DEVELOPMENT STRATEGY OF E-POCKET BOOK TO OPTIMIZE ALGEBRAIC THINKING SKILLS OF JUNIOR HIGH SCHOOL STUDENTS

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Abstract

Many middle school students face challenges in developing algebraic thinking skills, which hinders their understanding and application of algebraic concepts. This study aims to develop an E-Pocket Book as a learning medium to optimize middle school students' algebraic thinking skills. The research employs a development method using the ADDIE model (Analyze, Design, Development, Implementation, Evaluation). The subjects of this study are eighth-grade students from SMPN 14 in Serang City. The research instruments include both tests (cognitive tests) and non-tests (questionnaires). The cognitive test was administered to 59 students during the field trial and 8 students during the limited trial, with the results showing significant improvement in students' algebraic thinking skills, with increases of 71% and 79%, respectively. The non-test instruments consist of two types of questionnaires: assessment questionnaires and response questionnaires. The assessment questionnaire was given to two subject matter experts, who rated the e-pocket book as feasible (86%), and two media expert, who rated it feasible (86%). The response questionnaire was distributed to both mathematics teachers and students, with an overall feasibility rating of 87% from students. The findings indicate that the e-pocket book is a viable learning medium and effectively enhances students' algebraic thinking abilities.

Keywords: algebraic thinking; e-pocket book; junior high school; mathematical thinking; model ADDIE

Abstrak

Banyak siswa sekolah menengah pertama menghadapi tantangan dalam mengembangkan keterampilan berpikir aljabar, yang menghambat pemahaman dan penerapan konsep aljabar. Penelitian ini bertujuan untuk mengembangkan E-Pocket Book sebagai media pembelajaran untuk mengoptimalkan keterampilan berpikir aljabar siswa SMP. Penelitian ini menggunakan metode pengembangan dengan model ADDIE (Analyze, Design, Development, Implementation, Evaluation). Subjek penelitian ini adalah siswa kelas delapan dari SMPN 14 di Kota Serang. Instrumen penelitian meliputi tes (tes kognitif) dan non-tes (kuesioner). Tes kognitif diberikan kepada 59 siswa pada uji coba lapangan dan 8 siswa pada uji coba terbatas, dengan hasil menunjukkan peningkatan signifikan dalam keterampilan berpikir aljabar siswa, masing-masing sebesar 71% dan 79%. Instrumen non-tes terdiri dari dua jenis kuesioner: kuesioner penilaian dan kuesioner respon. Kuesioner penilaian diberikan kepada dua ahli materi yang menilai e-pocket book sebagai media yang layak (86%), dan dua ahli media yang menilai layak (86%). Kuesioner respon dibagikan kepada guru matematika dan siswa, dengan penilaian kelayakan keseluruhan sebesar 87% dari siswa. Temuan ini menunjukkan bahwa e-pocket book adalah media pembelajaran yang layak dan efektif dalam meningkatkan kemampuan berpikir aljabar siswa.

Kata Kunci: berpikir matematis; e-pocket book; kemampuan berpikir aljabar; model ADDIE; sekolah menengah pertama

INTRODUCTION

Algebra instruction plays a crucial role in mathematics education, particularly at the middle school level. The primary competencies expected from algebra learning include the ability to understand fundamental algebraic concepts, solve problems using symbolic manipulation, think abstractly, and apply algebraic concepts in real-world contexts (Gafurova, 2022; Kieran, 2020; Tong et al., 2021). Algebraic thinking involves mental processes such as developing ideas about numbers and operations, recognizing patterns and functions, and symbolizing mathematical ideas in the form of expressions and equations (Pitta-Pantazi et al., 2020; Vlassis & Demonty, 2022). Algebra is not merely a branch of mathematics; it is a universal language that enables students to study and understand relationships between variables, predict patterns, and analyze complex situations. It also serves as a foundational tool for other mathematical disciplines, such as arithmetic, geometry, statistics, and calculus. Furthermore, algebraic thinking supports logical reasoning, a critical skill in the modern world that demands data-based problem-solving and abstraction (Ammar et al., 2024; Polotskaia et al., 2022) In the 21st-century educational framework, mastering algebraic thinking is not only a learning target but also a pivotal foundation for developing competencies in science, technology, and everyday life. Hence, the success of algebra instruction serves as a key indicator of the quality of mathematics education at the middle school level.

Despite its importance, many middle school students face significant challenges in learning algebra. Common issues include difficulties in translating word problems into mathematical expressions, identifying critical elements within a problem, and determining appropriate steps for problem-solving (Martins & Martinho, 2021; Moleko, 2021). These challenges are reflected in the PISA 2022 results, which show that Indonesian students score significantly below the OECD average in mathematics, with an average score of 366 compared to the OECD average of 489 (OECD, 2023). Similarly, results from the Indonesian National Assessment (AKM) reveal that over 50% of students struggle with abstract concepts such as algebra (Kemendikbud, 2022). Observations at SMP Negeri 14 Serang City further revealed that over 70% of students experience difficulty translating word problems into mathematical expressions. Teachers also reported that traditional learning materials, such as textbooks, fail to engage students effectively. The learning resources typically used in schools, such as textbooks and worksheets, are often perceived as monotonous and unengaging (Christopoulos & Sprangers, 2021; Fitzmaurice et al., 2021). The dense text and lack of visually appealing elements make students less motivated to read or learn independently (Duke et al., 2021; Tomita, 2022). Moreover, traditional learning media are often less effective in enhancing students' learning motivation and their algebraic thinking abilities (Poçan et al., 2023; Wong & Wong, 2021). Within the context of the Merdeka Curriculum and National Assessments in Indonesia, these gaps present significant challenges to improving the quality of mathematics instruction. These challenges are critical to address, as they impact not only students' learning outcomes but also their overall interest and engagement in mathematics.

