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Realistic Mathematics-Based E-Booklets to Improve Students' Mathematical Literacy Ability

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Abstrak

Kemampuan literasi numerasi siswa SMP masih rendah. Diperlukan media untuk memfasilitasi peningkatan literasi numerasi, misalnya dengan E-booklet berbasis matematika realistik. Penelitian ini bertujuan mendeskripsikan proses pengembangan dan validitas, serta kepraktisan efektivitas pengembangan E-Booklet berbasis matematika realistik terhadap kemampuan literasi matematis siswa. Model penelitian dan pengembangan dalam penelitian ini menggunakan model ADDIE *(Analyze, Design, Development, Implementation, Evaluation)*. Penelitian dilakukan pada salah satu SMPN di Siliragung. Subjek penelitian dipilih dengan teknik *purposive sampling*. Data dikumpulkan melalui wawancara, kuesioner, dan tes. Analisis data menggunakan uji-t untuk mengetahui peningkatan kemampuan literasi matematis siswa. Hasil penelitian ini berupa e-booklet berbasis matematika realistik pada materi perbandingan dengan kriteria valid dengan rerata presentase validitas sebesar 93%. E-booklet ini dinyatakan praktis digunakan dalam proses pembelajaran dengan perolehan rerata kepraktisan sebesar 80% dan dinyatakan efektif dalam meningkatkan kemampuan literasi matematis siswa. E-booklet berbasis matematika realistik memenuhi kevalidan, kepraktisan dan keefektifan sehingga layak digunakan sebagai media pembelajaran.
Kata Kunci: E-Booklet; Literasi Matematis; Matematika Realistik; Media Pembelajaran

Abstract

The numeracy literacy ability of junior high school students is still low. Media is needed to facilitate the improvement of numeracy literacy, for example with realistic mathematics-based E-booklets. This study aims to describe the development process and validity, as well as the practicality of the effectiveness of developing realistic mathematics-based E-Booklets on students' mathematical literacy abilities. The research and development model in this study uses the ADDIE model (Analyze, Design, Development, Implementation, Evaluation). The study was conducted at one of the junior high schools in Siliragung. The research subjects were selected using purposive sampling techniques. Data were collected through interviews, questionnaires, and tests. Data analysis used the t-test to determine the improvement of students' mathematical literacy abilities. The results of this study were in the form of realistic mathematics-based e-booklets on comparative material with valid criteria with an average validity percentage of 93%. This e-booklet was declared practical to use in the learning process with an average practicality of 80% and was declared effective in improving students' mathematical literacy abilities. Realistic mathematics-based e-booklets meet validity, practicality and effectiveness so they are suitable for use as learning media.
Keywords: E-Booklet; Mathematical Literacy; Learning Media; Realistic Mathematics

I. INTRODUCTION

Low mathematics achievement among Indonesian students remains a prevalent concern (Oktaviana, Effendi, & Rosyadi, 2023; Septia & Wahyu, 2023). According to the results of the 2019 national examination, the average mathematics score was merely 46.19. This situation adversely affects Indonesia's standing in the global education landscape. In the 2012 Programme for International Student Assessment (PISA), Indonesia ranked 72nd out of 77 participating countries in the area of mathematical literacy, with an average score of 379 (Mahdiansyah & Rahmawati, 2014; Sari et al., 2023; Rahmawati, Cholily, & Zukhrufurrohmah, 2023).

Several factors contribute to the relatively low mathematics scores among students (Puspita, Herman, & Dahlan, 2023; Warsito et al., 2023). One primary factor is students' interest in learning mathematics. Interest is defined as an individual's inclination to engage in a specific activity voluntarily. In the context of education, interest in learning encompasses the ability of students to cultivate a sense of enjoyment and enthusiasm for the subject, which can be observed through empathy, attention, and active participation in the learning process. This interest is crucial to effective learning. Various elements can influence students' interest in mathematics, including the relevance of learning materials to real-life contexts, opportunities for active participation, and the efforts of educators to enhance student engagement through the use of stimulating learning media (Al Fuad & Zuraini, n.d.; Iqrima, Zulkarnain, & Kamaliyah, 2023).

