International Conference on Global Innovations in Education, Science, and Technology
Mataram, September 30-09, 2026

Faculty of Teacher Training and Education
Universitas Muhammadiyah Mataram
Mataram City, Indonesia

Developing an RME-Based Mathematics Pocket Book to Support 2D Geometry Learning in Elementary Schools

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Abstract: This research was motivated by the limited availability of dedicated mathematics pocket books at the elementary school level. This study aimed to develop a valid and practical mathematics pocket book focused on two-dimensional (2D) shapes based on the Realistic Mathematics Education (RME) approach. Using the Research and Development (R&D) method with the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation), the study involved fifth-grade students at Elementary School, South Jakarta, during the even semester of the 2024/2025 academic year. Expert validation confirmed high validity: linguistic validity (98%), media validity (84%), and instructional material validity (92%), all categorized as "very valid." Furthermore, practicality trials involving teachers and students yielded high practicality scores: 96.66% from teachers, 93.33% from a small group trial ($n = 5$), and 94.75% from a large group trial ($n = 27$), all falling into the "very practical" category. These findings demonstrate that the RME-based pocket book developed through the ADDIE model is highly valid and practical as a supplementary learning medium for fifth-grade mathematics instruction.

Keywords: 2D Shapes; Mathematics Education; Pocket Book; Realistic Mathematics Education (RME); ADDIE Model.

Article History:
Received: 01-08-2026
Online : 30-09-2026

A. INTRODUCTION

Education serves as the primary engine for social progress, human capital cultivation, and sustainable economic advancement within a globalized society (Witraguna et al., 2024: 47). In contemporary educational paradigms, the learning process must transcend rote memorization to nurture critical thinking, cognitive agility, and structured problem-solving skills (Nasril et al., 2023: 173). Within this ecosystem, teachers occupy a pivotal position as instructional architects responsible for structuring dynamic classroom environments (Muthma'innah, 2022: 76). Nevertheless, a chronic pedagogical shortfall persists across basic education: instructional activities often remain disengaged from real-world applicability, failing to bridge theoretical constructs with students daily lived experiences.

This instructional stagnation is particularly noticeable in elementary mathematics education. Conventional classroom routines frequently rely on one-way didactic lectures and whiteboard transcriptions, relegating students to passive listeners who struggle to internalize abstract concepts (Pabesak & Santoso, 2023: 2). Instructional media are rarely integrated systematically to stimulate conceptual discovery (Puspitarini & Hanif, 2019: 54; Tafonao, 2018:

104). Consequently, mathematics is widely stigmatized by young learners as rigid, intimidating, and overly complicated, despite its foundational role in fostering logical reasoning and analytical competence (Rahmah & Lubis, 2024: 93).

Among elementary mathematics curricula, two-dimensional geometry (flat shapes) constitutes a cornerstone domain. Flat shapes defined as closed planar geometric figures bounded by straight or curved line segments encompass essential conceptual dimensions such as side lengths, angles, perimeter, and area (Unaenah et al., 2020: 331). At the primary school level, mastering geometric principles requires concrete sensory visualization and contextual anchoring before progressing toward formal mathematical abstraction. When geometric concepts are introduced purely through algorithmic formulas, students merely memorize procedures without comprehending spatial properties or underlying geometric relationships. To bridge this cognitive divide, the Realistic Mathematics Education (RME) framework initially pioneered by Hans Freudenthal and further operationalized by Gravemeijer—offers an exemplary pedagogical alternative (Ma'arif & Sutarni, 2023: 2784; Nuraina et al., 2021: 545). RME posits that mathematics is a human activity that must originate from authentic, meaningful real-world phenomena (didactical phenomenology).

There is a balance between horizontal mathematization translating contextual problems into mathematical models and vertical mathematization carrying out further mathematical processes abstractly within the mathematical system itself. Examples of horizontal mathematization include identifying, structuring, and presenting problems in various ways, as well as transforming real-life situations into mathematical problems. Examples of vertical mathematization include representing relationships using formulas, refining and adjusting mathematical models, applying various models, constructing mathematical models, and generalizing. The Realistic Mathematics Education (RME) approach has several advantages and disadvantages that warrant consideration. According to Ndiung (cited in Widana, 2021: 451), the advantages and disadvantages of the RME approach include the following: 1) students become more independent and active in exploring concepts and connecting them to everyday experiences; and 2) RME boosts learning motivation through an activity-based approach, ensuring active participation from all students. Meanwhile, the disadvantages of the RME approach are: 1) teachers may lack the motivation to prepare creative lessons incorporating real-world examples; and 2) teachers face difficulties in providing instructional media that utilize concrete objects aligned with the concepts being taught.