To address these issues, innovative solutions are needed to improve students' understanding of algebra while simultaneously enhancing their motivation to learn. One such strategy is the development of an e-pocket book, a web-based digital learning medium designed to support mathematics instruction in a more interactive and flexible way (Akın, 2022; Cobb, 2020). The e-pocket book enables students to access materials, practice problems, and instructional videos anytime and anywhere through digital devices such as smartphones or laptops (Juniarti et al., 2021). The primary advantage of the e-pocket book over

conventional learning media lies in its ability to present material visually and engagingly (Saphira et al., 2023; Wiyono et al., 2023). Interactive features, such as instructional videos, worked examples with solutions, and student worksheets, are designed to help students comprehensively grasp algebraic concepts. This medium also facilitates independent learning in a more flexible manner, allowing students to learn at their own pace and according to their preferred learning style. In this study, the e-pocket book is designed based on indicators of algebraic thinking, such as generalization, transformation, and problem-solving, to effectively support students' skill development.

Previous studies have demonstrated the effectiveness of pocket book-based learning media, both in physical and digital formats, in improving students' understanding of mathematical concepts (Aswirna & Ritonga, 2020; Hasibuan et al., 2024; Wu et al., 2024; Yohannes et al., 2023). However, these media still have limitations, such as a lack of interactive features, technical constraints related to application installation, and insufficient flexibility. Physical pocket books, for instance, require time-consuming and costly printing processes and are prone to loss or damage (Kubišová, 2024; Melo, 2021). Meanwhile, digital pocket books based on applications often demand significant storage space and complex installation procedures, which limit their practicality (Bani & Masruddin, 2021; Stejskal et al., 2021). The e-pocket book developed in this study offers several novelties designed to address these limitations. It is web-based, eliminating the need for installation and enabling direct access through browsers on various devices. Furthermore, this e-pocket book is equipped with instructional videos, interactive practice problems, and assessments aligned with algebraic thinking indicators. Its visually engaging design and flexible accessibility aim to enhance students' enthusiasm for learning while supporting the development of their algebraic thinking skills.

This study aims to develop an e-pocket book as an interactive learning medium to enhance middle school students' algebraic thinking skills. By utilizing the features and accessibility of the e-pocket book, the study seeks to enable students to engage in independent learning, improve their understanding of algebraic concepts, and increase their motivation to study mathematics. The research question guiding this study is: How do the expert review and limited trial results of the e-pocket book contribute to the development of algebraic thinking skills among middle school students?

RESEARCH METHODS

Research Design and Approach

This study adopts a Research and Development (R&D) approach, selected for its focus on creating innovative products to enhance students' learning experiences. The goal of this research is to develop an e-pocket book to improve students' algebraic thinking skills. The study employs the ADDIE model, a systematic and iterative instructional design framework consisting of five phases: Analyze, Design, Develop, Implement, and Evaluate. This model ensures continuous evaluation and refinement at every phase, facilitating the creation of effective and practical learning tools. The ADDIE model has been widely recognized for its efficacy in developing technology-based educational materials (Branch, 2010; Dousay & Logan, 2011). The research flowchart is presented in Figure 1.

The flowchart in Figure 1. illustrates the ADDIE model procedure, a systematic framework consisting of five phases to guide the development and evaluation of the e-pocket book. In the Analyze

phase, a comprehensive literature review, curriculum analysis, and needs assessment were conducted to identify gaps in students' algebraic understanding. The literature review specifically examined common misconceptions in algebra, such as difficulties with patterns, variables, and real-world applications. Additionally, the review aligned the e-pocket book content with the Kurikulum Merdeka and assessed students' needs, including their digital proficiency and learning preferences, to ensure the material was both relevant and accessible. The Design phase focused on developing learning activities aimed at improving three key indicators of algebraic thinking: Generality, Transformational, and Meta-Global. For Generality, activities involved identifying and extending patterns in algebraic forms, such as recognizing constants, coefficients, and variables in sequences. For Transformational, tasks were designed to help students formulate algebraic operations with proper syntax, including simplifying expressions using basic arithmetic rules. For Meta-Global, exercises emphasized representing real-world problems as algebraic equations and vice versa, such as modeling financial transactions or solving age-related scenarios. These activities were specifically tailored to address common challenges and enhance students' understanding of algebraic concepts. Assessment methods, including pretests and posttests, were also designed to evaluate these skills comprehensively. During the Develop phase, the e-pocket book was created using Canva for content design and Heyzine for digital publication. To ensure its quality and alignment with educational standards, the product underwent expert validation by content and media experts. Content experts evaluated the e-pocket book's accuracy, relevance, and clarity, while media experts assessed its visual design, interactivity, and usability. Feedback from these experts was analyzed, and necessary revisions were made to refine the e-pocket book before implementation. In the Implement phase, the e-pocket book was introduced in a classroom setting over three weeks, during which data were collected through pretests, posttests, and student response questionnaires to evaluate its feasibility and effectiveness. Finally, the Evaluate phase focused on analyzing the data collected from tests and feedback forms to assess the e-pocket book's usability and its impact on students' algebraic thinking skills. The process is visually represented in the flowchart, detailing each phase and its corresponding activities.