Another contributing factor to low mathematics scores is students' difficulty in grasping mathematical concepts. Mathematics is inherently a discipline that relies heavily on conceptual understanding (Nastiti & Syaifudin, 2020). It encompasses a range of symbols and numbers that must be interpreted, many of which represent abstract ideas. Conceptual understanding refers to students' ability to absorb and comprehend mathematical concepts (Lestari & Yudhanegara, 2017; Purnomo & Sari, 2021). It involves the capacity to understand abstract notions that assist in categorizing objects and facts pertinent to mathematical problems (Nastiti & Syaifudin, 2020). Hence, a solid understanding of concepts is essential for students to effectively solve mathematical problems.

Interviews conducted with a seventh-grade mathematics teacher at SMP Negeri 1 Siliragung revealed that some students struggle with problem-solving tasks due to a lack of familiarity with such approaches. In the mathematics classroom, teachers often employ project-based or problem-based learning methods. However, these methods frequently result in unequal participation, with only one or two students actively engaging in group assignments.

To enhance students' conceptual understanding, teachers must adopt strategies that improve the quality of instruction, one of which involves implementing student-centered learning approaches. Such strategies position teachers not merely as the sole source of information, but as facilitators of the learning process (Widyanto & Vienlentia, 2022). Students should play an active role in their education, engaging with peers and

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the learning environment to acquire knowledge independently. Access to diverse and relevant learning resources is essential, as is the opportunity for students to express their creativity. The teacher's role is to facilitate, motivate, and innovate during the learning process, guiding students in problem-solving and fostering a multi-directional interaction among students, educators, and learning resources (Pertiwi et al., 2022).

One effective strategy employed in student-centered mathematics instruction is the Realistic Mathematics Education (RME) approach. This pedagogical framework emphasizes the relevance of mathematics to everyday life and connects mathematical concepts to human activities (Afriansyah et al., 2023). By leveraging real-world situations and the surrounding environment, the RME approach facilitates the mathematics learning process. This perspective is grounded in the ideas of Hans Freudenthal, who posited that mathematics is fundamentally an activity tied to human experiences. Within the RME framework, the classroom is perceived as a space where students can rediscover mathematical ideas and concepts through the exploration of problems that are pertinent to their daily lives. In this context, the teacher assumes the role of a guide, assisting students in their journey of rediscovery (Holisin, 2007b; Latifah et al., 2022).

Zainurie contends that the RME approach prioritizes students' realities and personal experiences as foundational elements of the learning process. Subsequently, students are encouraged to apply mathematical concepts in addressing challenges that are relevant to everyday contexts (Hartono, n.d.). According to Gravemeijer, three core principles underlie the RME framework: the principle of reinvention (guided reinvention), didactic phenomenology, and self-developed models (Saefudin, 2012). These principles can be further articulated through five fundamental characteristics of RME, including the use of contextual problems, incorporation of student contributions, utilization of models, fostering interaction, and establishing relationships between subject matter (Holisin, 2007a; Johar et al., 2023).

In addition to employing student-centered learning strategies, teachers must also utilize innovative learning media to enhance students' interest and understanding of mathematical concepts. As noted by Sadiman (in Netriwati & Lena, 2017), learning media encompass the materials, tools, or techniques that facilitate interaction between teachers and students within the educational context. The primary function of these media is to serve as communication tools that convey learning materials and clarify messages, thereby ensuring the effective achievement of educational objectives. Learning media can illustrate specific facts, concepts, principles, or procedures, providing real experiences that motivate students and enhance their retention of the material. Appropriate learning media can stimulate student engagement with the content, fostering a deeper understanding of mathematical concepts (Ika Amalia & Murti, 2020).

