)

Ethnomathematics was chosen as the basis for learning realistic mathematics because ethnomathematics functions as a complement to the mathematics curriculum in general, so that it can be used as an initial study in learning the concepts of mathematical concepts contextually according to what students experience on a daily basis (Rowlands & Carson, 2002). Ethnomathematics is an integration between mathematics and culture where mathematical concepts and principles can be found in certain cultural contexts and can bridge cultures in mathematics learning (Fendrik et al., 2024). Ethnomathematics also encourages the creation of high motivation for students in learning, especially students' mathematical literacy skills (Yohanes et al., 2019) because of the change in the learning process from textual to contextual that which makes it easier for students to solve the problems presented (Ain et al., 2023b) In addition to ethnomathematics also able to provide an understanding of culture and mathematics, and help develop the nation's character in students (Khatimah & Fatimah, 2023).

Reyog Ponorogo is a culture used as the basis for the development of this supplement book because Reyog Ponorogo is one of the cultural heritages that, since 2022, has been registered as an intangible cultural heritage at UNESCO. Several studies on ethnomathematical learning in the reyog culture also resulted in the findings that several

concepts of flat building and building space can be studied through the art of reyog Ponorogo (Fatmahanik, 2019). A similar study that became the previous study of this study was a study on the exploration of mathematical ideas in the art of Reyog Tulungagung (Hayuhantika & Rahayu, 2019). So that this cultural heritage is maintained, its preservation efforts must be maintained starting from the early stages of formal education, namely basic education. The development of this flat geometry supplement book is the first step to bring the art of Ponorogo reyog as a learning resource in mathematics learning. In addition, the instruments in the Reyog Ponorogo art are real objects that can be used as a starting point in learning the concept of flat building which is abstract and this is following the stage of cognitive development of children aged 7-12 years, namely at the concrete operational stage (Marinda, 2020).

METHODS

This type of research is *Research and Development* because to producing a new product or developing an existing process to be even better than the previous product (Rangkuti, 2016) by using the model developed by Reiser and Mollenda, namely ADDIE, with the stages of *Analysis, Design, Development, Implementation, and Evaluation* (Rangkuti, 2016). The instruments used in this study are validation sheets consisting of validation material experts, learning experts, media experts, and linguists, practicality response questionnaires, and pretest and posttest question sheets for numeracy literacy. The assessment of this supplement book was compiled using the Likert scale. The trial was carried out in one of PGMI's partner madrasas, namely at SD Tarbiyatul Islam Ponorogo, carried out in grade 2 with a total of 22 students. The data analysis technique uses content analysis to analyze data obtained from validator responses in the form of suggestions, notes, and comments, and percentage descriptive analysis is used to process data from assessments given to experts. The assessment instruments by experts are prepared based on the indicators of each type of assessment, which are as follows.

Table 1. Product Rating Indicators by Experts

Member Ratings	Aspects
Material	Content eligibility
	Quality of learning
	Presentation/display quality
	Quality of interaction
Design/Media	Readability
	Serving
	Graphic
Learning	Characteristics <i>Realistic Mathematics Education</i>
	Principle <i>Realistic Mathematics Education</i>
Language	Harassment
	Communicative
	Dialogical and Interactive
	Suitability with the level of development of students
	Collapse and integration of the mindset
	Use of terms, symbols, or icons.

Meanwhile, the preparation of test instruments refers to the numeracy literacy indicators (Han et al., 2017) as follows.

Table 2. Numeracy Literacy Indicators

No	Numeracy Literacy Indicators
1	Use a wide variety of numbers and symbols related to basic mathematics in solving problems in everyday life
2	Able to analyze information displayed in various forms (graphs, tables, charts, diagrams, and so on)
3	analyze the results of the analysis in making decisions

As for the level of validity of the products developed using the conversion scale of the achievement rate (Arikunto, 2018) as follows.

Table 3. Validity Criteria for Supplement Book Products

Percentage (%)	Product Eligibility Criteria
< 21%	Very invalid
21% - 40%	Invalid
41% - 60%	Quite valid
61% - 80%	Valid
81% - 100%	Highly Valid

Meanwhile, to determine the results of students' practical response to the product developed using the conversion scale (Sa'dun Akbar, 2017) as follows.

Table 4. Product Practicality Percentage Category

Score Interval	Category
80,01% - 100%	Very Practical
70,01% - 80%	Quite Practical
50,01% - 70%	Less practical
1% - 50%	Impractical

To measure whether there is a significant difference in the pretest and post-numeracy literacy data, it is carried out using the one sample t-test test. Meanwhile, to find out how much the numeracy literacy has increased and how effective the supplement book is developed using the *n-gain score formula* as follows:

$$N - gain = \frac{Skor\ posttest - Skor\ pretest}{Skor\ maksimal - skor\ pretest}$$

As for interpreting the level of numeracy literacy ability and the level of product effectiveness developed by adopting from Hake (Hake, 1998) as follows:

Table 5. N-Gain Score Criteria

Score N-Gain	Criteria
$\langle g \rangle < 0.30$	Low
$0.30 \leq \langle g \rangle < 0.70$	Medium
$0.70 \leq \langle g \rangle$	High

Table 6. Percentage N-Gain Criteria

N-Gain Percentage	Criteria
$\langle g \rangle < 40\%$	Ineffective
$40\% \leq \langle g \rangle < 55\%$	less effective
$55\% \leq \langle g \rangle < 75\%$	Quite effective
$75\% \leq \langle g \rangle$	effective

RESULTS AND DISCUSSION

The final goal of this study is to produce a product in the form of a flat geometry supplement book based on *the Realistic Mathematics Education* approach, based on ethnomathematics reyog Ponorogo, which contains elements of numeracy literacy. The development stages of ADDIE (*Analysis, Design, Development, Implementation, and Evaluation*) will be explained as follows:

a. Analysis

The analysis carried out in this study is first, the curriculum analysis is carried out by determining the learning outcomes of the flat building material in Phase A (grades 1 and 2), namely getting to know the flat building, arranging the flat building (composition) and unraveling the flat building (decomposition). Second, the analysis of students with the results that, in general, the characteristics of students in phase A of the thinking process are at the concrete operational stage, so that learning activities should be developed with physical objects or visualizations of physical objects. In this study, the researcher used Reyog Ponorogo to visualize flat geometry material. This is because Reyog Ponorogo is an art that is inherent in students and is liked by students, especially in the Ponorogo Regency area. Third, the analysis of the availability of learning resources is carried out by surveying the availability of mathematics learning support materials and the Minimum Competency Assessment follow-up program materials at the basic education level. This availability analysis is carried out through a search on reference sources that are accessible to the school. The first source is the website <https://repositori.kemdikbud.go.id>, through this page, 10 titles of children's reading books are found that contain numeracy literacy. The second source is through the Bintang Pusnas application, which is integrated with the national library. The third source was carried out on the I-Pusnas application, in this application, the author found 11 book titles related to numeracy literacy.

The lack of literacy resources related to numeracy is supported by the results of interviews conducted with teachers at SD Tarbiyatul Islam, who stated that to implement numeracy literacy, teachers must design their mathematics learning books with an appropriate approach. Existing books have not been able to facilitate students to learn independently and train numeracy literacy skills. Based on the results of the needs analysis, it is necessary to have a supporting book or a supplement book that can improve students' literacy and numeracy skills.

b. Design

At the product design stage, it is carried out in several processes, namely 1) the design stage of the component of the supplement book which includes the cover, identity of the book, foreword, table of contents, narrative of reyog ponorogo, mathematical concepts about building flat, independent student activities, group student activities and

bibliography. 2) The design stage of material or content, which includes getting to know the flat building, arranging, and decomposing the flat building. 3) the design stage of the supplementary book design, such as color selection and background design for the material/content of the module, the selection of covers, using A4 paper size, 1.5 spacing scale; Palatino Linotype typeface with size 16 for the body and size 18 for the subtitle. For the title, the author uses the typeface Argentum Sans Black with size 28. To attract the learning interest of Madrasah Ibtidaiyah students, the researcher used colorful fonts, animated images, and real pictures about the Ponorogo reyog. 4) designing instruments used to assess supplementary books to experts, namely material experts, media experts, learning experts, and linguists, designing student response questionnaires and test questions to measure the improvement of students' numeracy literacy, this is by the statement of Arif et al., that after conducting an analysis, the researcher plans a product that aims to create a prototype that can be used (Arif et al., 2022).

c. Development

At the product development stage, it is carried out through two stages, namely the development of supplement books, assessment, and revision of the developed products while The description at the development stage is explained as follows:

Product development

1. Book cover, book identity, Foreword, and table of contents

The supplement book cover consists of two pages, which are the front page and the back page. The front page consists of the title of the module, images related to the title of the module, a cover, in this case, the art of Reyog Ponorogo, and the flat building is presented in the form of animation, and the author's name. This is done to stimulate children's curiosity about the content of books. The identity of the book is a description of the supplement book, and the preface contains the author's gratitude and gratitude to the party who has helped complete the book, as well as a brief overview of the contents of the book. While the table of contents contains the initial part of the book's identity, discussions in the supplement book and contains bibliography. The display design can be presented in the following image:

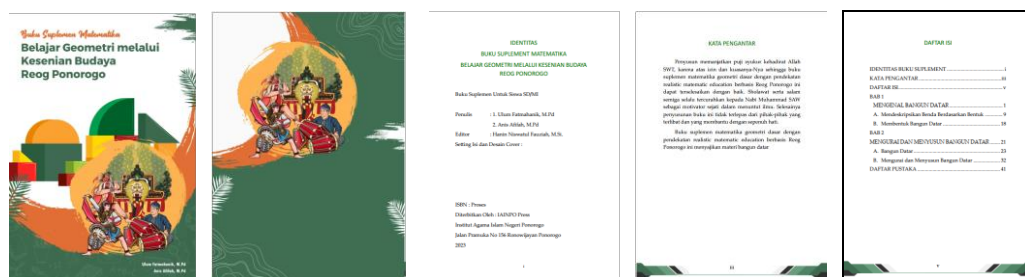


Figure 1 Cover design, book identity, foreword, table of contents

2. Core sections and bibliography

The core part consists of two chapters that refer to the learning outcomes of mathematics subjects in phase A. The first chapter, with the title Recognizing Flat Buildings contains two sub-chapters, namely describing objects based on shapes and forming flat buildings. In the sub-chapter of getting to know flat shapes, the author introduces four types of flat shapes, namely curved shapes, triangle shapes, rectangular shapes, and polygonal shapes, through the introduction of shapes on reyog

equipment, dancer equipment, and accompanying musical instrument equipment. The sub-chapter on forming a flat building contains material on how a building is formed from two or more buildings using visualization of the reyog Ponorogo equipment. After that, independent exercises are given by pairing several parts of a flat build so that it becomes a complete form of flat building. The second chapter in the supplement book is titled Unraveling and Compiling a Flat Build. This chapter consists of sub-chapters unraveling and arranging flat buildings. The bibliography contains references used in the preparation of supplements. The design of the display can be presented in the following image:

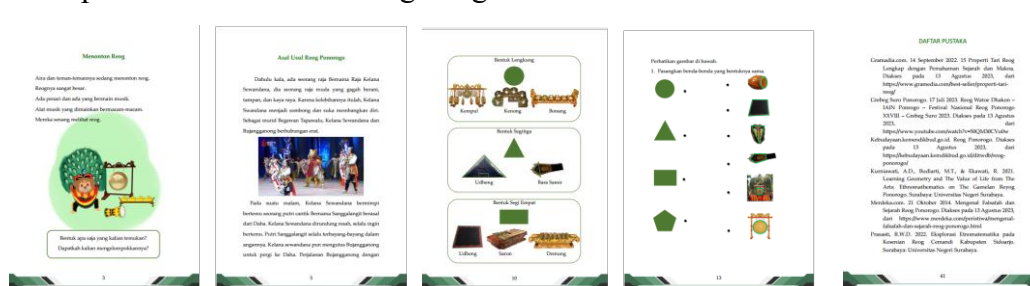
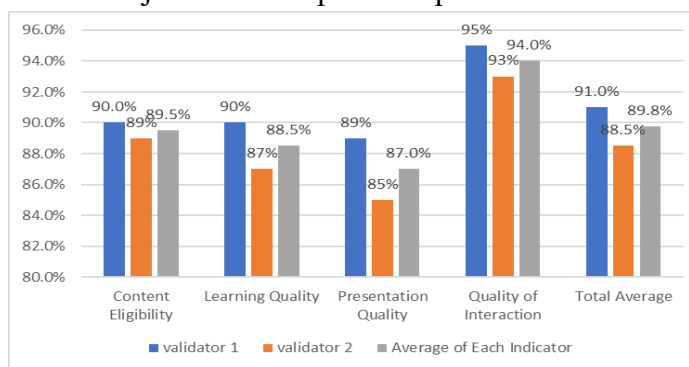


Figure 3. Example of content design and supplementary book library list

Member Ratings

Feasibility is assessed by conducting product evaluations with experts, including material experts, media experts, learning experts, and linguists. The total number of evaluators comprises eight validators, categorized by each type of validation. There are two validators specifically designated for subject matter expert validation, which aims to determine feasibility regarding the material of the product being developed. The results of the validation from the subject matter experts are presented as follows:

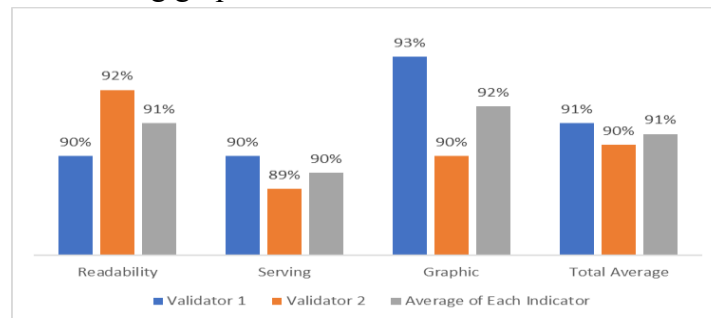


Graph 1. Material Expert Validation Results

Based on graph 1, the average percentage of validation of material experts as a whole in the development of supplement books is 89.8%, with very valid criteria. Material expert validation consists of four aspects, namely content feasibility, learning quality, presentation quality, and interaction quality. The average percentage obtained in the content feasibility aspect was 89.5%, the learning quality aspect 88.5%, while the quality of presentation was 87%, and the quality of interaction was 94%. This means that the supplement book is developed following the learning objectives to be achieved and following the needs of students. Nerita stated that teaching materials are said to be valid if they are by the curriculum, learning outcomes, study materials and the truth of the learning substance (Nerita et al., 2018) and if the teaching materials have been validated by material experts and meet validity standards, then the teaching materials are suitable

for use in the learning process. In addition, Suswina in (Yulia, 2021) also stated that teaching materials are said to be valid if there is a compatible with the material presented, able to encourage students' curiosity in exploring the material learned, and able to motivate students to read. The note given by the validator is that there needs to be instructions on each part of the supplement book, and the redaction of the competency test questions must be more realistic and not contain all the indicators of numeracy literacy.

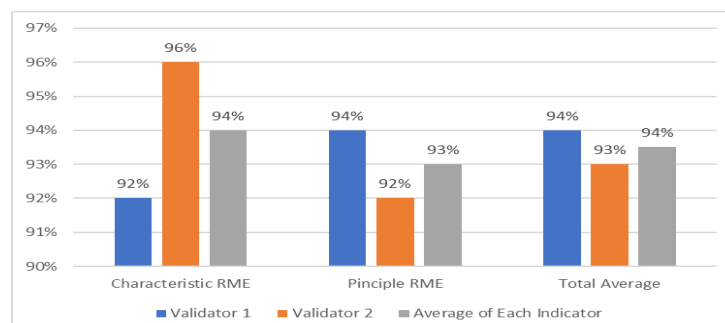
Furthermore, the validation of media experts aims to obtain the feasibility of the media from the supplement book developed. The results of the validation of media experts are presented in the following graph.



Graph 2. Media Expert Validation Results

Based on graph 2, the average percentage of validation of media experts as a whole in the development of supplement books is 91%, with very valid criteria. Media expert validation consists of three aspects, with a percentage of each aspect, namely the readability aspect of 91%, the presentation aspect of 90%, and the graphic aspect of 92%. This result is by Prastowo's statement in (Fatianti et al., 2024) which states that in teaching material, the use of images and graphics can motivate students in learning. In addition to the notes, suggestions, and criticisms given are that it is necessary to complete the image presented with the help of lines to emphasize the shape of the flat building in question and include the source of the image if it is not your creation.

Validation of learning experts aims to obtain feasibility in the use of learning approaches from the developed supplement books. The aspects that will be measured in this validation are the characteristics and principles of the Realistic Mathematics Education learning approach. The results of the validation of learning experts are presented in the following graph 3.

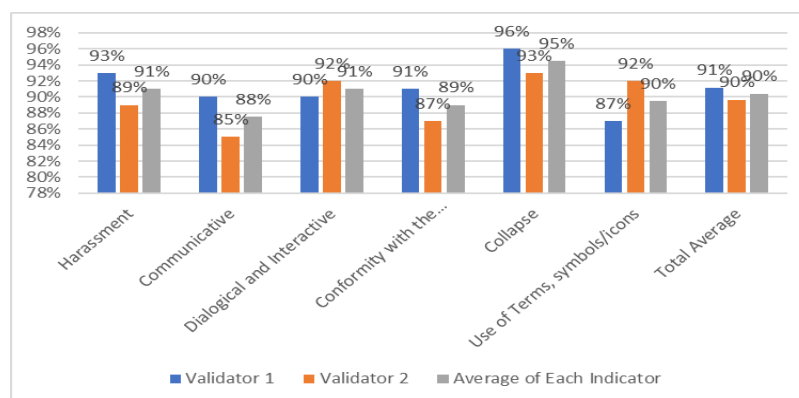


Graph 3. Learning Expert Validation Results

Based on graph 3, the average percentage of validation of learning experts overall in the development of supplement books is 94%, with very valid criteria. The average percentage of validation of learning experts in the characteristic aspects of *Realistics Mathematics Education* is 94% and the average in the aspect of *Realistics Mathematics*

Education principles is 93%. While suggestions for improvement in product development include the use of *Real Context* at the beginning of each learning in the supplement book, each problem does not accommodated all aspects of Realistic Mathematics Education.

As for linguistic validation, the aim is to obtain the feasibility of using language structure in the developed supplement book. The aspects that will be measured in this validation are straightforwardness, communicative, dialogical, suitability with the level of development of students, collapse, and use of thought flows, use of terms or icons. The results of linguistic validation are presented in the following 4 graphs.



Graph 4. Linguistic Validation Results

Based on graph 4, the average percentage of overall linguistic validation in the development of supplement books is 90%, with very valid criteria. The average percentage in the aspect of straightness is 91%, communication aspect 88%, dialogical and interactive aspect is 91%, the average percentage in the aspect of conformity with the level of development of students is 89%, while in the aspect of collapse and the use of the flow of thought is 95% and the percentage in the aspect of the use of terms or icons is 90%. These results are strengthened by Aisyah's statement that teaching materials are said to be valid if they contain a clear, easy-to-read, and understandable language structure (Aisyah et al., 2017) and there is also clarity in conveying using language with the correct rules (Yulia, 2021). Suggestions for improvement in linguist validation include the need to change the origin story of the Ponorogo reog into a narrative story with simple language, and there is inconsistency in the use of standard language.

d. Application

After going through the stages of product development, validation, and revision, the students' response to the developed product and its effectiveness in improving numeracy literacy skills will be measured. Hafiz (Fatianti et al., 2024) stated that in research, product development must be able to be used in learning, and considered good by observers. Therefore, the product is worth testing if the validator has stated that the product is valid.

Practical Response

The researcher tested the students' response to the supplement book developed by providing a questionnaire of practical responses to 2nd-grade students of SD Tarbiyatul Islam Kertosari Babadan Ponorogo, totaling 22 students. The results of the response to the supplement book are as follows:

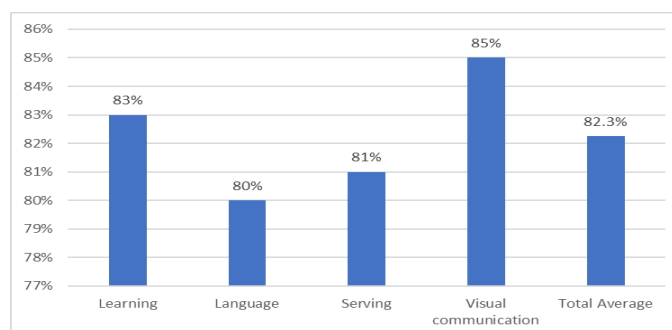


Chart 5. Results of Students' Practical Response to Supplement Books

Based on graph 5 above shows that the average percentage of students' practical responses to the learning aspect is 83%, the language aspect is 80%, the presentation aspect is 81%, and the visual communication aspect is 85%. Meanwhile, the overall average percentage in the development of supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics is 82.3%, with very practical criteria. The results of this practicality are also in line with the results of the research (Mustofa & Cintamulya, n.d.) which states that the teaching materials developed with very practical means that it very easy to use in learning.

Effectiveness of Supplement Books

Data on students' numeracy literacy ability in flat building materials was obtained through the pretest and posttest given to students. The pretest and posttest questions were prepared as many as 3 questions that have been adjusted to the numeracy literacy indicators. The difference between pretest and posttest results will be analyzed using one-sample t test. Pretest and posttest scores are presented in the following table.

Table 7. Numeracy Literacy Test Results

Before (pretest)					After (Postest)				
N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
22	50	70	62.0	6.12567	22	75	95	86,36	5.82520

Based on table 7 shows students' numeracy literacy skills before and after using supplement books. The average numeracy literacy ability before using supplement books is 62, while the average numeracy literacy ability after using supplement books is 86.36. Furthermore, to test whether there is an average difference between before and after using the supplement book, the normality test of the difference between pretests and posttests is first carried out. The results of the normality test are as follows:

Table 8. Normality Test Result Gain Score

	df	Sig	Taraf Sig	Keputusan Uji
Gain score Literasi Numerasi	22	0.216	0.05	Normal

From the results of the normality test, because it is $0.216 > 0.05$, the data is distributed normally. Henceforth, the homogeneity test on the difference between posttest and pretest was not carried out because the data came from the same subject. After the data is distributed normally, the next step is to conduct a one-sample t-test to find out whether there is a significant average difference between before and after using the supplement book. The test results are as follows.

Table 9. One Sample t Test Results

	t	df	Sig (two-side)	Taraf Sig	Keputusan uji
Gain score Literasi Numerasi	20.854	21	0.001	0.05	Ho Rejected

Based on Table 9, it shows that $0.001 < 0.05$, then H_0 is rejected, which means that there is a difference in numeracy literacy ability between before and after using the developed supplement book. Next, an n-gain test was carried out, which aimed to measure how large and effective the supplement books developed were on numeracy literacy ability. The results of the n-gain score test are presented in the following table.

Table 10. N-Gain Test Results

	N	Mean	Category
N-Gain Score	22	0.6461	Medium
N-Gain Persen	22	64.61	Quite Effective

Based on Table 10 it shows that the average n-gain score of numeracy literacy is 0.6461, which states that the increase in numeracy literacy ability is in the medium category. Furthermore, the average n-gain score percentage results showed 64.61%, which means that the supplement books developed in improving numeracy literacy are in the category of quite effective. These results show that supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics can improve students' numeracy literacy. This means that the Realistic Mathematics Education approach is effective for the development of teaching materials because, in its development, it integrates the real-world context. This is in line with Ariyani's statement that understanding in mathematics will be more meaningful if students can connect to daily life (Ariyani, 2019).

e. Evaluation

At this stage, an evaluation of the development process and assessment results is carried out by the validator. The level of validity can be seen from the results of the validity level of the book developed after an assessment by the validator. The overall validation results show that they are very valid. In addition, the results of the numeracy literacy test have increased moderately, and the supplement books developed are effective in improving numeracy literacy. The advantage of this supplement book is that it can be used in learning by teachers and students at the elementary level as a companion book to the main book, because the context of the material has been integrated with the reog Ponorogo culture. The disadvantage is that the numeracy literacy competency test presented is still limited, so its presentation needs to be further developed.