The research was conducted over six months, encompassing four phases: two months for analysis and design, 1.5 months for development, one month for implementation, and 1.5 months for evaluation and data analysis.
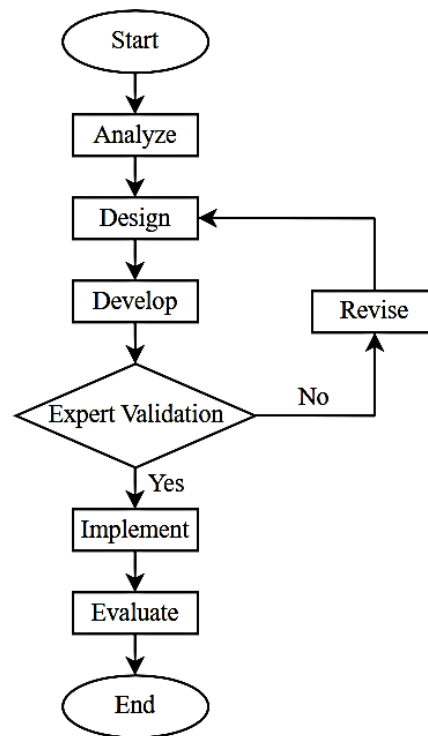
Figure 1. ADDIE Flowchart

Participant, Sampling, and Ethical Considerations

Participants in this study consisted of 67 eighth-grade students from SMP Negeri 14 Serang City, selected using purposive sampling. The selection criteria included access to adequate technological resources, such as computers or smartphones, and enrollment in a curriculum that covered algebra-related topics relevant to the study's objectives. From this group, 8 students were selected as the sample for the limited trial, focusing on initial testing and refinement of the e-pocket book, while the remaining 59 students participated as the sample for the field trial, which evaluated the tool's effectiveness on a larger scale. This division ensured a systematic approach to testing, starting with a smaller group for refinement before broader implementation. The study adhered to strict ethical principles to protect the rights and well-being of participants. Written informed consent was obtained from both students and their parents, ensuring they were fully aware of the study's purpose, procedures, and potential risks or benefits. Participation was entirely voluntary, with students free to withdraw from the study at any time without repercussions. Personal data collected during the study were anonymized and stored securely to maintain confidentiality, and the research was conducted with prior approval from the school administration, ensuring compliance with institutional policies. These ethical measures upheld the integrity of the study and safeguarded the participants' interests.

Data Collection and Instruments

The data collection process involved using validated instruments to ensure both accuracy and reliability. The instruments included cognitive tests, expert validation questionnaires, and response questionnaires for students. The instruments were validated by a team of four experts to ensure the quality

and feasibility of the e-pocket book. Two content experts evaluated the e-pocket book on four key aspects: (1) content feasibility, focusing on the appropriateness and relevance of the material; (2) presentation feasibility, assessing the clarity and engagement of the content; (3) alignment with learning indicators, verifying its consistency with the intended educational objectives; and (4) linguistic feasibility, ensuring the language was clear and accessible for the target audience. Additionally, two media experts assessed the e-pocket book based on three aspects: (1) product size, ensuring suitability for digital use; (2) cover design, evaluating its visual appeal and relevance; and (3) product content design, focusing on user-friendliness and interactivity. According to standard validation guidelines, the minimum number of experts required for conducting content validation is two members for smaller studies, while at least six experts are recommended for studies involving a larger sample size (Ananthan Munisamy, 2021; Roebianto et al., 2023; Yusoff, 2019). For this study, the use of four experts was deemed appropriate, considering the study's focus and relatively limited sample size. Their evaluations provided valuable feedback to refine the e-pocket book and ensure its alignment with educational standards. The validation process focused on content validity, where experts provided feedback on the suitability and effectiveness of the materials. Their feedback was analyzed using content analysis, and necessary revisions were made to address identified issues and improve the overall quality of the e-pocket book. Inter-rater reliability was measured using Cohen's Kappa, ensuring consistency and agreement among the experts' evaluations (Rau & Shih, 2021; Roebianto et al., 2023).

Student feedback was collected using response questionnaires that evaluated four aspects: (1) interest, which measured how engaging and motivating the e-pocket book was; (2) material, which assessed the relevance and usefulness of the content in improving algebraic thinking skills; (3) language, which evaluated the clarity and accessibility of the language used; and (4) overall average, which provided an overall satisfaction score. The feedback was analyzed to gauge the e-pocket book's effectiveness and user-friendliness.

The cognitive tests were designed to evaluate key indicators of students' algebraic thinking skills. The sample questions, categorized by specific indicators, are presented in the table below.

Table 1. Sample Questions for Ssessing Algebraic Thinking Skills

Indicator	Sample Question
Generality	Given the following expressions: $(x+1)(x+2)$, $(x+2)(x+3)$, $(x+3)(x+4)$, … Find the pattern in the results of these multiplications and determine the result of $(x+4)(x+5)$.
Transformational	If $p = 3$ and $q = 2$, calculate the result of the following expression: $4p^2 - 3pq + 2q^2$. Explain your calculation process.
Meta-Global	A company produces two types of goods: A, which takes $2x+3$ hours to produce, and B, which takes $x+5$ hours. The total production time for both goods is 120 hours. Find the value of x that satisfies this condition.

