

Designing a PMRI Electronic Pocketbook for Enhanced Algebra Conceptual Understanding and Learning Interest in Junior High School Students

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ABSTRACT

This study aims to develop electronic pocketbooks based on PMRI (the Indonesian adaptation of realistic mathematics education) tailored to enhance concept comprehension and stimulate interest in learning algebra among seventh-grade students. The pocketbooks are designed to meet the standards of validity, practicality, effectiveness, and feasibility for use in educational settings. The research follows the ADDIE development model, which includes stages of analysis, design, development, implementation, and evaluation. The study was conducted with 32 seventh-grade students at a junior high school in Yogyakarta. Data collection methods included tests and questionnaires. The findings indicate that the electronic pocketbooks are highly valid, practical, and effective. Therefore, it can be concluded that the PMRI electronic pocketbooks, oriented towards improving conceptual understanding and learning interest in junior high school students, satisfy the criteria of being valid, practical, effective, and feasible for educational use. Consequently, these pocketbooks have the potential to significantly enhance mathematics education by accommodating individual learning styles, promoting a deeper understanding of algebra, and improving overall academic performance among junior high school students.

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1. INTRODUCTION

Mathematics learning should provide ample opportunities for students to actively participate in the learning process so that they can understand the concepts of the material being studied correctly. One of the objectives of mathematics learning in the Ministry of Education's Curriculum and Assessment Standards Board Number 8 of 2022 is for students to understand mathematics learning materials in the form of facts, concepts, principles, operations, and mathematical relationships and apply them flexibly, accurately, efficiently, and appropriately in solving mathematical problems (mathematical understanding and procedural skills). The achievement of these learning objectives depends on the learning process carried out by the teacher in the classroom.

To improve and develop the quality of mathematics learning, teachers need to have innovative and creative knowledge and skills in managing classes and learning activities. Teachers or educational practitioners are required to have the initiative and motivation to improve the quality of work (Sudarsono et al., 2013). This is also supported in Permendikbudristek Number 16 of 2022 explained that each education unit must carry out a learning plan, in carrying out the learning process and assessing the learning process to improve the efficiency and effectiveness of learning. Based on the Permendikbudristek, teachers are required to be able to plan to learn by using the best possible types of media and learning resources so that learning can be carried out well and that learning outcomes are as expected.

Books have long been a reliable source of accurate information; however, with technological advancements, many have transitioned into more practical electronic formats. According to Prabowo & Heriyanto (2013), e-books are digital versions of books that contain specific information. While traditional books consist of paper pages with text and images, e-books present this information digitally, maintaining the format of text or images. The importance of e-books is increasingly recognized as they save storage space and eliminate the costs associated with physical book repairs (Ruddamayanti, 2019). Thus, the shift towards e-books represents a significant evolution in information dissemination and accessibility, offering practical benefits for both users and institutions.

Ramda (2017) revealed that students have difficulty in understanding math textbooks because the presentation of the material is complicated, both concepts and examples of the exercises. This shows that textbooks do not meet the indicators of learning media, as a result, students will not be interested in reading mathematics textbooks (Sinaga & Rachmawati, 2022). This can be seen in the initial research conducted by researchers, with the results of the suitability of the material in the book and the assessment standard of 54, 55%. However, in reality, students do not know the form and content of electronic pocketbooks by 72.9% and have never used electronic pocketbooks by 76.3% at school or home. Therefore, a book that is concise in its material, easy to understand, colorful, and interesting to read is needed, namely an electronic pocketbook.

Numerous studies have been conducted on pocketbooks, yet few have specifically explored those utilizing Indonesian Realistic Mathematics Education (PMRI). This approach, known as Realistic Mathematics Education (RME) or Indonesian Realistic Mathematics Education (PMRI), connects mathematical learning to everyday life, facilitating the discovery of mathematical concepts within real-world contexts (Wahyudi, 2016: 370). Van Reeuwijk (as cited in Drijvers, 2000: 191) emphasized that a key characteristic of PMRI is its incorporation of real-world contexts related to daily experiences, which aims to make mathematics learning more meaningful and increase student interest. This aligns with Woolfolk's (2007: 384) perspective that sustaining student interest involves integrating mathematical activities with real-life problems and encouraging active participation in various activities.

Algebra is a crucial topic in the Indonesian education curriculum, as mandated by Permendikbudristek Number 7 of 2022, which specifies that the introduction to algebra begins in the seventh grade of junior high school. Utami (2017) highlights the importance of algebraic forms in the secondary mathematics curriculum due to their inclusion in numerous concepts. These concepts are closely related to everyday problems that students frequently encounter, making the foundational understanding of algebraic forms in the seventh grade essential (Purwaningsih & Marlina, 2022; Basri et al., 2020; Oktaviani & Haerudin, 2021).