CONCLUSION

Based on the results of the data analysis, the developed supplement book is suitable for use because it meets the validity criteria with very high validity criteria, as shown by the assessment of material experts of 89.8%, media experts 91%, learning experts 94%, and linguists 90%. The results of the practical response showed an efficient criterion with an assessment of 82.3%. As for the increase in numeracy literacy, it is in the medium category, which is shown with an n-gain score of 0.6461. In addition, the n-gain score percent shows a value of 64.61%, which means that supplement books with a realistic mathematics education

approach based on the reog Ponorogo ethnomathematics are quite effective in improving numeracy literacy.

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[al.ibtida.snj] Submission Acknowledgement Kotak Masuk x

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NOTIFIKASI PERMINTAAN REVISI
(31 Mei 2025)

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Ulum Fatmahanik:

We have reached a decision regarding your submission to Al Ibtida: Jurnal Pendidikan Guru MI, "Development of Flat Geometry Supplement Book with the Realistic Mathematics Education Approach Based on Reog Ponorogo Ethnomathematics to Improve Numeracy Literacy of Elementary School Students".

Our decision is to: revision required, please revise immediately.
After that, please proofread your article by an expert translator.
To strengthen the diversity of our journal authors, please help us to collaborate your articles with authors from abroad.

Best regards,

Editorial team of Al Ibtida Jurnal Pendidikan Guru MI
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#20103 Review

[SUMMARY](#) [REVIEW](#) [EDITING](#)

Submission

Authors: Ulum Fatmahanik 
Title: Development of Flat Geometry Supplement Book with the Realistic Mathematics Education Approach Based on Reog Ponorogo Ethnomathematics to Improve Numeracy Literacy of Elementary School Students
Section: Articles
Editor: Wulan Andini 

Peer Review

Round 1

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**CATATAN DAN SARAN MASUKAN
REVIEWER 1**

Reviewer A:

Is the title of the article interesting?:

Not interesting

Does the title reflect the content of the article?:

At what level is the article original?

:

Medium

How would you rate the article based upon its novelty?:

Low (out of the date)

Does the abstract contain a brief description of the research objectives, methods used, research results, and conclusion?:

Yes

Is the gap presented in the study?:

No

How would you rate the accuracy of the research methods?:

Poor

Are the results of the research in accordance with the analytical methods used?:

No

Do the results of the study and the discussion answer the research questions posed?:

No

Do the results of the study and the discussion link the research findings with an established knowledge structure?:

No

Do the conclusions reflect the research findings?:

No

Overall Assessment:

:

Poor, major changes needed

Overall suggestions and comments from the review results:

:

To improve the quality of this article, I recommend revisiting the research objectives to make them clearer and more focused, ensuring they align with the study's overall goals. The methodology section should be expanded with more detailed explanations of the data collection and analysis processes to enhance transparency and replicability. It would also be beneficial to strengthen the literature review by incorporating more recent and diverse sources, particularly focusing on studies directly related to the Realistic Mathematics Education approach and ethnomathematics. Additionally, refining the data analysis with more advanced statistical methods and providing a deeper interpretation of the results would make the findings more robust. Finally, addressing the inconsistencies in the citation style, ensuring all references are correctly formatted, and expanding the range of sources would improve the academic rigor and credibility of the paper.

CATATAN DAN SARAN MASUKAN
REVIEWER 2

Reviewer B:

Is the title of the article interesting?:

Interesting

Does the title reflect the content of the article?:

At what level is the article original?

:

Medium

How would you rate the article based upon its novelty?:

Medium

Does the abstract contain a brief description of the research objectives, methods used, research results, and conclusion?:

No

Is the gap presented in the study?:

No

How would you rate the accuracy of the research methods?:

Good

Are the results of the research in accordance with the analytical methods used?:

Yes

Do the results of the study and the discussion answer the research questions posed?:

Yes

Do the results of the study and the discussion link the research findings with an established knowledge structure?:

No

Do the conclusions reflect the research findings?:

Yes

Overall Assessment:

:

Good, minor changes needed

Overall suggestions and comments from the review results:

:

1. Please strengthen the state of the arts your research by referring reputable international journal articles
2. please explain the gap analysis of your research with previous studies in the introduction
3. Research methods should be described in detail and operationally into 5-6 paragraphs, including research design, research procedure, data collecting technique, research instrument, data analysis techniques
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Development of a Supplementary Geometry Book Integrating Realistic Mathematics Education and Reog Ponorogo Ethnomathematics to Improve Elementary Students' Numeracy Literacy

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Abstract

This study presents the development of a supplementary geometry book for elementary students by integrating Reog Ponorogo ethnomathematics into the Realistic Mathematics Education (RME) approach to enhance numeracy literacy. The research employed a Research and Development (R&D) methodology using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Validation instruments involved expert evaluations in content, pedagogy, media, and language, alongside practicality questionnaires and numeracy literacy assessments. The developed book achieved high validity across expert domains: 89.8% (content), 91% (media), 94% (learning), and 90% (language). Student response also indicated high practicality (82.3%). A one-sample t-test and N-gain analysis showed a significant improvement in numeracy literacy, with an N-gain score of 0.6461 (categorized as moderate), reflecting a “quite effective” level. These findings suggest that incorporating ethnomathematical elements from local culture within an RME framework can provide meaningful, contextual learning experiences and foster mathematical understanding in early-grade students.

Keywords: *Supplementary Books, Realistic Mathematics Education, Ethnomathematics, Numeracy Literacy*

Abstrak

Penelitian ini bertujuan untuk mendiskripsikan pengembangan buku suplemen dengan pendekatan *Realistic Mathematics Education* berbasis etnomatematika reog Ponorogo dalam meningkatkan literasi numerasi. Pendekatan dan jenis penelitian yang digunakan adalah Research and Development dengan model ADDIE. Instrumen yang digunakan meliputi lembar validasi dari ahli materi, pembelajaran, media dan bahasa, serta angket respon kepraktisan dan soal literasi numerasi. Hasil pengembangan menunjukkan sangat valid digunakan dengan hasil penilaian ahli materi sebesar 89,8%, ahli media 91%, ahli pembelajaran 94% dan ahli bahasa 90%. Hasil Respon kepraktisan menunjukkan kriteria sangat praktis dengan penilaian 82,3%. Sementara itu, kemampuan literasi numerasi tergolong pada kategori sedang, dengan nilai N-gain sebesar 0,6461 atau 64,61% yang menunjukkan bahwa buku suplemen yang dikembangkan cukup efektif dalam meningkatkan literasi numerasi.

Kata Kunci: Buku Suplemen, Realistic Mathematics Education, Etnomatematika, Literasi Numerasi

INTRODUCTION

Numeracy literacy is a fundamental aspect of the National Literacy Movement, encompassing not only the ability to use numbers and symbols but also the skills needed to interpret, analyze, and communicate quantitative information in various formats such as graphs, tables, and charts for everyday decision-making (Atmazaki et al., 2017). Proficiency in numeracy goes beyond routine calculation; it reflects students' capacity to understand and apply mathematical concepts in authentic, real-life contexts (Han et al., 2017).

Despite its importance, the level of numeracy literacy among Indonesian students remains alarmingly low. Damanik and Handayani (2023) report that Indonesian students scored an average of 376 in mathematics on the 2018 Programme for International Student Assessment (PISA), placing the country 73rd out of 79 and well below the international average of 489 (Hewi & Shaleh, 2020). In line with these findings, the OECD (2019) noted that approximately 72% of Indonesian students had not reached minimum proficiency in mathematics. This problem is compounded by several factors, including limited access to contextualized mathematics tasks, a shortage of high-quality instructional materials that support numeracy development, and conventional teaching practices that often fail to engage learners (Indrastuti et al., 2024; Putrawangsa & Hasanah, 2022).

The scarcity of appropriate learning resources further hinders progress. According to the Ministry of Education and Culture, only 10 of the 644 titles in the national digital repository qualify as children's books containing elements of numeracy literacy. Moreover, the 2022 Minimum Competency Assessment (AKM) shows that the national average for numeracy was only 1.57 on a 1–3 scale. Although East Java slightly exceeded this figure with an average of 1.63, and Ponorogo Regency performed marginally better at 1.69, these scores still indicate a widespread need for more effective and contextually relevant numeracy instruction at the primary level.

One promising approach to address this need is Realistic Mathematics Education (RME), which encourages students to engage in problem-solving through meaningful, context-based scenarios. By situating mathematics within familiar situations, RME enables students to develop conceptual understanding through active participation (Palinussa et al., 2024; Sri Sutarni et al., 2024). Research has shown that this approach enhances student

participation and fosters more positive attitudes toward mathematics (Duong Huu et al., 2021). According to Ahmad Fauzan et al. (2024), RME not only improves academic achievement but also strengthens literacy and numeracy, particularly at the elementary level. Its adaptable nature makes it suitable for teachers with varying levels of experience and across different school settings, as it supports students in constructing mathematical knowledge from everyday life contexts (Palinussa et al., 2024).

In parallel, ethnomathematics has emerged as a culturally responsive approach to mathematics instruction. It situates mathematical learning within meaningful local cultural contexts, thereby enhancing student engagement and conceptual understanding (Prahmana et al., 2021; Hortelano & Lapinid, 2024). Research shows that cultural artifacts such as traditional games, music, and crafts—many of which are rich in mathematical content—can be integrated effectively into mathematics instruction (Kusuma et al., 2024; Lidinillah et al., 2022).

Ethnomathematics has been found to improve understanding in topics such as linear equations and geometry (Manapa, 2021; N. Sari et al., 2023) and to foster both numeracy literacy and student motivation when used in instructional materials such as worksheets (Kamal Arief SA et al., 2024). Thus, this approach not only contextualizes learning but also contributes to cultural preservation and the reinforcement of students' local identities.

Numerous studies have highlighted the benefits of RME-based materials in fostering creativity (Rismaratri & Nuryadi, 2018; Rudyanto et al., 2019; Sitorus, 2016), improving problem-solving skills (Ventistas et al., 2024; Yuanita et al., 2018), and promote mathematical literacy (Çakıroğlu et al., 2024; Nurmasari et al., 2023; Sumirattana et al., 2017). RME serves as a bridge between abstract mathematical ideas and the students' real-life experiences (Sevinc & Lesh, 2022; Vos, 2018). Similarly, integrating ethnomathematical perspectives in elementary school curricula has been shown to increase both academic performance and learning motivation (Alim et al., 2021; Putri et al., 2019; W. R. Sari & Mutmainah, 2018a).

Nevertheless, empirical studies that intentionally integrate RME with ethnomathematics—especially in early primary education—remain limited. Most existing implementations of RME are focused on secondary education, and few have evaluated their impact on numeracy literacy using standardized instruments. Furthermore, region-specific cultural elements such as *Reog Ponorogo*, which contain rich mathematical representations, are still largely absent from instructional design despite their educational potential.

To fill this gap, the present study aims to design and evaluate a supplementary geometry book for Phase A students (Grades 1–2), combining RME principles with ethnomathematical content derived from *Reog Ponorogo*. The goal is to create a culturally grounded, pedagogically sound learning resource that can enhance numeracy literacy while also supporting cultural appreciation. The study adopts a research and development approach to assess the material's validity, practicality, and effectiveness in classroom settings.