Table 1 illustrates representative questions used to assess students' algebraic thinking skills across three key indicators. Each question targets specific cognitive abilities, from identifying patterns and executing algebraic operations to solving contextual problems through algebraic modeling. These

questions were integral to evaluating the effectiveness of the e-pocket book in enhancing students' skills. Before full implementation, the instruments were piloted with a small group of 10 students. This pilot testing ensured clarity, appropriateness, and relevance of the questions. Feedback from the pilot group helped refine the questions in terms of difficulty and wording, ensuring the instruments accurately measured students' algebraic thinking skills.

Data Analysis and Conclusion

The data analysis utilized both qualitative and quantitative methods to evaluate the effectiveness of the e-pocket book in enhancing students' algebraic thinking skills. The qualitative analysis focused on content validity, where expert validation was conducted using a Likert scale (1–5) to assess the feasibility of the e-pocket book in terms of content accuracy, presentation quality, alignment with learning objectives, and language clarity. Ratings were categorized as very feasible (4.21–5.00), feasible (3.41–4.20), or not feasible (<3.41). Feedback from experts was analyzed using content analysis, and necessary revisions were made to refine the material. Cohen's Kappa was used to measure inter-rater agreement among experts, with results ranging from moderate (0.41–0.60) to almost perfect agreement (0.81–1.00), ensuring consistency and reliability in the validation process.

Quantitative analysis measured the improvement in students' algebraic thinking skills using the N-Gain formula, which calculates normalized learning gains between the pretest and posttest. Additionally, paired t-tests were performed to determine the statistical significance of the differences in scores, offering robust evidence of the e-pocket book's impact. Data analysis was conducted using SPSS version 22 and Microsoft Excel from Microsoft Office 2021, ensuring accuracy and reliability of results. These analyses demonstrated significant gains in students' abilities to recognize patterns, formulate algebraic expressions, and solve real-world problems using algebraic representations.

The decision-making process was grounded in these combined analyses. Feedback from experts determined whether revisions were necessary before implementation, while pretest and posttest data confirmed the e-pocket book's effectiveness in enhancing students' algebraic thinking. Student feedback through response questionnaires added a critical user perspective, reinforcing decisions to refine and validate the tool. Together, these steps ensured that each decision in the research—from validation to final evaluation—was evidence-based and aligned with the study's objectives.

RESULTS AND DISCUSSION
Analysis Phase

The Analyze stage was conducted to identify key challenges and opportunities for developing the e-pocket book. This phase involved a comprehensive literature review, curriculum analysis, and needs assessment to address gaps in students' algebraic understanding. Specifically, the analysis focused on uncovering common misconceptions in algebra, aligning the content with the Kurikulum Merdeka, and evaluating students' characteristics and preferences to ensure the e-pocket book would be relevant, engaging, and effective. Below, the detailed findings of the Analyze stage are presented in the following Table 2.

Table 2. Results of the Analyze Stage

Aspect	Findings	Implications
Performance Gap Analysis	- Students face misconceptions in algebra, particularly in understanding variables, patterns, and symbols. - Real-world applications are often challenging due to abstract representations. - Lack of interactive learning media limits engagement.	Highlights the need for an innovative, interactive tool to simplify abstract algebraic concepts and improve engagement.
Needs Analysis	- Algebraic expressions identified as a difficult topic for students. - Students require a medium that simplifies abstract concepts while being accessible and engaging. - Canva and Heyzine selected for content creation and digital publication.	Focuses the e-pocket book on enhancing comprehension of algebraic expressions and making learning interactive.
Curriculum Analysis	- Ensured alignment with the Kurikulum Merdeka, addressing core and basic competencies for algebraic thinking. - Content tailored to meet national education standards while supporting algebraic mastery.	Guarantees that the e-pocket book adheres to curriculum requirements and contributes to students' educational progress.
Student Characteristics	- Students find traditional math textbooks dense and unappealing. - Mathematics, especially algebra, is perceived as intimidating. - Students are proficient in using digital devices like PCs, laptops, and smartphones.	Develops a user-friendly, interactive e-pocket book that leverages students' digital proficiency to create a more effective learning experience.

Table 2 provides a comprehensive overview of key findings from the analysis phase and their implications for the development of the e-pocket book. The Performance Gap Analysis highlights critical challenges, such as misconceptions in algebra and the lack of interactive media, emphasizing the need for a tool that simplifies abstract concepts and improves engagement. The Needs Analysis identifies algebraic expressions as a particularly difficult topic, guiding the focus of the e-pocket book on enhancing comprehension through interactive and accessible design, supported by tools like Canva and Heyzine. The Curriculum Analysis ensures alignment with the Kurikulum Merdeka, guaranteeing that the e-pocket book meets national educational standards while supporting students' algebraic mastery. Finally, the Student Characteristics analysis underscores the importance of developing a user-friendly and interactive digital learning tool that leverages students' proficiency with technology to overcome the challenges posed by traditional math textbooks and the intimidating nature of algebra. Overall, the findings and their implications demonstrate a well-rounded foundation for designing an effective e-pocket book tailored to address students' needs and align with educational objectives.

Design Phase

The Design Phase focuses on creating the e-pocket book based on the analysis of student needs and includes several key steps. These steps begin with the development of a storyboard, which outlines the structure and flow of the e-pocket book. The design process also involves selecting the appropriate software tools, namely Canva for content creation and Heyzine for publishing and accessing the e-pocket book online. The e-pocket book content is centered around algebra, covering topics such as algebraic expressions, arithmetic operations, and modeling. To ensure clarity and ease of understanding, the content is designed to be concise and straightforward, with practice problems followed by detailed solutions to reinforce learning.