To resolve this operational bottleneck, the development of a printed Pocket Book presents an innovative, highly functional solution. A pocket book is a compact, portable learning medium designed with concise narrative structures, engaging visual illustrations, and high-density instructional value (Fajriana et al., 2022: 112; Oktaviani & Mellyzar, 2020: 159). Its ergonomic format allows pupils to review concepts independently anytime and anywhere without digital screen fatigue or dependency on electronic devices. Motivated by these considerations, this study developed, validated, and evaluated an RME-based Pocket Book covering flat shapes tailored for fifth-grade elementary school students. By integrating realistic scenarios, structured exploration tasks, and progressive mathematization frameworks into a pocket-sized format, this research delivers an empirically tested instructional resource that addresses educational needs in primary school mathematics.

B. METHOD

This investigation employed a Research and Development (R&D) methodology designed to engineer and test educational products (Rustamana et al., 2024: 60). The instructional design process was structured using the five-stage ADDIE paradigm (Analysis, Design, Development, Implementation, Evaluation), chosen for its iterative feedback loops and systematic quality-control mechanisms across all development phases (Sari, 2018: 86).

1. Research Phases (ADDIE Framework)

a. Analysis Phase: Conducted comprehensive pedagogical assessments, analyzing curriculum learning outcomes (Capaian Pembelajaran) under the Kurikulum Merdeka, syllabus requirements, instructional bottlenecks in Grade 5 classrooms, and the cognitive-developmental characteristics of elementary school students.

b. Design Phase: Formulated the instructional architecture of the Pocket Book, established learning objectives, outlined RME-aligned thematic units (covering squares, rectangles, triangles, parallelograms, trapezoids, rhombuses, and kites), selected typography and color palettes, and created initial digital layouts using Canva Pro. Research evaluation instruments (expert validation rubrics and user practicality questionnaires) were also drafted.

c. Development Phase**:** Translated digital designs into physical print media (utilizing 150 gsm Art Carton for durable laminated covers and 80 gsm premium HVS paper for interior pages). The prototype was then subjected to rigorous appraisal by an expert validation panel.

d. Implementation Phase: Conducted sequential field usability trials at SD Negeri Kebagusan 01 Pagi, Pasar Minggu District, South Jakarta, during the even semester of the 2024/2025 academic year. Testing included practitioner usability evaluation with the Grade 5 classroom teacher (n = 1), small-group student trial (n = 5), and large-group field implementation (n = 27).

e. Evaluation Phase: Performed formative and summative data analyses combining expert feedback, empirical validation scores, and student usability data to finalize the product.

2. Research Subjects and Data Collection

The study involved multi-stakeholder evaluators:

a. Three expert validators from Universitas Muhammadiyah Jakarta: a Language Specialist (evaluating linguistic correctness and readability), a Subject Matter Specialist (evaluating mathematical accuracy and RME fidelity), and a Media Design Specialist (evaluating layout, typography, and visual ergonomics).

b. Field users: One Grade 5 classroom teacher (Mrs. Devi Putri Utami, S.Pd.) and 27 fifth-grade students of SDN Kebagusan 01 Pagi.

Data collection instruments comprised structured Likert-scale validation questionnaires for experts and teachers (ranging from score 1 = "Very Poor" to 5 = "Very Good") (Sugiyono, 2021: 192) and dichotomous Guttman-scale questionnaires for student practicality trials (1 = "Yes", 0 = "No") (Sugiyono, 2021: 193).

3. Data Analysis Techniques

Expert validation and teacher practicality scores were computed using the percentage formula (1):

$$P = \frac{\sum S}{\sum S_{\max}} \times 100\%$$

Where:

P = Percentage validity or practicality score (%)

$\sum S$ = Total empirical score awarded by validators/practitioners

$\sum S_{\max}$ = Maximum possible theoretical score across all evaluated indicators

The calculated percentage was categorized using established criteria (Astriani & Akmalia, 2022: 3437), as presented in Table 1.