METHODS

This study adopted a Research and Development (R&D) design to produce a culturally contextualized mathematics supplementary book grounded in the principles of Realistic Mathematics Education (RME). The development process was guided by the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—which

offers a structured and iterative framework that supports continuous refinement based on feedback throughout each phase (Reiser and Mollenda cited in Rangkuti, 2016).

A combination of qualitative and quantitative instruments was used to evaluate the validity, usability, and effectiveness of the learning material. Validation involved structured expert reviews in four key areas: subject matter, pedagogical suitability, media presentation, and language use. Practicality was examined through student questionnaires, designed to assess the ease of use, clarity, and engagement of the material from the learner's perspective. To evaluate the impact of the product on learning outcomes, students completed pretests and posttests tailored to core indicators of numeracy literacy. Each tool was carefully designed to assess essential dimensions of educational quality, such as the relevance and accuracy of content, clarity of visual layout, alignment with student developmental stages, and the appropriateness of language and instructions. The criteria used in the expert validation are presented in Table 1.

Table 1. Product Rating Indicators by Experts

Member Ratings	Aspects
Material	Content eligibility
	Quality of learning
	Presentation/display quality
	Quality of interaction
Design/Media	Readability
	Serving
	Graphic
Learning	Characteristics of <i>Realistic Mathematics Education</i>
	Principles of <i>Realistic Mathematics Education</i>
Language	Harassment
	Communicative
	Dialogical and Interactive
	Suitability with the level of development of students
	Collapse and integration of the mindset
	Utilization of terminology, symbols, or icons.

The practicality questionnaire is designed to measure the ease of use and acceptance of the supplement book. The practicality of the product utilized is reflected in Table 2.

Table 2. Practicality Response Indicators

No.	Practicality Response Indicators
1.	Learning
2.	Language
3.	Serving
4.	Visual Communication

Meanwhile, the numeracy literacy test instrument was compiled based on the numeracy literacy indicators from Han et al. (2017), As presented in Table 3.

Table 3. Numeracy Literacy Indicators

No.	Numeracy Literacy Indicators
1.	Utilized a diverse range of numerical values and mathematical symbols to address everyday problem-solving
2.	Capable of interpreting data presented in multiple formats (such as graphs, tables, charts, diagrams, etc)
3.	Evaluated the findings from the analysis to inform decision-making

The data obtained from the product validation process was analyzed using content analysis to review suggestions and comments from validators, as well as percentage descriptive analysis to determine the level of product validity based on the criteria from Arikunto (2018). This can be seen in Table 4.

Table 4. Validity Criteria for Supplement Book Products

Percentage (%)	Product Eligibility Criteria
< 21%	Very invalid
21% - 40%	Invalid
41% - 60%	Quite valid
61% - 80%	Valid
81% - 100%	Highly Valid

Data from the student practicality questionnaire were also analyzed in a descriptive percentage manner and classified according to the categories in Table 5.

Table 5. Product Practicality Percentage Category

Score Interval	Category
80,01% - 100%	Very Practical
70,01% - 80%	Quite Practical
50,01% - 70%	Less practical
1% - 50%	Impractical

To evaluate the outcomes of the pretest and post-test in numeracy literacy, a one-sample t-test was conducted to identify any significant differences. Additionally, to assess the effectiveness of the product, the N-Gain value was calculated using Hake's formula (1998), and the results were interpreted based on the criteria outlined in Tables 6 and 7.

Table 6. N-Gain Score Criteria

Score N-Gain	Criteria
$\langle g \rangle < 0.30$	Low
$0.30 \leq \langle g \rangle < 0.70$	Medium
$0.70 \leq \langle g \rangle$	High

Table 7. Percentage N-Gain Criteria

N-Gain Percentage	Criteria
$\langle g \rangle < 40\%$	Ineffective
$40\% \leq \langle g \rangle < 55\%$	less effective
$55\% \leq \langle g \rangle < 75\%$	Quite effective
$75\% \leq \langle g \rangle$	effective

All stages of product development and testing are carried out sequentially and repeatedly to ensure that the resulting supplement books meet the measure of validity, usability, and efficiency of numeracy literacy learning. So that the resulting products can effectively contribute to the improvement of numeracy literacy of grade 2 elementary school students, especially through a mathematics learning approach that is contextual, interesting, and in accordance with the characteristics of children.

RESULTS AND DISCUSSION

The ultimate objective of this study is to create a supplementary book on flat geometry utilizing *the Realistic Mathematics Education* approach, based on ethnomathematics reyg Ponorogo, which contains elements of numeracy literacy. The results will be explained as follows:

a. Analysis

The analysis phase in this study involved three key components. First, a curriculum analysis was conducted to identify the targeted learning outcomes for flat geometry materials in Phase A (Grades 1 and 2). These outcomes include recognizing flat shapes, composing flat shapes (composition), and decomposing them (decomposition). Second, a student characteristic analysis was carried out to ensure that the developed materials align with the cognitive development of early-grade learners. Students in Phase A are generally at the concrete operational stage, in which learning is most effective when supported by physical objects or visual representations. Consequently, the instructional design emphasized hands-on and visual learning approaches. Third, an availability analysis of existing learning resources was conducted to examine the accessibility of mathematics-related literacy materials. This involved reviewing content from several official repositories. From the Ministry of Education and Culture's website (<https://repositori.kemdikbud.go.id>), only 10 children's books were identified as containing numeracy literacy elements. Additional searches through the Bintang Pusnas and I-Pusnas digital platforms—both connected to the National Library of Indonesia—revealed just 11 book titles relevant to numeracy literacy.

This scarcity of instructional materials was further substantiated by interviews with teachers at SD Tarbiyatul Islam. The teachers reported that existing mathematics textbooks do not adequately support independent learning or foster numeracy literacy skills. Consequently, they often must design their own instructional materials using suitable pedagogical approaches. These findings indicate an urgent need for the development of a culturally relevant supplementary book to support the enhancement of students' numeracy and literacy competencies.

b. Design

The design phase involved multiple stages aligned with the objectives of the ADDIE model. First, the structural design of the supplementary book was developed, including its core components and instructional flow. Second, the content development focused on the targeted flat geometry topics: recognizing, composing, and decomposing flat shapes, with contextual integration of Reog Ponorogo ethnomathematics. Third, the layout and visual design of the book were created to ensure accessibility and engagement for early-grade learners.

Additionally, this phase involved the design of evaluation instruments used during product validation. These included expert assessment rubrics covering material, media, instructional strategies, and language; student response questionnaires to evaluate practicality; and pretest–posttest instruments aligned with numeracy literacy indicators. As Arif et al. (2022) assert, following a thorough analysis, the design phase is intended to produce a usable prototype that can be iteratively refined based on empirical feedback.

c. Development

At the product development stage, it is performed across two stages, namely the development of supplement books, assessment, and revision of the developed products. While the description at the development stage is explained as follows:

Product Development

1. Book cover, book identity, Foreword, and Table of Contents

The cover of the supplement book consists of two pages, namely the front and back pages, the identity of the book which is a description of the supplement book, and the preface contains the author's gratitude and gratitude to the party who has helped complete the book and a brief overview of the contents of the book. While the table of contents contains the initial part of the book's identity, it also includes discussions in the supplement book and a bibliography. The design of the display can be presented in the following image:

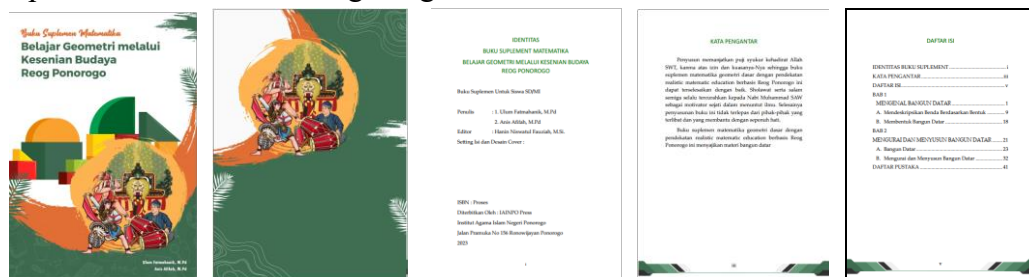


Figure 1 Cover design, book identity, foreword, table of contents

2. Core sections and bibliography

The core content of the supplementary book is organized into two chapters, each aligned with the learning outcomes for mathematics in Phase A (Grades 1 and 2). The first chapter, titled *Recognizing Flat Shapes*, comprises two sub-sections: *Describing Objects Based on Shape* and *Forming Flat Shapes*. In the first sub-section, students are introduced to four categories of two-dimensional shapes—curved, triangular, rectangular, and polygonal—through culturally relevant visualizations derived from Reog Ponorogo performance elements, including dancers' attire and traditional musical instruments. This ethnomathematical context serves to ground abstract geometric concepts in familiar, meaningful representations. The second sub-section focuses on the composition of flat shapes, illustrating how larger figures can be constructed from the combination of simpler geometric forms. These instructional materials also draw upon imagery and motifs from Reog Ponorogo to reinforce visual-spatial reasoning. The second chapter, *Decomposing and Reconstructing Flat Shapes*, includes two sub-sections: *Unraveling* and *Arranging Flat Shapes*. This chapter guides students in analyzing composite figures by breaking them into constituent parts and reconstructing them, thereby supporting early

development of spatial decomposition and composition skills. The visual and contextual design of these sections is illustrated in Figure 2.

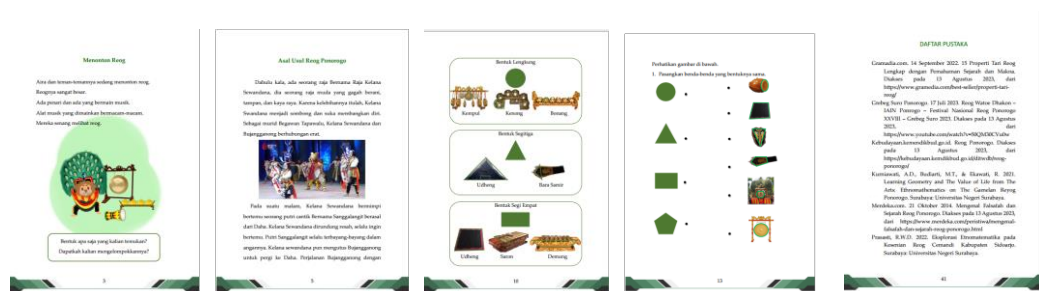
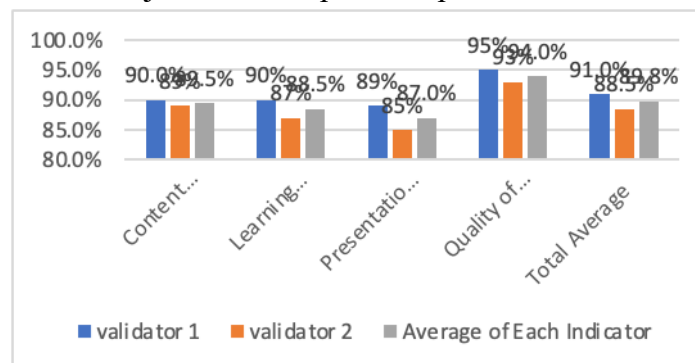


Figure 2. Example of content design and supplementary book library list

Member Ratings

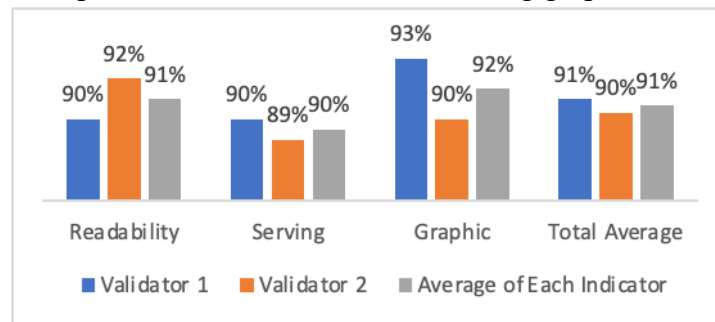
Feasibility is assessed by conducting product evaluations with experts, including material experts, media, learning, and linguists. The total number of evaluators comprises eight validators, categorized by each type of validation. There are two validators specifically designated for subject matter expert validation, which aims to determine feasibility regarding the material of the product being developed. The results of the validation from the subject matter experts are presented as follows:



Graph 1. Material Expert Validation Results

Based on Graph 1, the average validation score provided by content experts for the developed supplementary book was 89.8%, which falls within the “highly valid” category. Specifically, the content feasibility aspect scored an average of 89.5%, learning quality 88.5%, presentation quality 87%, and interaction quality 94%. These results indicate that the material is well-aligned with intended learning objectives and appropriately addresses students' cognitive and developmental needs. According to Nerita et al (2018), instructional materials are considered valid when they align with the curriculum, support learning outcomes, and present accurate subject matter content. Similarly, Yulia (2021a) emphasized that valid teaching materials not only match the content being taught but also foster student engagement, curiosity, and motivation to learn. Despite the strong overall validation, expert reviewers noted that the supplementary book would benefit from clearer instructional guidance in each section and more realistic formulations of competency test items, which should be aligned with, but not attempt to cover, all indicators of numeracy literacy.