Furthermore, the design process explores various ideas for structuring the e-pocket book, with a focus on aligning the content with specific indicators of algebraic thinking. These indicators, primarily derived from Kieran (2004), were carefully selected to ensure that the e-pocket book facilitates the development of key algebraic thinking skills in students. The technical sub-indicators and specific questions were developed by the researchers to align with algebraic concepts. The following table outlines the indicators and their corresponding sub-indicators, which guide the content and activities within the e-pocket book.

Table 3. Indicators of Algebraic Thinking

Algebraic Thinking Indicator	Sub-indicators
Generalization	• Understanding patterns that emerge from algebraic forms and operations. • Identifying constants, coefficients, and variables. • Expressing algebraic expressions in standard algebraic forms. • Collecting like terms in an algebraic expression.
Transformational	• Formulating algebraic operations with appropriate syntax. • Solving algebraic operations (addition, subtraction, multiplication, division, exponentiation, and fractions) using algebraic properties. • Simplifying algebraic expressions to equivalent forms using algebraic properties and operations.
Meta Global Level	• Representing and transforming problems into algebraic forms and vice versa to solve them. • Modeling problems as algebraic expressions and solving them using the model. • Interpreting the value of an algebraic expression by substituting values into variables.

These indicators in Table 3 ensure that the e-pocket book supports students in developing the essential skills needed for algebraic thinking, from recognizing patterns to solving complex algebraic problems. By following this structured design approach, the e-pocket book aims to provide a comprehensive learning experience that promotes mastery in algebra for middle school students.

Figure 2 illustrates the e-pocket book design process carried out using Canva, a web-based graphic design platform that allows the creation of educational materials with an attractive and interactive layout. In this design phase, Canva is used to arrange visual elements, such as text, images, and graphics, that support student comprehension of algebraic concepts. By using Canva, designers can effectively organize the layout and structure the information in a format that is easy for students to understand. This includes arranging text, practice questions, and visual aids that clarify algebraic concepts.
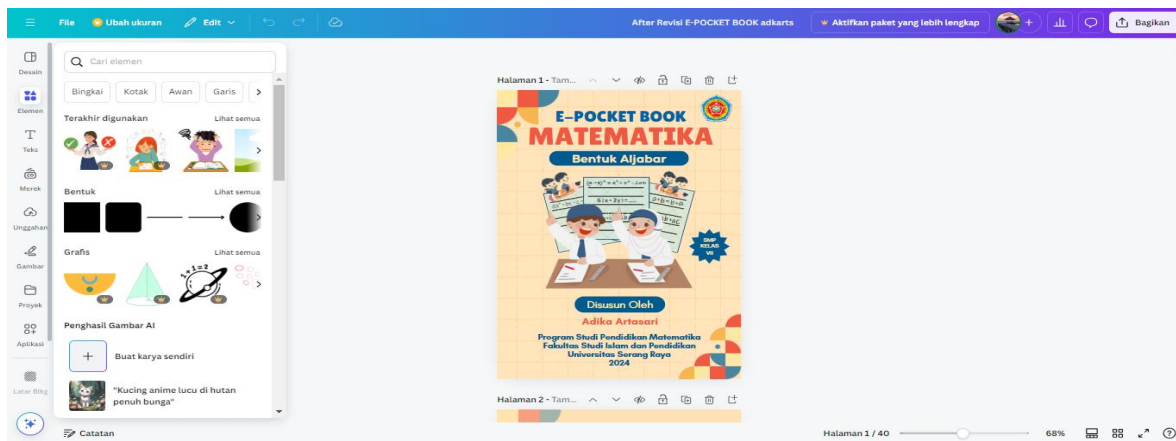

Figure 2. The E-Pocket Book Design Process in Canva

Figure 2 depicts the initial phase of creating an e-pocket book, focusing on a visual design that helps students understand algebraic material. In Canva, each element is organized with an emphasis on simplicity and visual appeal, aiming to reduce student boredom with a subject often considered difficult. These design elements include the use of color, appropriate typography, and relevant illustrations to explain complex mathematical concepts, such as algebraic expressions and arithmetic operations.