Siregar et al. (2021) state that the low level of concept understanding ability and lack of innovation in teaching and learning activities will certainly have an impact on student learning outcomes and mathematical abilities, because understanding the concepts of mathematics learning is the key to understanding higher mathematics lessons (Lambertus, 2016). This is supported by data on student learning outcomes based on the Regional Education Standardization Assessment (ASPD) in D.I. Yogyakarta for the 2022/2023 academic year, which shows that the value of mathematics subjects is the lowest of other subjects with a value of 48.60 on a scale of 100. This is in line with Novitasari's research (2016), which states that the factors of student concept errors in learning mathematics are caused by

teacher and student factors. The teacher factor is that the teacher does not master the right learning approaches and models used to deliver the subject matter. In addition, students lack interest in learning mathematics so that they do not pay attention to the material and ultimately do not understand the concept.

Another study stated that the ability to understand students' mathematical concepts had significant differences before and after the implementation of Indonesian Realistic Mathematics Education (PMRI) (Sari & Yuniarti, 2018). Learning activities using the PMRI approach emphasize on linking material with real life and making students' experiences a starting point for learning more realistically or not abstractly so that it is easy to understand (Herzamzam, 2018; Kurino & Cahyaningsih, 2020). In addition, pocketbooks with the PMRI approach are effectively used in mathematics learning (Istianah, 2016). It can also encourage students' interest in learning math concepts that seem monotonous and abstract because realistic education is closely related to problems that occur in everyday life (Siregar & Prabawanto, 2021; Syafriaedi, et al., 2019).

The success of learning is closely linked to affective factors, particularly interest. According to Permendikbudristek Number 16 of 2022, one of the objectives of learning mathematics is to foster curiosity, confidence, and relevance to mathematics. Curiosity and interest in mathematics are integral to students' overall interest in learning. Elliot et al. (2000) assert that interest is closely related to curiosity. Vulperhost et al. (2018) further explain that interest can be cultivated from situations of personal interest, which manifest as focus, attention, and affect. Tatiana et al. (2022) also note that changes in learning interest over time support a positive learning environment. Sustained interest in learning is crucial for continuous education, necessitating the development of independence (OECD, 2020).

Given the theoretical insights, opinions, and facts outlined above regarding Indonesian Realistic Mathematics Education (PMRI), the role of pocketbooks in enhancing students' conceptual understanding and interest in learning, and the scarcity of learning resources adopting the PMRI approach, there is a clear need to develop PMRI electronic pocketbooks focused on algebra for junior high school students. These pocketbooks should aim to improve students' concept comprehension and foster a strong interest in learning.

2. METHODS

This type of research is development or Research and Development (R&D). According to Sugiyono (2019), research and development is a research method used to produce certain products and test their effectiveness. This study aims to develop and test PMRI electronic pocketbook products and determine the feasibility level of learning media from the aspects of validity, practicality, and effectiveness in terms of concept understanding ability and learning interest of junior high school students. The development model used is the ADDIE model. ADDIE stands for five stages, namely analysis, design, development, implementation, and evaluation.

Thirty-two subjects were purposively taken from VII grade students in the 2023/2024 academic year at a junior high school in Yogyakarta. The schedule for conducting this research is adjusted to the schedule of mathematics subjects in class VII odd semester which will be used as a test subject. Before the trial, the results of the initial design were first validated by experts to prove the validity of the product. If it is proven valid and has been revised according to the input by the validator, then the PMRI electronic pocketbook can be used by students and teachers in learning mathematics.

This research adopted a multifaceted approach to data collection, integrating both quantitative and qualitative methodologies. Quantitative data was obtained through a combination of tests and non-test techniques. Tests included assessments of students' conceptual understanding of algebra, conducted through problem-solving tasks and standardized question formats. Additionally, student interest was measured using questionnaires designed to gauge engagement and preferences regarding the PMRI Electronic Pocketbook. Non-test methods involved expert validators scoring the resource based on predefined criteria and gathering feedback from teachers and students on its practicality in

the classroom. This comprehensive approach, utilizing a range of instruments including validity assessments, practicality evaluations, and effectiveness measures, aimed to provide a thorough analysis of the PMRI Electronic Pocketbook's impact on algebra learning outcomes and student engagement at the junior high school level. Thus, to find out if the product developed is valid, practical, and effective, a quantitative-to-qualitative data conversion technique is used where the scoring is classified into five criteria. Where the criteria are very good, good, good enough, less good, and not good.