One potential educational resource that can be developed is the E-Booklet. An E-

Booklet is an electronic-based document designed to convey information pertinent to the learning material (Suhartono Putri, 2021). E-Booklet-type teaching materials serve as supplementary resources to existing textbooks (Ika Amalia & Murti, 2020). They enable students to engage in in-depth learning and present material in a concise, engaging, and easily comprehensible manner (Violla & Fernandes, 2021). According to Imtihana, the visual elements of E-Booklets can capture students' attention and interest through the integration of relevant images and a vibrant color palette, along with a simple layout that encourages engagement (Fathurrohman et al., 2021).

Given the information presented, E-Booklets represent a compelling avenue for development as supporting resources in the educational process, as their practical nature facilitates student comprehension. Several researchers have previously developed E-Booklets, particularly within the field of Mathematics Education. For instance, Amalia (2020) created an E-Booklet focused on independence and responsibility, integrated with the Edmodo application, designed for flat shape material for fourth-grade students at Laboratorium UM. Similarly, Sopanda (2023) developed E-Booklet media that incorporated learning videos aimed at enhancing critical thinking skills in relation to functions for eighth-grade students at SMP Santo Fransiskus Asisi Pontianak. However, there remains a gap in the literature regarding the development of realistic mathematics-based E-Booklets aimed at improving students' mathematical literacy skills.

Based on this overview, the present research is motivated to explore the "Development of Realistic Mathematics-Based E-Booklets as an Effort to Improve Students' Mathematical Literacy Skills."

II. METHOD

This study employs a Research and Development (RnD) methodology, focusing specifically on the development of learning media. The development research model represents a systematic approach for designing and creating educational programs or products (Sugiyono, 2019). The primary objectives of development research include assessing the validity, practicality, and effectiveness of the produced product—in this case, an E-Booklet.

The ADDIE model (Analysis, Design, Development, Implementation, Evaluation) was utilized as the development framework for this study. The research was conducted at SMP Negeri 1 Siliragung during the even semester of the 2022/2023 academic year. The subjects comprised 37 students from class VII C, selected through a purposive sampling technique based on specific student characteristics.

Data collection methods included interviews, questionnaires, and tests. Interviews were conducted to gain insights into the students' learning environment, competencies, characteristics, and educational needs. Questionnaires were administered to evaluate the responses of both students and teachers regarding the use of E-Booklets in the learning process, thereby enabling an analysis of their practicality. Additionally, tests were employed to assess the enhancement of students' mathematical literacy skills.

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To evaluate the validity of the developed media, a validity analysis was performed. Validity serves as a measure of the accuracy and appropriateness of a measurement instrument, with a valid instrument accurately reflecting what it is intended to measure. The validity analysis was conducted using the following formula:

$$p = \frac{f}{n} \times 100\%$$

Note:
P = percentage of answers
f = value obtained
n = maximum value
Adopted from (Suhartono Putri, 2021)

For practicality analysis, the data obtained from the student response questionnaire were averaged to derive a total score. The realistic mathematics-based E-Booklet is deemed suitable for use if the results of the questionnaire analysis fall within the practical or very practical categories. The assessment procedure for practicality employs the same formula used for validity.

Table 1.
Outlines The Criteria for Validity and Practicality Levels

Value Achievement	Validation Category	Description
25% - 40 %	Not valid/not practical	Should not be used
40% - 55%	Less valid/ less practical	Should not be used
56% - 70%	Quite valid/ quite practical	Can be used with revision
71% - 85%	Valid/practical	Can be used
86% - 100%	Very valid/very practical	Very good to use

To analyze the effectiveness of the realistic mathematics-based E-Booklets on students' mathematical literacy skills, the study utilized pre-test and post-test scores. These scores were analyzed using a T-test with the assistance of SPSS software, following prerequisite tests for normality and homogeneity. This analytical process aimed to determine the extent of improvement in students' mathematical literacy skills.