The image also shows the selection of layouts that make it easy for students to navigate, ensuring they can follow the learning process and interact with the material. Canva enables responsive designs, ensuring the resulting e-pocket book is accessible across various devices, including computers and smartphones. This design process in Canva also takes into account the indicators of algebraic thinking skills, ensuring that each part of the e-pocket book is designed to support the development of skills such as generalization, transformation, and mathematical modeling. By leveraging Canva, this design process aims to create a learning medium that is not only informative but also visually engaging, which is expected to enhance students' interest and motivation in learning algebra.
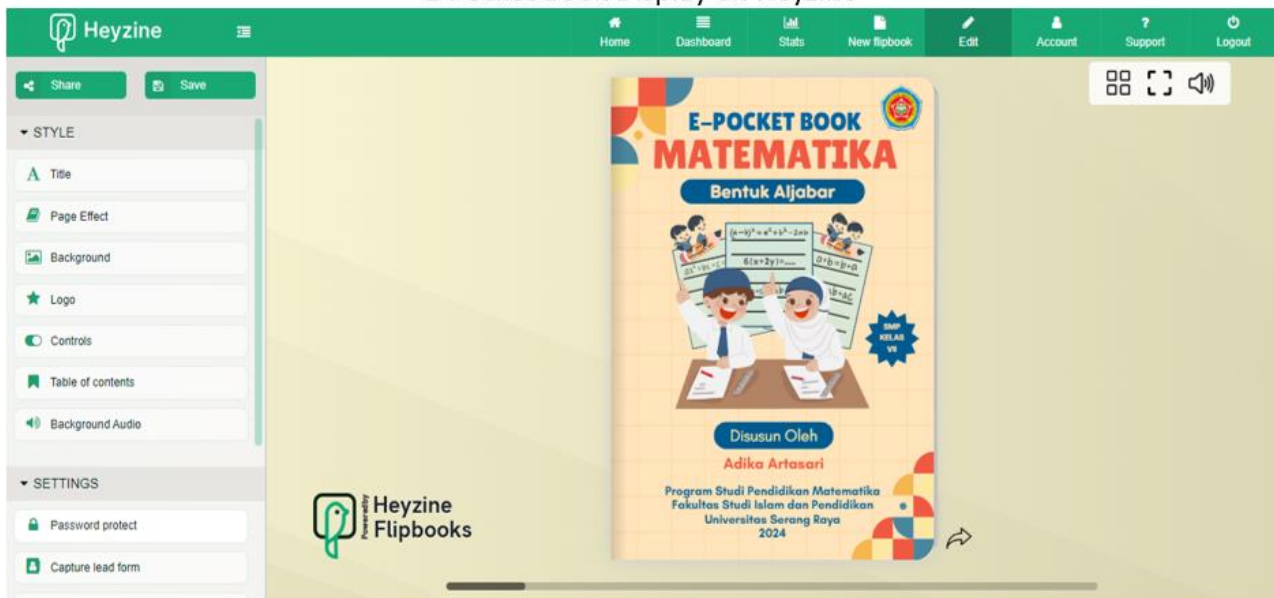
Development Phase

In the development phase, the e-pocket book is designed to optimize students' algebraic thinking skills, particularly in the topic of algebraic expressions. The final product consists of 40 pages, incorporating essential elements such as the cover, introduction, table of contents, core competencies and basic competencies, achievement indicators, concept maps, learning objectives, material content aligned with indicators, example problems, practice exercises with solutions, supporting images, and an author profile. The e-pocket book is developed using Canva for the layout design and exported to Heyzine, a

platform that converts the material into a flipbook PDF format in A5 size. The fonts used in the design are Poppins and Inter to ensure clarity and readability.

The assessment instruments include both cognitive tests (pre-test and post-test) and non-cognitive instruments in the form of questionnaires directed towards experts and students. The validation process involves three experts: a content expert, a mathematics education expert, and a media expert, who assess the feasibility of the product. Based on the feedback from these experts, the e-pocket book is revised to enhance its quality and ensure it is suitable for use as an effective teaching material.

Figure 3. Development Results of the E-Pocket Book

After the e-pocket book is fully developed, the next step is to conduct expert validation to assess its feasibility and gather suggestions for improvement from the validators. This ensures that the e-pocket book is ready for use as an educational tool. The results of the product's feasibility are outlined below.

The e-pocket book underwent validation by two content experts who evaluated it based on four aspects, which included a total of 18 statements. The analysis of the content validation results is presented in Table 4.

Table 4. Results of Content Expert Validation

Assessment Aspect	Average	Description	Percentage	Category
Content Feasibility	4,3	Very Feasible	86%	Highly Satisfactory
Presentation Feasibility	4,1	Feasible	82%	Highly Satisfactory
Alignment with Indicators	4,5	Very Feasible	90%	Highly Satisfactory
Linguistic Feasibility	4,2	Feasible	84%	Highly Satisfactory
Average	4,3	Very Feasible	86%	Highly Satisfactory

Based on Table 4, the total average score of the validation results is 4,3 (86%). This score indicates that the content of the e-pocket book is classified as "Very Feasible" or "Highly Satisfactory" in overall percentage.

Two media expert conducted the validation, focusing on three aspects and 14 statements. The analysis of the media validation results is presented in Table 5.

Table 5. Results of Media Expert Validation

Assessment Aspect	Average	Description	Percentage	Category
Product Size	4,2	Feasible	84%	Highly Satisfactory
Cover Design	4,1	Feasible	82%	Highly Satisfactory
Product Content Design	4,6	Very Feasible	92%	Highly Satisfactory
Average	4,3	Feasible	86%	Highly Satisfactory

Based on Table 4, the average score of the media validation is 4,3 which places the product in the "Very Feasible" level or "Highly Satisfactory" category in overall percentage.

To ensure consistency among validators, inter-rater reliability was measured using Cohen's Kappa, which yielded a result of 0.82, indicating substantial agreement among the validators. This high level of agreement reflects the consistency and reliability of the validation process, ensuring that the feedback provided was cohesive and trustworthy. The validation results indicated that the e-pocket book was rated as highly feasible in terms of content and language, while being rated as feasible in terms of presentation and alignment with indicators. These ratings highlight the overall strength of the e-pocket book while identifying specific areas that required improvement.

The feedback from the validators suggests that minor revisions are necessary to enhance the quality and functionality of the e-pocket book. The following table summarizes the key feedback provided and the actions taken to address these suggestions.