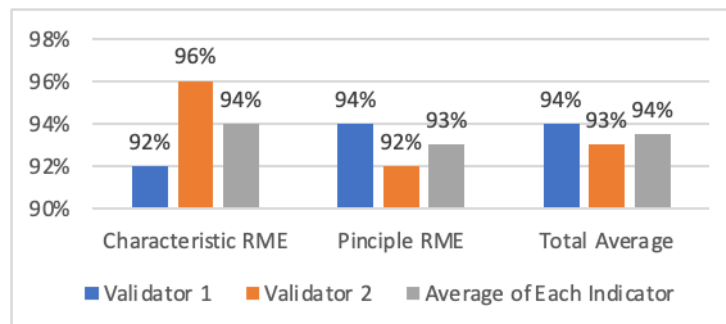
Furthermore, the validation of media experts is conducted to determine the feasibility of the media within the developed supplement book. The results of the validation of media experts are illustrated in the following graph.



Graph 2. Media Expert Validation Results

Based on Graph 2, the average percentage of validation of media experts in the development of supplement books is 91%, with very valid criteria. Media expert validation consists of three aspects, with a percentage of each aspect, namely the readability aspect of 91%, the presentation aspect of 90%, and the graphic aspect of 92%. This result is by Prastowo's statement, (Fatianti et al., 2024) which states that in teaching material, the use of images and graphics can motivate students in learning. In addition to the notes, suggestions, and criticisms given are that it is necessary to complete the image presented with the help of lines to emphasize the shape of the flat building in question and include the source of the image if it is not your creation.

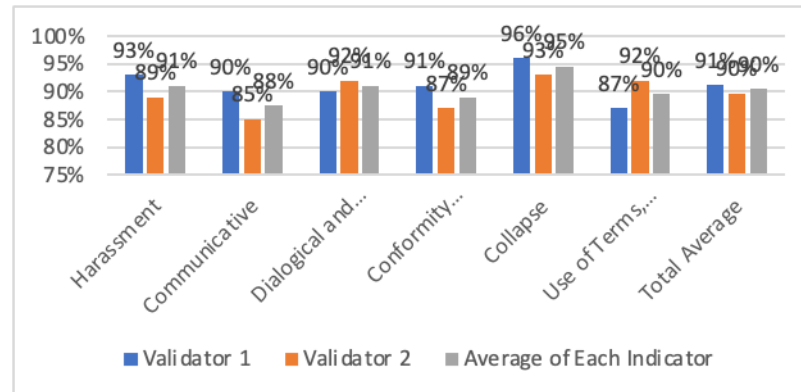
Validation of learning experts aims to obtain feasibility in the use of learning approaches from the developed supplement books. The aspects that will be measured in this validation are the characteristics and principles of the Realistic Mathematics Education learning approach. The results of the validation of learning experts are presented in the following Graph 3.



Graph 3. Learning Expert Validation Results

Based on Graph 3, the average percentage of validation of learning experts overall in the development of supplement books is 94%, with very valid criteria. The average percentage of validation of learning experts in the characteristic aspects of *Realistic Mathematics Education* is 94%, and the average in the aspect of *Realistic Mathematics Education* principles is 93%. While suggestions for improvement in product development include the use of *Real Context* at the beginning of each learning session in the supplement book, each problem does not accommodate all aspects of Realistic Mathematics Education. As for linguistic validation, the aim is to obtain the feasibility of using language structure in the developed supplement book. The aspects that will be measured in this validation are straightforwardness, communicative, dialogical, suitability

with the level of development of students, collapse, and use of thought flows, use of terms or icons. The results of linguistic validation are presented in Graph 4.



Graph 4. Linguistic Validation Results

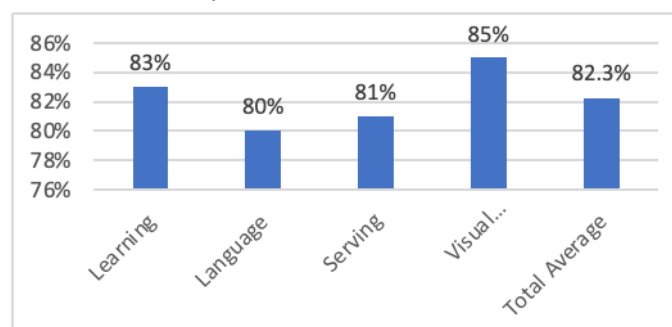
Based on Graph 4, the average percentage of overall linguistic validation in the development of supplement books is 90%, with very valid criteria. The average percentage in the aspect of straightness is 91%, communication aspect 88%, dialogical and interactive aspect is 91%, the average percentage in the aspect of conformity with the level of development of students is 89%, while in the aspect of collapse and the use of the flow of thought is 95% and the percentage in the aspect of the use of terms or icons is 90%. These results show the validity of the teaching materials because they contain a clear, easy-to-read, and understandable language structure. This is following Yulia's (2021) statement that valid teaching materials are those that contain clarity in conveying and using language with the correct rules. Suggestions for improvement in linguist validation include the need to change the origin story of the Ponorogo reog into a narrative story with simple language, and there is an inconsistency in the use of standard language.

d. Application

After going through the stages of product development, validation, and revision, the students' response to the developed product and its effectiveness in improving numeracy literacy skills will be measured. Hafiz (Fatianti et al., 2024) stated that in research, product development must be able to be used in learning and be considered good by observers. Therefore, the product is worth testing if the validator has stated that the product is valid.

Practical Response

The researcher tested the students' response to the supplement book developed by providing a questionnaire of practical responses to 2nd-grade students of SD Tarbiyatul Islam Kertosari Babadan Ponorogo, totaling 22 students. The results of the response to the supplement book are as follows:



Graph 5. Results of Students' Practical Response to Supplement Books

Based on graph 5 above shows that the average percentage of students' practical responses to the learning aspect is 83%, the language aspect is 80%, the presentation aspect is 81%, and the visual communication aspect is 85%. Meanwhile, the overall average percentage in the development of supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics is 82.3%, with very practical criteria. This outcome is in line with the results of a study (Mustofa & Cintamulya, 2017) which states that the teaching materials developed with very practical means that it very easy to use in learning.

Effectiveness of Supplement Books

Data on students' numeracy literacy ability in flat building materials was obtained through the pretest and posttest given to students. The pretest and posttest questions were prepared as many as 3 questions that have been adjusted to the numeracy literacy indicators. The difference between pretest and posttest results will be analyzed using a one-sample t-test. Pretest and posttest scores are presented in Table 8.

Table 8. Numeracy Literacy Test Results

Before (pretest)					After (Postest)				
N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
22	50	70	62.0	6.12567	22	75	95	86,36	5.82520

Table 8 shows students' numeracy literacy skills before and after using supplementary books. The average numeracy literacy ability before using supplement books is 62, while the average numeracy literacy ability after using supplement books is 86.36. Furthermore, to test whether there is an average difference between before and after using the supplement book, the normality test of the difference between pretests and posttests is first carried out. The results are as follows.

Table 9. Normality Test Result Gain Score

			Df	Sig	Taraf Sig	Keputusan Uji
Gain score	Literacy	22	0.216	0.05		Normal
Numeracy						

Based on the results of the normality test, the data were found to be normally distributed, as indicated by the significance value of 0.216, which exceeds the threshold of 0.05. Therefore, a homogeneity test for the difference between posttest and pretest scores was deemed unnecessary, given that both datasets were obtained from the same group of participants. Following the confirmation of normal distribution, a one-sample t-test was applied to assess if the mean scores differed significantly before and after the implementation of the supplementary book. The outcomes of this analysis are presented below.

Table 10. One Sample t Test Results

	t	df	Sig (two-sided)	Sig	Decision Test
Gain score Literacy Numeracy	20.854	21	0.001	0.05	Ho Rejected

Based on Table 10, because $0.001 < 0.05$, H_0 was rejected, indicating a significant difference in numeracy literacy skills before and after the use of supplementary books. Furthermore, an N-gain test was conducted to assess the effectiveness of the supplement books on numeracy literacy skills. The outcome N-gain score test is as follows.

Table 11. N-Gain Test Results

	N	Mean	Category
N-Gain Score	22	0.6461	Medium
N-Gain Persen	22	64.61	Quite Effective

Table 11 shows that the average n-gain score of numeracy literacy is 0.6461, which states that the increase in numeracy literacy ability is in the medium category. Furthermore, the average n-gain score percentage results showed 64.61%, which means that the supplement books developed for improving numeracy literacy are in the category of quite effective. These results show that supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics can improve students' numeracy literacy. This means that the Realistic Mathematics Education approach is effective for the development of teaching materials because, in its development, it integrates the real-world context so that understanding in mathematics will be more meaningful if students can connect to daily life (Ariyani, 2019).

e. Evaluation

The findings revealed a substantial improvement in students' numeracy literacy following the implementation of the developed supplementary book. The average score increased from 62 (pretest) to 86.36 (posttest), with a one-sample t-test yielding a statistically significant result ($t = 20.854$, $p = 0.001$). The mean N-gain score was 0.6461 (64.61%), placing the intervention in the “moderately effective” category. These results demonstrate the effectiveness of integrating Realistic Mathematics Education (RME) with Reog Ponorogo ethnomathematics in enhancing mathematical understanding at the elementary level.

This study reinforces prior research that highlights RME's capacity to improve mathematical reasoning through real-world contextualization (van den Heuvel-Panhuizen & Drijvers, 2020; Fauzan, Slettenhaar, & Plomp, 2021) and responds to challenges identified by Ekawati et al. (2020) regarding Indonesian students' difficulties in spatial and geometric literacy. The cultural contextualization using ethnomathematics further amplifies learning impact, as shown in studies by Prahmana & D'Ambrosio (2020) and Son et al. (2020), who found that blending RME with local cultural contexts increases cognitive engagement and accessibility across diverse student groups.

In addition, the development of a supplementary book grounded in Realistic Mathematics Education (RME) and the ethnomathematical elements of Reog Ponorogo has proven to be highly valid and practical for classroom implementation at the elementary school level. The intervention has also demonstrated a notable effectiveness in enhancing students' numeracy literacy. These findings align with those reported by Fendrik et al. (2024), who emphasized that instructional models incorporating ethnomathematical contexts can significantly strengthen mathematical competencies. Similarly, studies conducted by Indrastuti et al. (2024) and Khatimah (N. Sari et al., 2023) affirmed the

positive impact of RME-based student worksheets (LKPD) in advancing numeracy literacy through the integration of authentic, real-life contexts that resonate with students' everyday experiences. The current study also reinforces the conclusions drawn by Sari and Muthmainah (2018b), who asserted that embedding ethnomathematics into instructional settings not only cultivates student motivation but also deepens conceptual understanding in mathematics. Similarly, ethnomathematics-based learning fosters connections between students' lived experiences and formal mathematical concepts (Rowlands and Carson, 2002).