Table 1. Expert Validity and Practicality Qualification Criteria

Score Interval (P)	Validity Classification	Practicality Classification
80% < P ≤ 100%	Very Valid	Very Practical
60% < P ≤ 80%	Valid	Practical
40% < P ≤ 60%	Moderately Valid	Moderately Practical
20% < P ≤ 40%	Low Validity	Less Practical
0% ≤ P ≤ 20%	Invalid	Impractical

Student practicality survey data obtained via Guttman scaling were calculated using formula (2) (Sofiasyari et al., 2023: 1792):

$$P = \frac{F}{N} \times 100\%$$

Where:

P = Practicality percentage score (%)

F = Total cumulative positive responses obtained from students

N = Total maximum possible positive score (number of items × number of respondents)

C. RESULTS AND DISCUSSION

1. Development of a Pocketbook Based on Realistic Mathematics Education (RME) for 2D Shape Topics for Elementary School Students

a. Analysis

An analysis of mathematics instruction in Grade V at SD Negeri Kebagusan 01 Pagi reveals a gap between conventional teaching practices still dominated by lectures and the demands of 21st century learning, which emphasize active student engagement. Current methods often render students passive, fail to provide sufficient cognitive stimulation, and do not foster intrinsic motivation, particularly regarding abstract topics such as 2D shapes. A lack of adequate instructional media hinders the understanding of geometric concepts that require visualization; consequently, the development of such media serves not merely as an aid but as a strategic solution to address low student motivation and comprehension. Curriculum analysis indicates that the Grade V unit on 2D shapes entails learning outcomes regarding the comparison of shape characteristics and learning objectives covering both cognitive and

applied aspects; therefore, the media to be developed must simultaneously support the attainment of these competencies. Aligned with constructivist theory and the Realistic Mathematics Education (RME) approach, a Pocket Book is proposed to bridge theoretical concepts with students' real-world experiences. This medium offers visual, interactive, and contextual content tailored to the visual and kinesthetic learning styles of elementary school students. Although students possess basic understanding, they are unfamiliar with contextual learning models like RME; thus, the Pocket Book is designed as a pedagogical intervention to boost motivation, interest, and engagement while shifting the teaching paradigm from a teacher-centered approach to a student-centered one, wherein students actively construct their own knowledge.

b. Design

During the design stage, the researcher developed an initial model of a "Pocket Book" learning aid serving as a blueprint from development through to final evaluation by adopting the Realistic Mathematics Education (RME) approach; this ensures the material is not merely theoretical but relevant to students' daily activities, thereby enhancing understanding and learning motivation. Content regarding 2D shapes including rectangles, squares, parallelograms, trapezoids, kites, rhombuses, and triangles was organized according to Learning Outcomes and supplemented with definitions, formulas, characteristics, contextual examples, and practice problems. This content was then brought to life through an engaging visual design created in Canva Pro, utilizing a clear blend of images, colors, and typography to ensure the material was both informative and appealing to students. In this phase, the researcher also designed a research instrument a questionnaire to gather feedback, results, and suggestions from trial participants through both qualitative and quantitative data. The instrument underwent a tiered validation process by three experts (linguistics, subject matter, and media) to ensure that the language, content, and design adhered to educational standards. Following expert validation, a practicality test was conducted using questionnaires distributed to teachers and students at SD Negeri Kebagusan 01 Pagi across two stages small-group and large-group trials to obtain empirical data regarding the media's ease of use. This entire process reflects a systematic methodology that prioritizes the validity, quality, and suitability of the product prior to its dissemination.

c. Development

The development stage is an essential phase in the Research and Development (R&D) cycle, focusing on transforming the product design into a functional prototype ready for testing. This process begins with the systematic creation of the media, starting with digital visual design using Canva Pro, which encompasses both cover and interior layouts. The researcher integrates comprehensive learning material on 2D shapes complemented by practice exercises into the design. Once the final design is approved, a physical prototype of the pocketbook is produced according to technical specifications: 150-gram art carton paper for the cover to ensure durability, and 80-gram HVS paper for the interior pages. Following production, a crucial next step is expert validation, aimed at assessing the product's suitability across three key aspects: language (by a linguist), visual design and functionality (by a media expert), and content accuracy (by a subject matter expert). The validation results serve as the

basis for necessary revisions before the pocketbook is tested with the research subjects. The results of developing the Realistic Mathematics Education (RME) based pocketbook on 2D shapes are presented in the following table.

The design of the Pocket Book Bangun Datar 2D Shapes Pocket Book as presented in Table 5 and Figure 3 is specifically structured to reflect the principles of Realistic Mathematics Education (RME). This learning medium is designed to facilitate the learning process through "progressive mathematization" and "guided reinvention" by presenting concepts in a gradual and structured manner. Furthermore, the design adopts the approach of "didactical phenomenology" by integrating contextual problems that align with students' everyday experiences and situations. The objective is to encourage students to construct their own understanding, ultimately fostering the creation of "self-developed models" that serve as valid representations of their personal mathematical thinking. To view the developed learning medium prototype, please access the Pocket Book Bangun Datar via the following link: https://heyzine.com/flip-book/7852832781.html

d. Implementation

The implementation stage serves as a crucial validation phase within the Research and Development cycle, during which the Pocket Book learning media prototype undergoes empirical testing to assess its level of practicality. This testing was conducted systematically with fifth-grade students at SD Negeri Kebagusan 01 Pagi using previously validated questionnaires. The practicality assessment was carried out in two stages: a small-group trial involving five students and a large-group trial involving 27 students. Both trials aimed to evaluate the product's practicality. The data obtained from these field trials reflect the direct experiences and opinions of both teachers and students regarding the classroom use of the Pocket Book media; the resulting practicality percentages are presented below:

1. Results of the teacher response questionnaire

   The questionnaire administered to teachers involved Ms. Devi Putri Utami, S.Pd., the homeroom teacher for Grade V. It focused on assessing the practicality of the media specifically regarding ease of classroom operation, time efficiency during implementation, and the ease with which the media could be integrated into existing learning outcomes. The results were derived from a 12 question survey, with the data converted to a five point scale.

Table 2. Results of the Teacher Practicality Test

Aspect	Persentase (%)	Level of Practicality
1) Benefit 2) Ease of Use 3) Attractiveness	96,66%	Very Practical

Based on the data presented in Table 2, the pocketbook medium achieved a very high assessment score of 96.66%. This figure places the medium in the "Highly Practical" category, confirming that the product meets standards for functionality and operational practicality without requiring significant revisions regarding teacher implementation.

2. Results of the student response questionnaire

Subsequently, practicality testing was extended to end users specifically students through a two-stage process to ensure consistent acceptance. The practicality tests were conducted in two phases: a small group trial involving five students and a large-group trial involving 27 students. Both trials aimed to gather evaluations regarding the product's practicality. The following are the assessment result percentages derived from the questionnaires completed by the respondents:

Table 3. Results of the Small Group Practicality Test

Aspect	Persentase (%)	Level of Practicality
1) Ease of Use 2) Attractiveness	93,33%	Very Practical

Based on Table 3, the results of the small-group practicality test yielded a score of 93.33% among the five participating students, placing it in the highly practical category; additionally, expert feedback and suggestions were incorporated to enhance the quality of the Pocket Book learning medium. This small group result 93.33% practicality rating strongly confirms that the medium is easy to understand and effectively stimulates student interest in learning. The large-group trial involved the entire Grade 5 population, consisting of 27 students. At this stage, the medium was tested in an actual classroom setting to assess its stability and broad acceptance.

Table 4. Results of the Large-Group Practicality Test

Aspect	Persentase (%)	Level of Practicality
1) Ease of Use 2) Attractiveness	94,75%	Very Practical

Table 4 presents the results of the practicality test conducted with a large group, showing a score of 94.75%, which falls into the highly practical category. This assessment is based on the average scores of 27 students and incorporates feedback and suggestions from practitioners to enhance the quality of the Pocket Book learning media. The consistently high overall score exceeding 90% across all test subjects, including both teachers and students demonstrates that the Pocket Book meets the criteria for high practicality. These results firmly confirm the product's practicality as an innovative, effective, and efficient learning medium for mathematics, particularly for the topic of 2D shapes.

e. Evaluation

The evaluation stage is a pivotal phase in the ADDIE development model, serving as a mechanism for quality control and determining the final suitability of the media. This stage presents a comprehensive synthesis of media validation data from experts and media

practicality data from field users. These findings and recommendations provide the empirical basis for the researcher to revise and finalize the Pocket Book learning media.

1) **Validity of a Pocket Book Based on Realistic Mathematics Education (RME) for Elementary School Students**

   Following the development phase, the media requires validation. Validation of the pocketbook was conducted by three competent expert validators to theoretically verify the validity of its content, design, and language, ensuring the product aligns with scientific and pedagogical standards. This assessment utilized a questionnaire covering specific dimensions, such as the material's alignment with the Independent Curriculum (Kurikulum Merdeka), graphic presentation, and text readability. The product must meet the Valid criterion for the media to be utilized as instructional material.

   a. Linguist

   This pocketbook was evaluated by a linguist teaching at the Faculty of Education, Universitas Muhammadiyah Jakarta. Revisions to the pocketbook were made based on the expert's comments and suggestions. The results of the linguistic evaluation regarding grammar and readability are presented in the following table:

Table 5. Results of Linguist Validation

Validator	Validator	Persentase (%)	Level of Practicality
Linguist	1) Grammar 2) Legibility	98%	Highly valid

The assessment by language experts presented in Table 9 shows a score of 98%, classified as highly valid, consequently, the developed pocketbook is considered highly suitable for supporting teaching and learning activities.

   b. Subject Matter Expert

   The subject matter expert is a lecturer competent in mathematics who possesses mastery of the material regarding 2D shapes. This expert validates the pocketbook in terms of content, suitability, and the characteristics of Realistic Mathematics Education (RME).