3. FINDINGS AND DISCUSSION

3.1 Findings

In the development of PMRI electronic pocketbook products oriented to the ability to understand concepts and student interest in learning which can be accessed through the link <https://online.flippingbook.com/view/665301711/>, development is carried out using the research and development model, namely ADDIE with various stages including the analysis stage, design stage, development, then implementation and finally evaluation.

The steps used in the electronic pocketbook in the PMRI model include understanding contextual problems, explaining contextual problems, solving contextual problems, comparing and discussing answers, and concluding. The purpose of this step is to be oriented towards the ability to understand concepts and student interest in learning.

The following will explain the components of preparing the PMRI electronic pocketbook.

1. Electronic Pocket Guide Cover

The cover is located at the front and contains the title of the electronic pocketbook, school-level logo, material, and author's name.

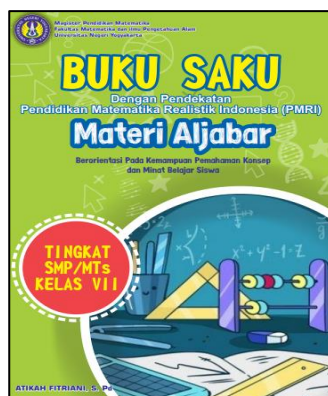


Figure 1. Cover of the Electronic Pocket Guide

2. Identity of the Electronic Pocket Guide

The identity of the electronic pocketbook contains the title of the electronic pocket book, material, school level, author's name, supervisor, validator 1, validator 2, validator 3, validator 4, cover design name, layout design name, year, address and study program.

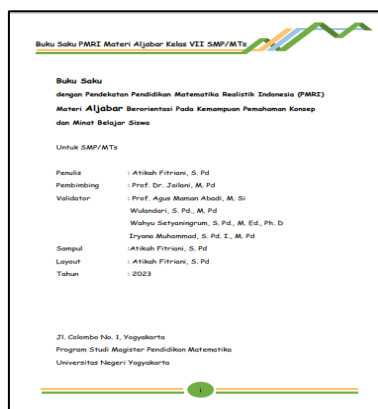


Figure 2. Identity of the Electronic Pocket Guide

3. Contents of the PMRI Electronic Handbook

The electronic pocketbook contains the stages of learning with PMRI



Figure 3: Contents of the PMRI Electronic Pocket Guide

4. Practice Questions

Practice questions are used to measure students' understanding of example problems.

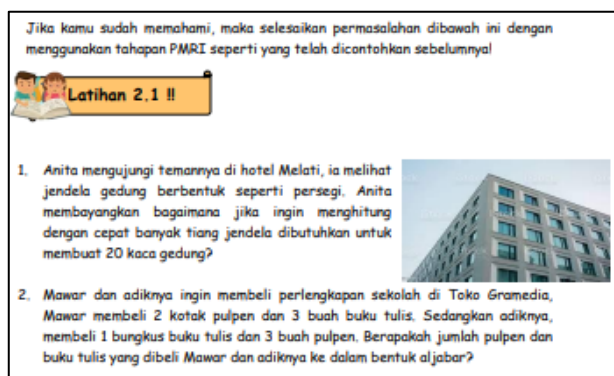


Figure 4.: Exercise Question

5. Book Usage Example

Students are learning with the developed electronic pocketbook.



Figure 5. Example of Book Usage

Based on the results of the PMRI electronic pocketbook validation from the material and media expert validators, there were several suggestions and input related to the material contained in the media. After getting suggestions and input from the validators, the researchers improved the media in accordance with the suggestions and input from the material and media expert validators. The trial was conducted for 6 meetings and the process followed the learning schedule determined by the school. Learning is carried out twice a week face-to-face. At meetings 1 to 5, trials were conducted on PMRI electronic pocketbooks that had been developed based on learning objectives for algebra material for junior high school students in grade VII. In meeting 6, the test was carried out for the concept understanding ability test, student interest questionnaire, and student practicality questionnaire.

The validity of the PMRI electronic pocketbook was affirmed through a validation process conducted by two pairs of esteemed reviewers specializing in Mathematics Education from different universities. Validation by experts shows the results that the assessment of electronic pocketbooks is included in the very valid category, the learning implementation observation sheet is included in the very valid category, the teacher's practicality sheet is included in the very valid category, the student's practicality sheet is included in the very valid category, the concept understanding ability test instrument is included in the very valid category and the student interest questionnaire is included in the very valid category. These results indicate that the PMRI electronic pocketbook criteria are valid.