Moreover, this work extends the findings of Nurmasari et al. (2023) on the adaptation of RME through Realistic Mathematics Engineering and affirms the conclusions Anwas et al. (2022), that underscore the pivotal role of material quality in literacy outcomes. By integrating Reog Ponorogo—a rich local cultural asset—into early-grade mathematics instruction, this study offers a scalable model for contextualizing national curriculum content, supporting both numeracy literacy goals and cultural preservation.

CONCLUSION

This study demonstrates that combining Realistic Mathematics Education with ethnomathematical elements from Reog Ponorogo offers an effective strategy for enhancing numeracy literacy in elementary education. The developed supplementary book met high standards of validity and practicality and significantly improved students' numeracy skills. These findings reinforce the value of contextual, culture-based learning in mathematics and support further integration of ethnomathematical perspectives into instructional design to foster meaningful, relevant, and engaging learning experiences.

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#20103 Review

[SUMMARY](#) [REVIEW](#) [EDITING](#)

Submission

Authors	Ulum Fatmahanik
Title	Development of Flat Geometry Supplement Book with the Realistic Mathematics Education Approach Based on Reog Ponorogo Ethnomathematics to Improve Numeracy Literacy of Elementary School Students
Section	Articles
Editor	Wulan Andini

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Round 1

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Ahmad Arifuddin
kepada saya ▾

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We have reached a decision regarding your submission to Al Ibtida: Jurnal Pendidikan Guru MI, "Development of Flat Geometry Supplement Book with the Realistic Mathematics Education Approach Based on Reog Ponorogo Ethnomathematics to Improve Numeracy Literacy of Elementary School Students".

Our decision is to: Accepted

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Thanks,

Best regards,
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ARTIKEL TERBIT
(29 JUNI 2025)

Development of a Supplementary Geometry Book Integrating Realistic Mathematics Education and Reog Ponorogo Ethnomathematics to Improve Elementary Students' Numeracy Literacy

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Abstract

This study presents the development of a supplementary geometry book for elementary students by integrating Reog Ponorogo ethnomathematics into the Realistic Mathematics Education (RME) approach to enhance numeracy literacy. The research employed a Research and Development (R&D) methodology using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Validation instruments involved expert evaluations in content, pedagogy, media, and language, alongside practicality questionnaires and numeracy literacy assessments. The developed book achieved high validity across expert domains: 89.8% (content), 91% (media), 94% (learning), and 90% (language). Student response also indicated high practicality (82.3%). A one-sample t-test and N-gain analysis showed a significant improvement in numeracy literacy, with an N-gain score of 0.6461 (categorized as moderate), reflecting a “quite effective” level. These findings suggest that incorporating ethnomathematical elements from local culture within an RME framework can provide meaningful, contextual learning experiences and foster mathematical understanding in early-grade students.

Keywords: *supplementary books, realistic mathematics education, ethnomathematics, numeracy literacy.*

Abstrak

Penelitian ini menyajikan pengembangan buku suplemen geometri untuk siswa sekolah dasar dengan mengintegrasikan etnomatematika Reog Ponorogo ke dalam pendekatan Pendidikan Matematika Realistik (RME) untuk meningkatkan literasi numerasi. Penelitian ini menggunakan metodologi Penelitian dan Pengembangan (R&D) dengan menggunakan model ADDIE (Analisis, Desain, Pengembangan, Implementasi, Evaluasi). Instrumen validasi melibatkan evaluasi ahli dalam konten, pedagogi, media, dan bahasa, di samping kuesioner praktikalitas dan penilaian literasi numerasi. Buku yang dikembangkan mencapai validitas tinggi di seluruh domain ahli: 89,8% (konten), 91% (media), 94% (pembelajaran), dan 90% (bahasa). Respon siswa juga menunjukkan kepraktisan tinggi (82,3%). Uji-t satu sampel dan analisis N-gain menunjukkan peningkatan yang signifikan dalam literasi numerasi, dengan skor N-gain sebesar 0,6461 (dikategorikan sebagai sedang), yang mencerminkan tingkat "cukup efektif". Temuan ini menunjukkan bahwa menggabungkan unsur-unsur etnomatematika dari budaya lokal dalam kerangka RME dapat memberikan pengalaman belajar yang bermakna dan kontekstual serta menumbuhkan pemahaman matematika pada siswa kelas awal.

Kata kunci: *buku suplemen, realistic mathematics education, etnomatematika, literasi numerasi.*

INTRODUCTION

Numeracy literacy is a fundamental aspect of the National Literacy Movement, encompassing not only the ability to use numbers and symbols but also the skills needed to interpret, analyze, and communicate quantitative information in various formats such as graphs, tables, and charts for everyday decision-making (Atmazaki et al., 2017). Proficiency in numeracy goes beyond routine calculation; it reflects students' capacity to understand and apply mathematical concepts in authentic, real-life contexts (Han et al., 2017).

Despite its importance, the level of numeracy literacy among Indonesian students remains alarmingly low. Damanik and Handayani (2023) report that Indonesian students scored an average of 376 in mathematics on the 2018 Programme for International Student Assessment (PISA), placing the country 73rd out of 79 and well below the international average of 489 (Hewi & Shaleh, 2020). In line with these findings, the OECD (2019) noted that approximately 72% of Indonesian students had not reached minimum proficiency in mathematics. This problem is compounded by several factors, including limited access to contextualized mathematics tasks, a shortage of high-quality instructional materials that support numeracy development, and conventional teaching practices that often fail to engage learners (Indrastuti et al., 2024; Putrawangsa & Hasanah, 2022).

The scarcity of appropriate learning resources further hinders progress. According to the Ministry of Education and Culture, only 10 of the 644 titles in the national digital repository qualify as children's books containing elements of numeracy literacy. Moreover, the 2022 Minimum Competency Assessment (AKM) shows that the national average for numeracy was only 1.57 on a 1–3 scale. Although East Java slightly exceeded this figure with an average of 1.63, and Ponorogo Regency performed marginally better at 1.69, these scores still indicate a widespread need for more effective and contextually relevant numeracy instruction at the primary level.

One promising approach to address this need is Realistic Mathematics Education (RME), which encourages students to engage in problem-solving through meaningful, context-based scenarios. By situating mathematics within familiar situations, RME enables students to develop conceptual understanding through active participation (Palinussa et al., 2024; Sri Sutarni et al., 2024). Research has shown that this approach enhances student participation and fosters more positive attitudes toward mathematics (Duong Huu et al., 2021). According to Ahmad Fauzan et al. (2024), RME not only improves academic achievement but also strengthens literacy and numeracy, particularly at the elementary level. Its adaptable nature makes it suitable for teachers with varying levels of experience and across different school settings, as it supports students in constructing mathematical knowledge from everyday life contexts (Palinussa et al., 2024).

In parallel, ethnomathematics has emerged as a culturally responsive approach to mathematics instruction. It situates mathematical learning within meaningful local cultural contexts, thereby enhancing student engagement and conceptual understanding (Prahmana et al., 2021; Hortelano & Lapinid, 2024). Research shows that cultural artifacts such as traditional games, music, and crafts—many of which are rich in mathematical content—can be integrated effectively into mathematics instruction (Kusuma et al., 2024; Lidinillah et al., 2022).

Ethnomathematics has been found to improve understanding in topics such as linear equations and geometry (Manapa, 2021; N. Sari et al., 2023) and to foster both numeracy literacy and student motivation when used in instructional materials such as worksheets (Kamal Arief SA et al., 2024). Thus, this approach not only contextualizes learning but also contributes to cultural preservation and the reinforcement of students' local identities.

Numerous studies have highlighted the benefits of RME-based materials in fostering creativity (Rismaratri & Nuryadi, 2018; Rudyanto et al., 2019; Sitorus, 2016), , improving problem-solving skills (Ventistas et al., 2024; Yuanita et al., 2018), , and promote mathematical literacy (Çakıroğlu et al., 2024; Nurmasari et al., 2023; Sumirattana et al., 2017). RME serves as a bridge between abstract mathematical ideas and the students' real-life experiences (Sevinc & Lesh, 2022; Vos, 2018). Similarly, integrating ethnomathematical perspectives in elementary school curricula has been shown to increase both academic performance and learning motivation (Alim et al., 2021; Putri et al., 2019; W. R. Sari & Mutmainah, 2018a).

Nevertheless, empirical studies that intentionally integrate RME with ethnomathematics—especially in early primary education—remain limited. Most existing implementations of RME are focused on secondary education, and few have evaluated their impact on numeracy literacy using standardized instruments. Furthermore, region-specific cultural elements such as *Reog Ponorogo*, which contain rich mathematical representations, are still largely absent from instructional design despite their educational potential.

To fill this gap, the present study aims to design and evaluate a supplementary geometry book for Phase A students (Grades 1–2), combining RME principles with ethnomathematical content derived from *Reog Ponorogo*. The goal is to create a culturally grounded, pedagogically sound learning resource that can enhance numeracy literacy while also supporting cultural appreciation. The study adopts a research and development approach to assess the material's validity, practicality, and effectiveness in classroom settings.

METHODS

This study adopted a Research and Development (R&D) design to produce a culturally contextualized mathematics supplementary book grounded in the principles of Realistic Mathematics Education (RME). The development process was guided by the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—which offers a structured and iterative framework that supports continuous refinement based on feedback throughout each phase (Reiser and Mollenda cited in Rangkuti, 2016).

A combination of qualitative and quantitative instruments was used to evaluate the validity, usability, and effectiveness of the learning material. Validation involved structured expert reviews in four key areas: subject matter, pedagogical suitability, media presentation, and language use. Practicality was examined through student questionnaires, designed to assess the ease of use, clarity, and engagement of the material from the learner's perspective. To evaluate the impact of the product on learning outcomes, students completed pretests and posttests tailored to core indicators of numeracy literacy. Each tool was carefully designed to assess essential dimensions of educational quality, such as the relevance and accuracy of content, clarity of visual layout, alignment with student developmental stages, and the appropriateness of language and instructions. The criteria used in the expert validation are presented in Table 1.

Table 1. Product Rating Indicators by Experts

Member Ratings	Aspects
Material	Content eligibility
	Quality of learning
	Presentation/display quality
	Quality of interaction
Design/Media	Readability
	Serving
	Graphic
Learning	Characteristics of <i>Realistic Mathematics Education</i>
	Principles of <i>Realistic Mathematics Education</i>
Language	Harassment
	Communicative
	Dialogical and Interactive
	Suitability with the level of development of students
	Collapse and integration of the mindset
	Utilization of terminology, symbols, or icons.

The practicality questionnaire is designed to measure the ease of use and acceptance of the supplement book. The practicality of the product utilized is reflected in Table 2.

Table 2. Practicality Response Indicators

No.	Practicality Response Indicators
1.	Learning
2.	Language
3.	Serving
4.	Visual Communication

Meanwhile, the numeracy literacy test instrument was compiled based on the numeracy literacy indicators from Han et al. (2017), As presented in Table 3.

Table 3. Numeracy Literacy Indicators

No.	Numeracy Literacy Indicators
1.	Utilized a diverse range of numerical values and mathematical symbols to address everyday problem-solving
2.	Capable of interpreting data presented in multiple formats (such as graphs, tables, charts, diagrams, etc)
3.	Evaluated the findings from the analysis to inform decision-making

The data obtained from the product validation process was analyzed using content analysis to review suggestions and comments from validators, as well as percentage descriptive analysis to determine the level of product validity based on the criteria from Arikunto (2018) . This can be seen in Table 4.

Table 4. Validity Criteria for Supplement Book Products

Percentage (%)	Product Eligibility Criteria
< 21%	Very invalid
21% - 40%	Invalid
41% - 60%	Quite valid
61% - 80%	Valid
81% - 100%	Highly Valid

Data from the student practicality questionnaire were also analyzed in a descriptive percentage manner and classified according to the categories in Table 5.