Table 6. Summary of Validator Feedback and Actions Taken

Aspect	Theme	Feedback	Action Taken
Content Feasibility	Coverage of algebraic indicators	Add more real-life application examples.	Additional examples have been included.
Alignment with Indicators	Cognitive level alignment	Revise some task wordings for better student understanding.	Task wording revised accordingly.
Product Size	File accessibility and usability	Reduce file size to ensure faster loading times.	Optimized file size for improved accessibility.
Product Content Design	Layout and interactivity	Improve navigation and structure of activities.	Revised layout to simplify navigation and added interactive elements.

Implementation Phase

The implementation phase aimed to assess the effectiveness of the e-pocket book, which had been validated during the development phase. This stage involved direct testing with 67 eighth-grade students through both limited and field trials to ensure its practical application in a real learning environment. The e-pocket book, presented in flipbook format via the Heyzine platform, was shared through an online link.

The implementation process began with the researcher obtaining permission to conduct the study by submitting a formal research proposal letter to the school. Coordination meetings were held with the curriculum coordinator and the mathematics teacher to discuss data collection methods and plan the trial process. Once the framework was established, students were given access to the e-pocket book through the shared link, along with clear instructions on how to navigate and utilize the resource.

To evaluate the e-pocket book's impact, students were first required to complete a pre-test designed to measure their initial algebraic thinking skills. Following this, they accessed and studied the material in the e-pocket book, which included explanations, worked examples, and practice exercises. After engaging with the content, students completed a post-test to assess their progress and understanding of the material. Finally, they were asked to provide feedback on the e-pocket book by filling out a questionnaire via Google Forms.

After collecting data from students' algebraic thinking tests and responses, the researcher analyzed the results. The findings are summarized as follows.

Table 7. Results of Students' Algebraic Thinking Skills (Pre-Test & Post-Test)

Trial Type	Students	Pre-Test (Min)	Pre-Test (Max)	Pre-Test (Average)	Post-Test (Min)	Post-Test (Max)	Post-Test (Average)	N-Gain	Category
Limited Trial	8	19	34	25	70	91	84	0.79	High
Field Trial	59	4	49	17.7	61	100	76.2	0.71	High

Table 7 presents the results of students' algebraic thinking skills tests from the pre-test and post-test in both the limited trial and field trial. In the limited trial, which involved 8 students, the average pre-test score of 25 increased significantly to 84 in the post-test, with an N-Gain of 0.79, categorized as

high. Similarly, in the field trial with 59 students, the average pre-test score of 17.7 improved to 76.2 in the post-test, with an N-Gain of 0.71, also categorized as high. These results demonstrate a significant enhancement in students' algebraic thinking skills after using the e-pocket book.

Table 8. Analysis of Student Responses

Trial Type	Assessment Aspect	Average Score	Percentage	Criteria
Limited Trial	Interest	33.3	83%	Excellent
	Material	33.75	84%	Excellent
	Language	37.5	94%	Excellent
	Overall Average	34.86	87%	Excellent
Field Trial	Interest	227	86%	Excellent
	Material	229.5	87%	Excellent
	Language	231.5	87%	Excellent
	Overall Average	229.33	87%	Excellent

Table 8 summarizes the analysis of students' responses to the e-pocket book during the limited trial and field trial. In the limited trial, students gave an average score of 87% across the aspects of interest, material, and language, classified as excellent. Similarly, in the field trial, the overall average score remained consistent at 87%, indicating that students found the e-pocket book engaging, relevant, and easy to understand. The consistent positive responses across both trials highlight the effectiveness of the e-pocket book in supporting student engagement and learning in algebra.

Evaluation Phase

The Evaluation Phase focused on analyzing the data collected from both the Implementation Stage and Development Phase to assess the effectiveness and overall quality of the e-pocket book. This phase involved evaluating student performance, user feedback, and expert reviews to ensure that the e-pocket book met its intended educational objectives. The expert reviews, conducted during the Development Phase, provided valuable insights into the pedagogical and visual quality of the e-pocket book, and the feedback was revisited during the evaluation to assess the adjustments made based on expert recommendations.

Quantitative analysis was performed on the pre-test and post-test results, revealing significant improvements in students' algebraic thinking skills. The N-Gain formula showed high scores of 0.79 for the limited trial and 0.71 for the field trial, indicating that the e-pocket book effectively enhanced students' learning outcomes and algebraic thinking skills. These results demonstrate the significant impact of the e-pocket book on students' performance in algebra.

User feedback, collected through student response questionnaires, showed an overall approval rate of 87%, categorizing the e-pocket book as excellent. Students praised the tool for its user-friendliness, clear explanations, and engaging design, highlighting its effectiveness as an interactive learning tool. The analysis of expert reviews, with material experts rating the product at 86% and media experts assigning a score of 86%, confirmed the e-pocket book's pedagogical and visual quality. The expert validators highlighted key improvements: adding real-life examples for better relevance, revising task wordings for

clarity, optimizing file size for faster loading, and refining navigation and layout to enhance usability and interactivity.

Overall, the Evaluation Phase confirmed that the e-pocket book is an effective learning tool. The positive results from students, educators, and experts underscore its potential to significantly improve students' algebraic thinking skills. Recommendations for future improvements include integrating more interactive features, expanding content coverage, and conducting long-term studies to evaluate skill retention and application. The evaluation also reinforced the e-pocket book's scalability and relevance as a valuable resource for mathematics education.