Table 6. Subject Matter Expert Validation Results

Validator	Validator	Persentase (%)	Level of Practicality
Subject Matter Expert	1) Content Validity 2) Suitability of Presentation 3) Characteristics of Realistic Mathematics Education (RME)	92%	Highly valid

The score obtained from the subject matter expert was 84%, classified as highly valid, this indicates that the material compiled in the module possesses a high level of validity for use in the learning process, encompassing aspects such as content validity, appropriateness of presentation, and the characteristics of Realistic Mathematics Education (RME).

c. Media Expert

A media expert evaluated the presentation and materials contained in the pocketbook, which were assessed by a lecturer knowledgeable about instructional media and skilled in instructional media design.

Table 11. Media Expert Validation Results

Validator	Validator	Persentase (%)	Level of Practicality
Media Expert	1) Graphical Display 2) Layout 3) Ease and Simplicity	84%	Highly valid

Based on Table 11, the media expert validation yielded an evaluation of 84%, placing it in the highly valid category regarding aspects of graphic design, layout, ease of use, and simplicity. This indicates that the developed pocketbook medium is suitable and appropriate for supporting the learning process. Based on the three validation results, it can be concluded that the language expert validation achieved the highest score at 98%, while the subject matter expert validation reached 92%, both fall into the Highly Valid category. Meanwhile, the media expert validation yielded a score of 84%, which is also categorized as Highly Valid. These collective validity scores confirm that the product meets the criteria for high validity. Nevertheless, the researcher noted several critical points for improvement. Specifically, the language expert highlighted the need to correct the spelling of certain non-standard phrases and compound words (such as “on” and “beside”), whereas the subject matter expert emphasized the need to more explicitly reinforce the representation of Realistic Mathematics Education (RME) elements to maximize the media's contextual approach. These points became the primary focus of revisions aimed at enhancing the product's substantive quality.

2) Practicality of a Pocket Book Based on Realistic Mathematics Education (RME) for Elementary School Students

Product Practicality (User Testing) involved assessing operational feasibility and user acceptance through a practicality test with teachers and fifth-grade students at SD Negeri Kebagusan 01 Pagi. This test focused on measuring aspects of ease of use,

appeal, and the utility of the Pocket Book media within a real world learning context. The results consistently confirmed a high level of practicality.

a) Teacher Practicality Test

Based on field test results involving teacher feedback, it can be concluded that the pocketbook's practicality rating reached 96.66%, placing it in the Highly Practical category. These results indicate that the developed product meets the criteria for a high-quality learning resource and serves as a practical, effective tool for teachers during instruction despite minor issues regarding the resolution of a few slightly blurry images.

b) Student Practicality

Questionnaire results based on student responses indicate consistent reception, the Small Group Trial achieved a score of 93.33% "Highly Practical", and the Large Group Trial achieved 94.75% "Highly Practical", placing both within the same category. The consistently high scores exceeding 90% across all trial scales empirically demonstrate that the Pocket Book medium possesses strong pragmatic validity, is effective, and is easily implemented by end users.

3) Final Evaluation and Follow up

Based on the overall findings from expert validation and field based practicality testing, the researcher conducted a final evaluation and implemented targeted corrective measures. These steps included orthographic corrections (specifically regarding compound words) and the addition and refinement of content to strengthen RME elements in accordance with subject matter expert recommendations. Through this systematic revision process, the Pocket Book was refined to achieve a final status of Highly Valid and Highly Practical, making it a recommended innovative learning tool for the topic of 2D shapes.

D. CONCLUSIONS AND SUGGESTIONS

Based on the research and development of the Pocket Book learning medium for mathematics specifically focusing on 2D shapes it can be concluded that: 1) The Pocket Book medium was developed using the ADDIE model. 2) Evaluations indicate that the Pocket Book possesses high validity and is highly practical for implementation. This is evidenced by the assessment percentages from experts and questionnaire results from teachers and students: language experts rated it at 98% (highly valid), media experts at 84% (highly valid), and content experts at 92% (highly valid); meanwhile, the practicality test by teachers reached 96.66% (highly practical), the small-group trial achieved 93.33% (highly practical), and the large-group trial reached 94.75% (highly practical). The medium's ease of use is demonstrated by its accessibility for both teachers and students, its simple yet engaging presentation, and its ability to help students understand the material in a contextual and enjoyable manner.

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