III. RESULT AND DISCUSSION

This study resulted in the development of an E-Booklet based on realistic mathematics, which encompasses comparative material, specifically focusing on the concepts of value and inverse value. The initial phase of this research involved conducting a needs analysis. This analysis was carried out through interviews with teachers and students, as well as by observing the textbooks utilized by educators in the learning process (Amalia et al., 2020).

During the analysis phase, it was identified that SMP Negeri 1 Siliragung follows the 2013 curriculum. However, mathematics instruction predominantly occurs through conventional lecture methods, resulting in passive engagement from grade VII students. Consequently, these students struggle to grasp comparative material effectively. This conclusion is supported by questionnaire results indicating that 61% of students could not solve contextual problems due to a lack of understanding of the concept of comparison. Additionally, 74% of students reported difficulties in recognizing and applying the fundamental principles of mathematics particularly regarding

comparative material in everyday problem-solving scenarios.

In response to these findings, questionnaire was distributed to assess the requirements for enhancing the learning experience. The results revealed that 96% of students expressed a need for supplementary books or media beyond the standard student textbooks (LKS) to aid their comprehension of comparative material. However, 57% of the students indicated that they lacked access to additional supportive resources. Hence, the researcher deemed it necessary to develop a student learning medium that facilitates both independent and group learning to address these needs.

The subsequent stage of this study involved the compilation of the E-Booklet media. This phase commenced with the formulation of learning objectives aligned with the Core Competencies (KI) and Basic Competencies (KD) stipulated in the 2013 curriculum. The E-Booklet was constructed using various reference sources, including the grade VII student book provided by the Ministry of Education, Culture, Research and Technology (2013 Curriculum, revised edition 2017) and the mathematics book authored by Marsudi Raharjo, published by Erlangga.

The content of the E-Booklet focuses on comparison and ratio material, featuring subtopics on value comparison and inverse value. The E-Booklet is designed in accordance with the characteristics of a realistic mathematics approach, which emphasizes the use of contextual problems, student contributions, interaction between students and teachers, and the interrelation of subject matter. It includes examples of contextual questions aimed at enhancing students' mathematical literacy skills.

To ensure an engaging learning experience, the E-Booklet was designed with an appealing layout, incorporating colors that resonate with the students' preferences (Amalia et al., 2020). The design process utilized features from the Microsoft Word application, with the final document converted into PDF format. Subsequently, the E-Booklet was uploaded to the website https://anyflip.com, enabling it to be transformed into a flipbook accessible to anyone with the link.

The structure of the mathematics E-Booklet based on realistic mathematics includes a cover page, book identity, foreword, usage instructions, table of contents, Core Competencies (KI), Basic Competencies (KD), learning objectives, concept maps, instructional materials, practice questions, answer keys, and bibliography. The media is designed to be both attractive and informative, thereby stimulating students' interest in the presented material (Kurniawan & Wahyuni, 2024; Oktaviya & Wahyuni, 2024; Violla & Fernandes, 2021).

The third stage of the research is the development phase. This stage involves the validation of the designed product to ascertain its suitability for implementation in the learning process. Validation is conducted by a panel of expert validators, including subject matter experts, media specialists, and design experts. Prior to the utilization of the media, it is imperative that this validation process is completed (Rahayu, 2023; Ika, 2021; Nisa et al., 2024). According to (Haque & Zafri, 2021; Oktaviya & Wahyuni, 2024; Sarip et al., 2022),

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validation serves as a crucial step in ensuring the development of teaching materials that are grounded in established educational theories, thereby confirming their appropriateness for use in the instructional context. The validation results are depicted in Figure 1.