Discussion

The findings of this study demonstrate that the developed e-pocket book is an effective educational tool for improving students' algebraic thinking skills. The N-Gain scores of 0.79 (limited trial) and 0.71 (field trial), categorized as high, signify a significant improvement in students' cognitive abilities. These results indicate that the e-pocket book successfully addressed gaps in understanding algebraic concepts. The improvement is consistent with prior research on the effectiveness of digital learning tools, such as Long et al. (2021), which found positive results with similar interventions. However, this study advances the field by specifically targeting algebraic thinking skills, which have often been overlooked in digital learning interventions (Saphira et al., 2023). This study highlights the importance of focusing on algebraic thinking as a specialized approach to digital learning in mathematics education, which helps students move beyond procedural knowledge to a deeper understanding of mathematical concepts (Nilimaa, 2023). Emphasizing algebraic reasoning not only enhances critical thinking and problem-solving skills but also equips students for success in advanced mathematics and real-world applications (Mansah & Safitri, 2022; Romaito et al., 2021; Safitri et al., 2024; Safitri & Ansyari, 2024).

The student response questionnaires, with an approval rate of 87%, highlight the e-pocket book's practicality, user-friendliness, and engaging design. Features such as interactive exercises, clear explanations, and visual elements were essential in these outcomes. One student remarked, *"The visuals made understanding variables much easier."* This feedback emphasizes the e-pocket book's strength in making complex concepts more accessible through visual aids. Similarly, expert validation scores of 86% (content) and 86% (media) validate the tool's pedagogical and visual quality. These scores are comparable to the findings of Litke (2020), which also highlighted the importance of aligning digital tools with cognitive learning objectives in mathematics. This alignment between content and visual representation has been shown to foster better student engagement and understanding (Tarigan et al., 2023). Interactive learning, particularly through the use of visual elements, has been shown to significantly enhance student retention and engagement in mathematics education (Muir et al., 2022). By providing students with visual aids and interactive tasks, complex concepts become more accessible and memorable, leading to deeper cognitive processing and better learning outcomes.

The e-pocket book addressed several common challenges in algebra learning, such as misconceptions about patterns, variables, and symbols. By integrating real-life application examples and providing step-by-step guidance, the e-pocket book helped students overcome difficulties related to abstract algebraic concepts. For instance, students were able to recognize and work with variables in a more contextualized manner. Despite these strengths, however, some students still struggled with higher-

order problem-solving tasks, which indicates that further development of tailored exercises may be needed to support these areas. Integrating real-world applications into algebra education not only makes the content more relevant to students' lives but also deepens their understanding of algebraic concepts (Alam & Mohanty, 2024; Jung et al., 2024). Research has shown that when students apply algebra to solve real-life problems, they develop stronger problem-solving skills and a greater appreciation for the subject.

While the study achieved promising results, it also faced several limitations. The sample size for the limited trial (8 students) was relatively small, which may limit the generalizability of the findings to a broader student population. This limitation is significant when considering the diversity of student learning styles and capabilities, which may not be fully captured in a smaller sample. Additionally, the focus on a single algebraic topic—algebraic expressions—restricts the scope of applicability to other mathematical areas. Further research should include a broader range of mathematical topics to assess the e-pocket book's adaptability across the curriculum.

Furthermore, the e-pocket book's reliance on digital devices and stable internet connections is a technical limitation, particularly for students in under-resourced areas. This issue could contribute to unequal access to the learning tool, reinforcing existing inequalities in education. These limitations underscore the importance of considering digital divide issues in future iterations of digital learning tools. Another challenge is the potential bias in student responses, as students who are more familiar with digital tools may have rated the usability more favorably than those with less experience. Additionally, while the pre-test and post-test assessments measured algebraic thinking skills, they did not provide a comprehensive assessment of other cognitive areas such as metacognitive strategies, which could have enriched the evaluation of the e-pocket book's effectiveness.

Building on these findings, future research should focus on several key areas. First, expanding the e-pocket book to include other mathematical topics, and incorporating interactive features such as quizzes, simulations, and real-time feedback, could further enhance its utility and effectiveness. Second, longitudinal studies are needed to evaluate the long-term retention and application of skills acquired through the e-pocket book. This would provide insight into the sustainability of the learning benefits over time. Third, conducting trials in diverse educational contexts, particularly in under-resourced schools, would provide more insights into the e-pocket book's adaptability and scalability. Given the issues identified with digital access, it is essential to explore offline-compatible features and low-tech alternatives to ensure broader accessibility for students in disadvantaged areas. Teacher training on how to effectively implement digital learning tools should be a key component of future studies. Providing educators with clear guidelines on how to integrate the e-pocket book into lesson plans will enhance its impact and overcome potential challenges related to classroom implementation.

CONCLUSION

The findings of this study directly address the research questions, specifically regarding how the expert review and limited trial results of the e-pocket book contribute to the development of algebraic thinking skills among middle school students. The expert validation results indicate that the e-pocket book is feasible, with material experts evaluating the content, presentation, and language as "Highly Satisfactory" and media experts rating the design and usability as "Highly Satisfactory" as well. These positive evaluations underscore the educational quality and appropriateness of the e-pocket book for the

intended purpose. In addition, the significant improvement in students' algebraic thinking, as shown by the N-Gain scores from both the limited and field trials, demonstrates that the e-pocket book effectively enhances students' algebraic skills. The increased post-test scores confirm that the e-pocket book aids students in understanding algebraic concepts, solving algebraic problems, and improving overall mathematical reasoning. Therefore, the study concludes that the e-pocket book is not only feasible but also effective in improving students' algebraic thinking, fulfilling both the practical and theoretical goals outlined in the research questions.

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