Table 5. Product Practicality Percentage Category

Score Interval	Category
80,01% - 100%	Very Practical
70,01% - 80%	Quite Practical
50,01% - 70%	Less practical
1% - 50%	Impractical

To evaluate the outcomes of the pretest and post-test in numeracy literacy, a one-sample t-test was conducted to identify any significant differences. Additionally, to assess the effectiveness of the product, the N-Gain value was calculated using Hake's formula (1998), and the results were interpreted based on the criteria outlined in Tables 6 and 7.

Table 6. N-Gain Score Criteria

Score N-Gain	Criteria
$\langle g \rangle < 0.30$	Low
$0.30 \leq \langle g \rangle < 0.70$	Medium
$0.70 \leq \langle g \rangle$	High

Table 7. Percentage N-Gain Criteria

N-Gain Percentage	Criteria
$\langle g \rangle < 40\%$	Ineffective
$40\% \leq \langle g \rangle < 55\%$	less effective
$55\% \leq \langle g \rangle < 75\%$	Quite effective
$75\% \leq \langle g \rangle$	effective

All stages of product development and testing are carried out sequentially and repeatedly to ensure that the resulting supplement books meet the measure of validity, usability, and efficiency of numeracy literacy learning. So that the resulting products can effectively contribute to the improvement of numeracy literacy of grade 2 elementary school students, especially through a mathematics learning approach that is contextual, interesting, and in accordance with the characteristics of children.

RESULTS AND DISCUSSION

The ultimate objective of this study is to create a supplementary book on geometry utilizing the *Realistic Mathematics Education* approach, based on ethnomathematics reyog Ponorogo, which contains elements of numeracy literacy. The results will be explained as follows:

ANALYSIS

The analysis phase in this study involved three key components. First, a curriculum analysis was conducted to identify the targeted learning outcomes for flat geometry materials in Phase A (Grades 1 and 2). These outcomes include recognizing flat shapes, composing flat shapes (composition), and decomposing them (decomposition). Second, a student characteristic analysis was carried out to ensure that the developed materials align with the cognitive development of early-grade learners. Students in Phase A are generally at the concrete operational stage, in which learning is most effective when supported by physical objects or visual representations. Consequently, the instructional design emphasized hands-on and visual learning approaches. Third, an availability analysis of existing learning resources was conducted to examine the accessibility of mathematics-related literacy materials. This involved reviewing content from several official repositories. From the Ministry of Education and Culture's website (<https://repositori.kemdikbud.go.id>), only 10 children's books were identified as containing numeracy literacy elements. Additional searches through the Bintang Pusnas and I-Pusnas digital platforms—both connected to the National Library of Indonesia—revealed just 11 book titles relevant to numeracy literacy.

This scarcity of instructional materials was further substantiated by interviews with teachers at SD Tarbiyatul Islam. The teachers reported that existing mathematics textbooks do not adequately support independent learning or foster numeracy literacy skills. Consequently, they often must design their own instructional materials using suitable pedagogical approaches. These findings indicate an urgent need for the development of a culturally relevant supplementary book to support the enhancement of students' numeracy and literacy competencies.

DESIGN

The design phase involved multiple stages aligned with the objectives of the ADDIE model. First, the structural design of the supplementary book was developed, including its core components and instructional flow. Second, the content development focused on the targeted flat geometry topics: recognizing, composing, and decomposing flat shapes, with contextual integration of Reog Ponorogo ethnomathematics. Third, the layout and visual design of the book were created to ensure accessibility and engagement for early-grade learners.

Additionally, this phase involved the design of evaluation instruments used during product validation. These included expert assessment rubrics covering material, media, instructional strategies, and language; student response questionnaires to evaluate practicality; and pretest–posttest instruments aligned with numeracy literacy indicators. As Arif et al. (2022) assert, following a thorough analysis, the design phase is intended to produce a usable prototype that can be iteratively refined based on empirical feedback.

DEVELOPMENT

At the product development stage, it is performed across two stages, namely the development of supplement books, assessment, and revision of the developed products. While the description at the development stage is explained as follows:

Product Development

Book cover, book identity, Foreword, and Table of Contents

The cover of the supplement book consists of two pages, namely the front and back pages, the identity of the book which is a description of the supplement book, and the preface contains the author's gratitude and gratitude to the party who has helped complete the book and a brief overview of the contents of the book. While the table of contents contains the initial part of the book's identity, it also includes discussions in the supplement book and a bibliography. The design of the display can be presented in the following image:

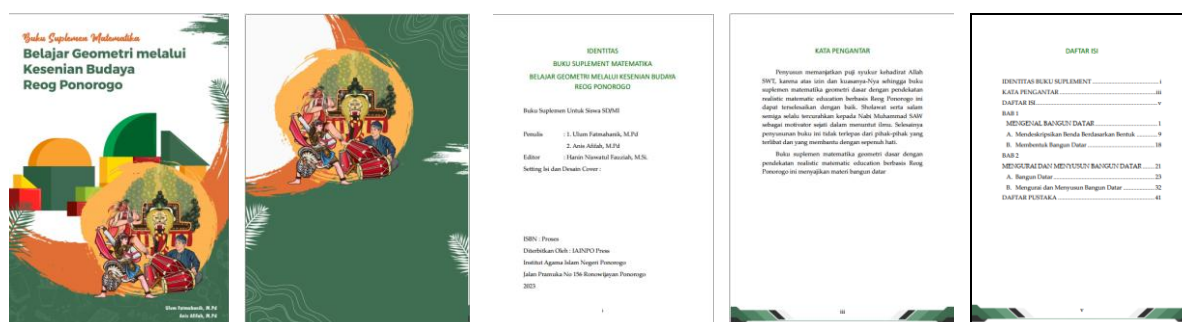


Figure 1 Cover design, book identity, foreword, table of contents

Core sections and bibliography

The core content of the supplementary book is organized into two chapters, each aligned with the learning outcomes for mathematics in Phase A (Grades 1 and 2). The first chapter, titled *Recognizing Flat Shapes*, comprises two sub-sections: *Describing Objects Based on Shape* and *Forming Flat Shapes*. In the first sub-section, students are introduced to four categories of two-dimensional shapes—curved, triangular, rectangular, and polygonal—through culturally relevant visualizations derived from Reog Ponorogo performance elements,

including dancers' attire and traditional musical instruments. This ethnomathematical context serves to ground abstract geometric concepts in familiar, meaningful representations. The second sub-section focuses on the composition of flat shapes, illustrating how larger figures can be constructed from the combination of simpler geometric forms. These instructional materials also draw upon imagery and motifs from Reog Ponorogo to reinforce visual-spatial reasoning. The second chapter, *Decomposing and Reconstructing Flat Shapes*, includes two sub-sections: *Unraveling* and *Arranging Flat Shapes*. This chapter guides students in analyzing composite figures by breaking them into constituent parts and reconstructing them, thereby supporting early development of spatial decomposition and composition skills. The visual and contextual design of these sections is illustrated in Figure 2.

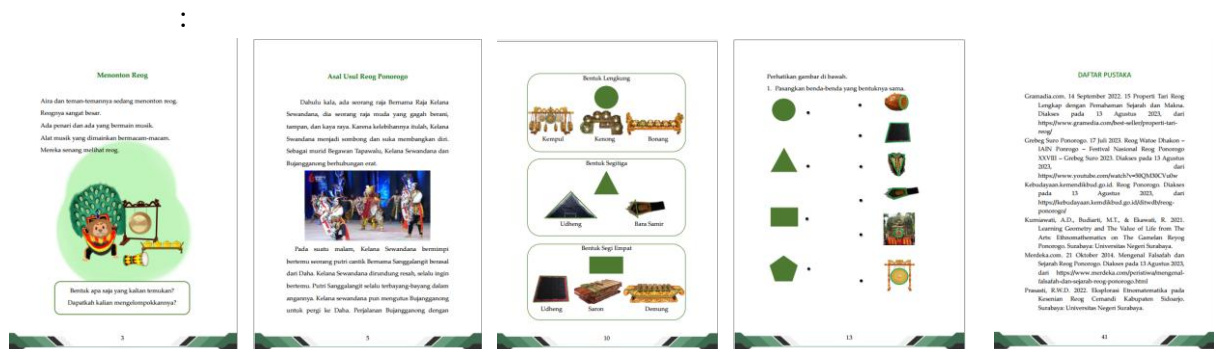
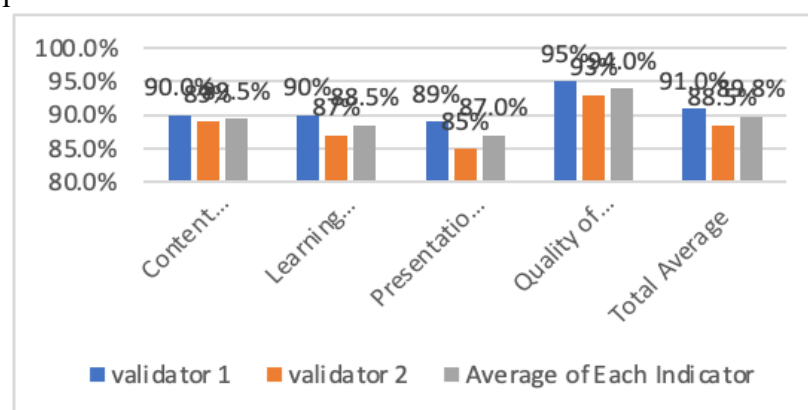


Figure 2. Example of content design and supplementary book library list

Member Ratings

Feasibility is assessed by conducting product evaluations with experts, including material experts, media, learning, and linguists. The total number of evaluators comprises eight validators, categorized by each type of validation. There are two validators specifically designated for subject matter expert validation, which aims to determine feasibility regarding the material of the product being developed. The results of the validation from the subject matter experts are presented as follows:

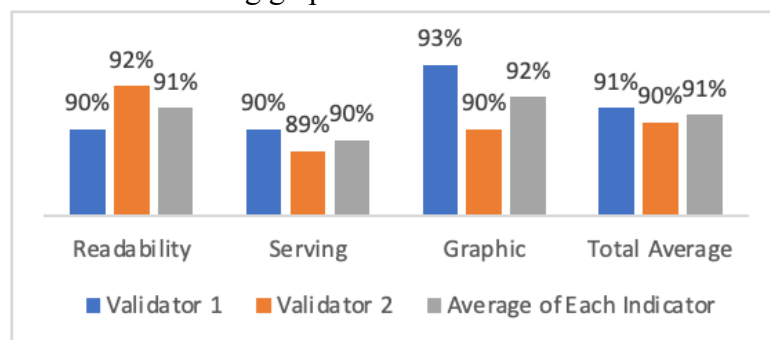


Graph 1. Material Expert Validation Results

Based on Graph 1, the average validation score provided by content experts for the developed supplementary book was 89.8%, which falls within the “highly valid” category. Specifically, the content feasibility aspect scored an average of 89.5%, learning quality 88.5%, presentation quality 87%, and interaction quality 94%. These results indicate that the material is well-aligned with intended learning objectives and appropriately addresses

students' cognitive and developmental needs. According to Nerita et al (2018), instructional materials are considered valid when they align with the curriculum, support learning outcomes, and present accurate subject matter content. Similarly, Yulia (2021a) emphasized that valid teaching materials not only match the content being taught but also foster student engagement, curiosity, and motivation to learn. Despite the strong overall validation, expert reviewers noted that the supplementary book would benefit from clearer instructional guidance in each section and more realistic formulations of competency test items, which should be aligned with, but not attempt to cover, all indicators of numeracy literacy.