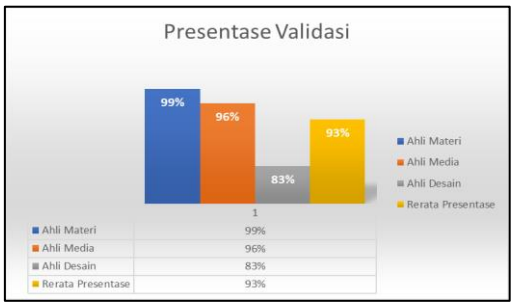

Figure 1. Validation Percentage

The validation scores are summarized in Chart 1. According to the data presented in Chart 1, the developed e-booklet received a validation percentage of 99% (very valid) from subject matter experts, 96% (very valid) from media experts, and 83% (valid) from design experts, resulting in an overall average validation percentage of 93%. This indicates that the e-booklet meets the criteria for being classified as very valid. The validity assessment is conducted to ensure that the media utilized is appropriate and reliable for implementation in the learning process (Haque & Zafri, 2021; Prananda et al., 2022; Violla & Fernandes, 2021)

The subsequent stage is the implementation phase, which aims to assess students' responses to the developed e-booklet media and to evaluate its practicality in a learning context. The trial was conducted in two phases: a small-scale trial involving eight students from class VII B on June 20, 2023, and a large-scale trial involving 37 students from class VII C on June 23, 2023, at SMP Negeri 1 Siliragung. During this process, data on teacher responses to the e-booklet were also collected to gain insights into their perspectives regarding its use in the classroom. The following is a summary of the practicality assessment results.

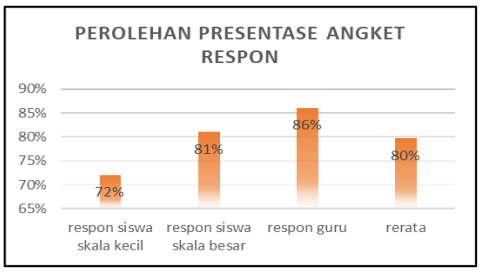

Figure 2. Percentage of Questionnnaire Response

Based on the responses collected from both student and teacher questionnaires, the percentage of student responses during the small-scale trial was 72%. In the large-scale trial, the percentage of student responses increased to 81%, while teacher responses were recorded at 86%. Consequently, the overall average response rate was 80%, indicating that the realistic mathematics-based e-booklet is practically applicable in the learning process.

In addition to assessing practicality, an effectiveness test was conducted to evaluate the impact of the e-booklet on enhancing students' mathematical literacy skills. The data used for this evaluation comprised pre-test and post-test scores collected from students at SMPN 1 Siliragung. The learning activities commenced with a brief review of the fundamental concepts related to comparison material, followed by the administration of the pre-test. After completing the pre-test, students engaged with the e-booklet material during the learning process. Subsequently, they were asked to complete post-test questions to

determine the effectiveness of the e-booklet media on improving their mathematical literacy skills. Figure 3 presents the distribution of students' pre-test and post-test scores.

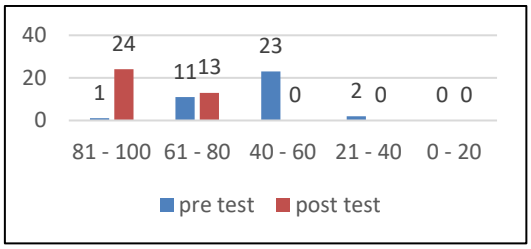

Figure 3. Distribution of Student Score

As illustrated in Chart 3, the average pre-test score was 58, while the average post-test score increased to 85. This indicates a significant improvement, with the average post-test score surpassing the average pre-test score. The implementation of e-booklets has been shown to enhance the learning experience, as they are engaging and easily comprehensible (Amalia et al., 2020). The use of e-booklet media in educational settings encourages students to think critically, develop problem-solving skills, actively seek additional information, and increase their motivation throughout the learning process (Amalia et al., 2020; Sopanda, 2023).

To assess the impact of e-booklet media on students' mathematical literacy skills, a statistical test was employed. Specifically, a T-test was utilized to evaluate the effectiveness of the e-booklet intervention. Prior to conducting the T-test, prerequisite tests, including normality and homogeneity tests, were performed to ensure that the data collected were normally distributed and homogeneous.