The practicality of the developed media is based on media assessment by teachers, media assessment by students, and observations of learning implementation by observers. Assessment by teachers and students was carried out after all learning meetings were completed. Observers assess the implementation of learning when learning takes place for each meeting. Based on the results of the analysis of the practicality of the media by students, it was found that the average score of students was 56.7 which was included in the very practical category. This result shows that the media developed is very practical to be implemented in learning.

The effectiveness of PMRI electronic pocketbooks can be seen from the results of the analysis of concept understanding ability tests and student learning interest. Based on the effectiveness criteria for the first concept understanding test, namely the average student concept understanding ability test scores more than or equal to the KKTP value of 75, the results are effective and the second effectiveness criteria, namely at least 85% of students in the class score more than or equal to 75, the results are effective because the average student concept understanding ability test score is 85.31 and many students are complete, namely 29 students out of 32 students tested. This means that 86% of students on the concept understanding ability test exceeded the KKTP set. The effectiveness of the concept understanding ability test results can also be seen from the results of the one-sample t-test which states that $t_{hitung} = 97.80 > t_{0.05(31)} = 1.695$. The following table shows an overview of the results of the concept understanding ability test for each indicator.

Table 1. Achievement per Indicator of Concept Understanding Ability

No	Concept Understanding Ability Indicator	Percentage	Criteria
1.	Specify example and not for example	93, 8%	Highly Effective
2.	Restate a concept	94, 8%	Highly Effective
3.	Use mathematical procedures in solving math problems	79,6%	Effective
	Average Percentage (%)	89,4%	Highly Effective

The average test of concept understanding ability after being tested is 89.4%, with a very effective category. The criteria for students' concept understanding ability on each indicator are 93.8% on the indicator of determining examples and non-examples, 94, 8% on the indicator of restating a concept, and 79.6% on the indicator of using mathematical procedures in solving mathematical problems. Based on these results, it can be concluded that electronic pocketbooks are effective in learning mathematics in terms of student concept understanding ability test results.

The effectiveness of the results of the learning interest questionnaire obtained the average score of the student learning interest questionnaire obtained is 85.69 with the category "Effective", so it can be stated that the electronic pocketbook has met the effectiveness in terms of student learning interest questionnaires. The effectiveness of the results of the student interest questionnaire can also be seen from the results of the one-sample t-test which states that $t_{hitung} = 53.77 > t_{0.05} (31) = 1.695$, so H_0 is rejected, meaning that the average score of the student interest questionnaire is more than 73. The following table shows an overview of the results of students' interest in learning each indicator.

Table 2. Achievement per Indicator of Student Learning Interest

No	Indicators of Student Learning Interest	Percentage	Criteria
1.	Having curiosity about activities related to understanding math materials and math tasks	86, 88%	Highly Effective
2.	Paying attention to and participating in math learning	85,31%	Highly Effective
3.	Active in the math learning process and math assignments	86,25%	Highly Effective
4.	Excitement in math	83,62%	Highly Effective
5.	Choosing activities related to learning math over other activities	88,95%	Highly Effective
	Average Percentage (%)	86, 40%	Highly Effective

The research findings demonstrate highly positive outcomes regarding students' interest and engagement in learning mathematics through the utilization of PMRI (Realistic Mathematics Education) electronic pocketbook. It is evident that the electronic pocketbook has sparked a significant level of curiosity among students towards activities related to understanding mathematical materials and tasks. With 86.88% of students showing high effectiveness in this aspect, it suggests that the interactive and engaging nature of the electronic pocketbook has succeeded in capturing students' interest and stimulating their curiosity about math concepts and problems. Moreover, the findings indicate that students are actively paying attention to and participating in math learning activities, with 85.31% demonstrating high effectiveness. This suggests that the electronic pocketbook is not only