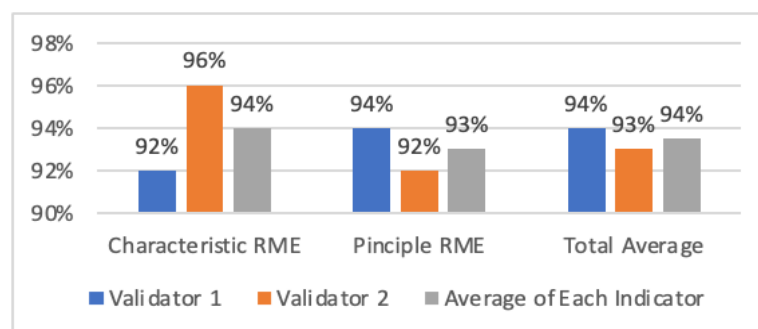
Furthermore, the validation of media experts is conducted to determine the feasibility of the media within the developed supplement book. The results of the validation of media experts are illustrated in the following graph.



Graph 2. Media Expert Validation Results

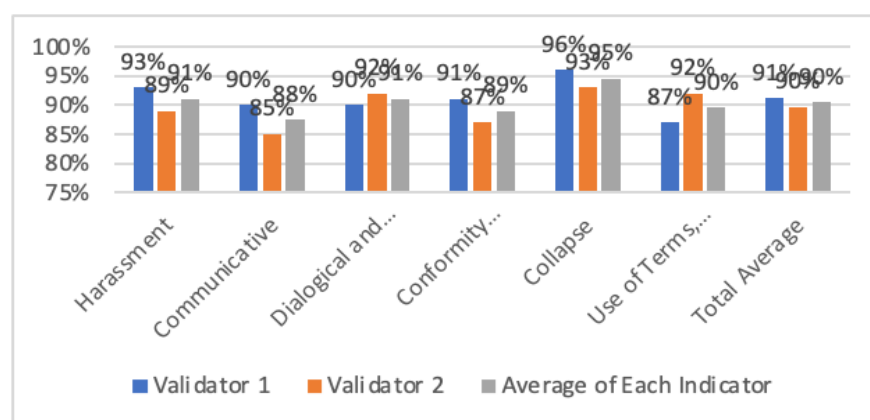
Based on Graph 2, the average percentage of validation of media experts in the development of supplement books is 91%, with very valid criteria. Media expert validation consists of three aspects, with a percentage of each aspect, namely the readability aspect of 91%, the presentation aspect of 90%, and the graphic aspect of 92%. This result is by Prastowo's statement, (Fatianti et al., 2024) which states that in teaching material, the use of images and graphics can motivate students in learning. In addition to the notes, suggestions, and criticisms given are that it is necessary to complete the image presented with the help of lines to emphasize the shape of the flat building in question and include the source of the image if it is not your creation.

Validation of learning experts aims to obtain feasibility in the use of learning approaches from the developed supplement books. The aspects that will be measured in this validation are the characteristics and principles of the Realistic Mathematics Education learning approach. The results of the validation of learning experts are presented in the following Graph 3.



Graph 3. Learning Expert Validation Results

Based on Graph 3, the average percentage of validation of learning experts overall in the development of supplement books is 94%, with very valid criteria. The average percentage of validation of learning experts in the characteristic aspects of *Realistic Mathematics Education* is 94%, and the average in the aspect of *Realistic Mathematics Education* principles is 93%. While suggestions for improvement in product development include the use of *Real Context* at the beginning of each learning session in the supplement book, each problem does not accommodate all aspects of Realistic Mathematics Education. As for linguistic validation, the aim is to obtain the feasibility of using language structure in the developed supplement book. The aspects that will be measured in this validation are straightforwardness, communicative, dialogical, suitability with the level of development of students, collapse, and use of thought flows, use of terms or icons. The results of linguistic validation are presented in Graph 4.



Graph 4. Linguistic Validation Results

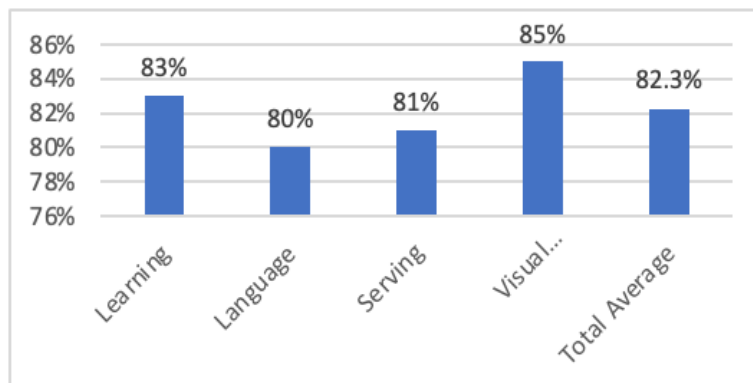
Based on Graph 4, the average percentage of overall linguistic validation in the development of supplement books is 90%, with very valid criteria. The average percentage in the aspect of straightness is 91%, communication aspect 88%, dialogical and interactive aspect is 91%, the average percentage in the aspect of conformity with the level of development of students is 89%, while in the aspect of collapse and the use of the flow of thought is 95% and the percentage in the aspect of the use of terms or icons is 90%. These results show the validity of the teaching materials because they contain a clear, easy-to-read, and understandable language structure. This is following Yulia's (2021) statement that valid teaching materials are those that contain clarity in conveying and using language with the correct rules. Suggestions for improvement in linguist validation include the need to change the origin story of the Ponorogo reog into a narrative story with simple language, and there is an inconsistency in the use of standard language.

IMPLEMENTATION

After going through the stages of product development, validation, and revision, the students' response to the developed product and its effectiveness in improving numeracy literacy skills will be measured. Hafiz (Fatianti et al., 2024) stated that in research, product development must be able to be used in learning and be considered good by observers. Therefore, the product is worth testing if the validator has stated that the product is valid.

Practical Response

The researcher tested the students' response to the supplement book developed by providing a questionnaire of practical responses to 2nd-grade students of SD Tarbiyatul Islam Kertosari Babadan Ponorogo, totaling 22 students. The results of the response to the supplement book are as follows:



Graph 5. Results of Students' Practical Response to Supplement Books

Based on graph 5 above shows that the average percentage of students' practical responses to the learning aspect is 83%, the language aspect is 80%, the presentation aspect is 81%, and the visual communication aspect is 85%. Meanwhile, the overall average percentage in the development of supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics is 82.3%, with very practical criteria. This outcome is in line with the results of a study (Mustofa & Cintamulya, 2017) which states that the teaching materials developed with very practical means that it very easy to use in learning.

Effectiveness of Supplement Books

Data on students' numeracy literacy ability in flat building materials was obtained through the pretest and posttest given to students. The pretest and posttest questions were prepared as many as 3 questions that have been adjusted to the numeracy literacy indicators. The difference between pretest and posttest results will be analyzed using a one-sample t-test. Pretest and posttest scores are presented in Table 8.

Table 8. Numeracy Literacy Test Results

Before (pretest)					After (Postest)				
N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
22	50	70	62.0	6.12567	22	75	95	86,36	5.82520

Table 8 shows students' numeracy literacy skills before and after using supplementary books. The average numeracy literacy ability before using supplement books is 62, while the average numeracy literacy ability after using supplement books is 86.36. Furthermore, to test whether there is an average difference between before and after using the supplement book, the normality test of the difference between pretests and posttests is first carried out. The results are as follows.

Table 9. Normality Test Result Gain Score

			Df	Sig	Taraf Sig	Keputusan Uji
Gain	score	Literacy	22	0.216	0.05	Normal
Numeracy						

Based on the results of the normality test, the data were found to be normally distributed, as indicated by the significance value of 0.216, which exceeds the threshold of 0.05. Therefore, a homogeneity test for the difference between posttest and pretest scores was deemed unnecessary, given that both datasets were obtained from the same group of participants. Following the confirmation of normal distribution, a one-sample t-test was applied to assess if the mean scores differed significantly before and after the implementation of the supplementary book. The outcomes of this analysis are presented below.

Table 10. One Sample t Test Results

		t	df	Sig (two-sided)	Sig	Decision test
Gain	score	20.854	21	0.001	0.05	Ho Rejected
Literacy	Numeracy					

Based on Table 10, because $0.001 < 0.05$, H_0 was rejected, indicating a significant difference in numeracy literacy skills before and after the use of supplementary books. Furthermore, an N-gain test was conducted to assess the effectiveness of the supplement books on numeracy literacy skills. The outcome N-gain score test is as follows.

Table 11. N-Gain Test Results

	N	Mean	Category
N-Gain Score	22	0.6461	Medium
N-Gain Persen	22	64.61	Quite Effective

Table 11 shows that the average n-gain score of numeracy literacy is 0.6461, which states that the increase in numeracy literacy ability is in the medium category. Furthermore, the average n-gain score percentage results showed 64.61%, which means that the supplement books developed for improving numeracy literacy are in the category of quite effective. These results show that supplementary books with the Realistic Mathematics Education approach based on Reog Ponorogo ethnomathematics can improve students' numeracy literacy. This means that the Realistic Mathematics Education approach is effective for the development of teaching materials because, in its development, it integrates the real-world context so that understanding in mathematics will be more meaningful if students can connect to daily life (Ariyani, 2019).

EVALUATION

The findings revealed a substantial improvement in students' numeracy literacy following the implementation of the developed supplementary book. The average score increased from 62 (pretest) to 86.36 (posttest), with a one-sample t-test yielding a statistically significant result ($t = 20.854$, $p = 0.001$). The mean N-gain score was 0.6461 (64.61%), placing the intervention in the "moderately effective" category. These results demonstrate the

effectiveness of integrating Realistic Mathematics Education (RME) with Reog Ponorogo ethnomathematics in enhancing mathematical understanding at the elementary level.

This study reinforces prior research that highlights RME's capacity to improve mathematical reasoning through real-world contextualization (van den Heuvel-Panhuizen & Drijvers, 2020; Fauzan, Slettenhaar, & Plomp, 2021) and responds to challenges identified by Ekawati et al. (2020) regarding Indonesian students' difficulties in spatial and geometric literacy. The cultural contextualization using ethnomathematics further amplifies learning impact, as shown in studies by Prahmana & D'Ambrosio (2020) and Son et al. (2020), who found that blending RME with local cultural contexts increases cognitive engagement and accessibility across diverse student groups.

In addition, the development of a supplementary book grounded in Realistic Mathematics Education (RME) and the ethnomathematical elements of Reog Ponorogo has proven to be highly valid and practical for classroom implementation at the elementary school level. The intervention has also demonstrated a notable effectiveness in enhancing students' numeracy literacy. These findings align with those reported by Fendrik et al. (2024), who emphasized that instructional models incorporating ethnomathematical contexts can significantly strengthen mathematical competencies. Similarly, studies conducted by Indrastuti et al. (2024) and Khatimah (N. Sari et al., 2023) affirmed the positive impact of RME-based student worksheets (LKPD) in advancing numeracy literacy through the integration of authentic, real-life contexts that resonate with students' everyday experiences. The current study also reinforces the conclusions drawn by Sari and Muthmainah (2018b), who asserted that embedding ethnomathematics into instructional settings not only cultivates student motivation but also deepens conceptual understanding in mathematics. Similarly, ethnomathematics-based learning fosters connections between students' lived experiences and formal mathematical concepts (Rowlands and Carson, 2002).

Moreover, this work extends the findings of Nurmasari et al. (2023) on the adaptation of RME through Realistic Mathematics Engineering and affirms the conclusions Anwas et al. (2022), that underscore the pivotal role of material quality in literacy outcomes. By integrating Reog Ponorogo—a rich local cultural asset—into early-grade mathematics instruction, this study offers a scalable model for contextualizing national curriculum content, supporting both numeracy literacy goals and cultural preservation.

CONCLUSION

This study demonstrates that combining Realistic Mathematics Education with ethnomathematical elements from Reog Ponorogo offers an effective strategy for enhancing numeracy literacy in elementary education. The developed supplementary book met high standards of validity and practicality and significantly improved students' numeracy skills. These findings reinforce the value of contextual, culture-based learning in mathematics and support further integration of ethnomathematical perspectives into instructional design to foster meaningful, relevant, and engaging learning experiences.

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