1. Normality Test

The normality of the data was assessed using the Kolmogorov-Smirnov test, facilitated by SPSS 26 software. This test was employed to ascertain whether the collected data followed a normal distribution. According to the criteria established, a significance value greater than 0.05 indicates that the data are normally distributed. The results of the normality test are presented in Figure 4.

Tabel 4. Hasil uji normalitas

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		37
Normal Parameters[a,b]	Mean	0,0000000
	Std. Deviation	8,71143429
Most Extreme Differences	Absolute	0,093
	Positive	0,066
	Negative	-0,093
Test Statistic		0,093
Asymp. Sig. (2-tailed)		,200[c,d]

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Figure 4. Result of Normality Test

The results of the normality test yielded a significance value of 0.200. Since this value exceeds 0.05, we can conclude that the data are normally distributed.

2. Homogeneity Test

The homogeneity test is conducted to assess whether the variances of the obtained data are homogeneous. This test was performed using SPSS 26 software. A significance value greater than 0.05 indicates that the data variances are homogeneous. The results are as Figure 5.

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
post test	Based on Mean	1,357	5	28	0,270
	Based on Median	0,620	5	28	0,686
	Based on Median and with adjusted df	0,620	5	20,836	0,686
	Based on trimmed mean	1,262	5	28	0,308

Figure 5. Result of Homogeneity Test

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The results of the homogeneity test indicated a significance value of 0.270. Since this value exceeds 0.05, it can be concluded that the variances of the obtained data are homogeneous.

3. t-Test

A t-test was conducted to assess the impact of using e-booklet media by examining the differences in student scores before and after the intervention. The t-test was performed using SPSS 26 software, with a significance threshold set at 0.05. If the obtained significance value (2-tailed) is less than 0.05, it indicates a statistically significant difference between the pre-test and post-test scores. The results of the t-test are presented in Figure 6.

Paired Samples Test

							t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	pre test - post test	-27,162	12,668	2,083	-31,386	-22,939	-13,043	36	0,000

Figure 6. Result of t-test

The results of the T-test revealed a significance value of 0.000, indicating that 0.000<0.05. This finding suggests a significant impact of using e-booklet media on students' mathematical literacy skills. Therefore, it can be concluded that the implementation of e-booklet media is effective in enhancing students' mathematical literacy skills.

The final stage of this study involves the evaluation phase, which assesses the extent to which the study objectives have been achieved. The developed realistic mathematics-based e-booklet received a validity percentage of 93% and a practicality percentage of 80%. Furthermore, based on the results of the T-test, the use of e-booklets has been confirmed to be effective in improving students' mathematical literacy skills. Consequently, realistic mathematics-based e-booklets are deemed suitable for educational use. As noted by Lisnani & Asmaruddin (2018), Amalia et al. (2020), Prananda et al. (2022), Sopanda (2023), and Violla & Fernandes (2021), e-booklets are considered appropriate for learning if they fulfill the criteria of validity, practicality, and effectiveness.

IV. CONCLUSION

The developed realistic mathematics-based e-booklet meets the criteria for validity, achieving a percentage of 93%, and is deemed practical for use in the learning process, with a percentage of 80%. Furthermore, the e-booklet has been confirmed as effective in enhancing the mathematical literacy skills of seventh-grade students at SMPN 1 Siliragung.

The researcher aspires for this realistic mathematics-based e-booklet to serve as an alternative solution for both students and mathematics teachers at SMP Negeri 1 Siliragung, aiming to improve the quality of the learning process, particularly in the teaching of comparison material. It is anticipated that students will engage in active knowledge discovery through interaction with their environment, thereby applying mathematical concepts to real-life situations.

To facilitate effective learning, students are encouraged to carefully read the instructions for utilizing the realistic mathematics-based e-booklet media. Furthermore, it is recommended that students complete the exercises included in

the e-booklet to deepen their understanding of the comparison material and to practice problem-solving skills related to everyday life.

Finally, the researcher hopes that mathematics teachers will continue to develop and refine realistic mathematics-based e-booklet media to ensure optimal use that aligns with the characteristics and needs of their students.

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