drawing students' curiosity but also encouraging their active involvement in the learning process, fostering a dynamic and participatory classroom environment. Additionally, the research highlights that students are highly active in the math learning process and in completing math assignments, with 86.25% effectiveness. This suggests that the electronic pocketbook is not only engaging students during instructional time but also motivating them to actively engage with math outside of regular classroom activities, thereby promoting continuous learning and practice. Furthermore, the data show that there is a significant level of excitement among students regarding mathematics, with 83.62% effectiveness. This indicates that the electronic pocketbook is successful in generating enthusiasm and interest in math, turning what might be perceived as a daunting subject into one that students find enjoyable and stimulating. The findings also reveal that a vast majority of students, 88.95%, are choosing activities related to learning math over other activities, indicating a strong preference for math-related tasks facilitated by the electronic pocketbook. This suggests that the electronic pocketbook is not only effective in engaging students but also in fostering a positive attitude towards mathematics, encouraging students to prioritize math learning over other recreational activities. Overall, the research findings indicate that the utilization of PMRI electronic pocketbook has had a highly positive impact on students' interest, engagement, and enthusiasm for learning mathematics. The interactive and engaging nature of the electronic pocketbook has succeeded in fostering curiosity, active participation, excitement, and a preference for math-related activities among students, ultimately contributing to a highly effective learning environment.

3.2 Discussion

The findings from the research, along with the literature provided by Siregar et al. (2021) and other relevant studies, underscore the critical role of innovative teaching approaches, such as the Indonesian Realistic Mathematics Education (PMRI), in addressing challenges related to students' conceptual understanding and overall mathematical proficiency. Siregar et al. (2021) emphasize that deficiencies in concept understanding and the lack of innovative teaching methodologies can significantly impact students' learning outcomes and mathematical abilities. This sentiment is echoed by Novitasari (2016), who attributes student concept errors in mathematics to both teacher and student factors, including ineffective teaching approaches and a lack of student interest.

The literature further highlights the effectiveness of the PMRI approach in enhancing students' understanding of mathematical concepts. By linking mathematical concepts to real-life situations, PMRI facilitates a more contextual and concrete understanding of mathematical concepts, thereby addressing the abstract nature of mathematics that often poses challenges for students (Herzamzam, 2018; Kurino & Cahyaningsih, 2020). Additionally, the use of pocketbooks incorporating the PMRI approach has been found effective in engaging students and fostering their interest in learning mathematics (Istianah, 2016).

Importantly, literature emphasizes the role of interest in fostering effective learning experiences. According to Permendikbudristek Number 16 of 2022 and supported by Elliot et al. (2000), interest and curiosity are integral components of effective learning. By creating learning environments that capture students' curiosity and interest, educators can enhance students' engagement and motivation, ultimately leading to improved learning outcomes. The success of PMRI in enhancing students' interest and engagement in mathematics aligns with the broader understanding that interest plays a crucial role in driving continuous learning and skill development (OECD, 2020).

Furthermore, the integration of PMRI into pocketbooks not only makes mathematical concepts more accessible but also supports the development of independent learning skills. By fostering students' curiosity and interest in mathematics through realistic and meaningful learning experiences, educators can cultivate a deeper understanding of mathematical concepts and promote students' independence in learning. This comprehensive approach ensures that students are better equipped to tackle mathematical challenges, thereby improving their overall academic performance and lifelong learning capabilities.

In summary, the research findings, along with the insights provided by Siregar et al. (2021) and other relevant literature, highlight the importance of innovative teaching approaches like PMRI in addressing challenges related to students' concept understanding ability and overall mathematical proficiency. By integrating real-life contexts and fostering students' interest in mathematics, PMRI not only enhances students' understanding of mathematical concepts but also promotes their engagement and motivation in learning, ultimately contributing to improved learning outcomes.

4. CONCLUSION

The findings of this study underscore the significant impact of Indonesian Realistic Mathematics Education (PMRI) electronic pocketbooks on students' mathematical interest, engagement, and comprehension. By offering meaningful and contextually relevant learning experiences, PMRI enhances students' understanding of mathematical concepts while also fostering their interest, engagement, and motivation in learning mathematics. This study suggests that integrating PMRI approaches into mathematics education can lead to more effective teaching and learning practices, ultimately benefiting students' academic achievement and mathematical proficiency.

Educators should consider incorporating PMRI methodologies to foster deeper conceptual understanding and increase student motivation in mathematics. Theoretical frameworks emphasizing the importance of interest and engagement in effective learning are substantiated by this study, indicating that PMRI aligns well with such theories. Schools should invest in resources and training to support educators in effectively implementing PMRI, while policymakers should consider integrating PMRI principles into mathematics curricula.

Future research could explore the long-term effects of PMRI implementation, investigate its differential impacts on diverse student populations, integrate PMRI with other pedagogical approaches, and examine teachers' perceptions and professional development needs regarding PMRI. Such research endeavors will enrich our understanding of PMRI's efficacy and inform strategies for further enhancing mathematics education. Overall, this study highlights the potential of PMRI to transform mathematics education by making it more engaging and effective for students.

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