



MarBel Math: Android-Based Electronic Mathematics Book to Enhance Learning Outcomes for Fourth-Grade Students

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ABSTRAK

Keterbatasan dalam menyediakan media pembelajaran inovatif yang sejalan dengan perkembangan Ilmu Pengetahuan dan Teknologi memberikan dampak negative bagi siswa seperti kesulitan dalam memahami materi, rendahnya motivasi belajar, dan rendahnya hasil belajar. Tujuan penelitian ini adalah untuk mengembangkan media pembelajaran buku elektronik berbasis Android bernama MarBel Math untuk materi bangun datar di kelas IV Sekolah Dasar. Penelitian ini menggunakan metode penelitian Research and Development (R&D) dengan model pengembangan ADDIE yang memiliki lima tahap yaitu Analysis, Design, Development, Implementation, dan Evaluation. Teknik pengumpulan data menggunakan teknik tes maupun non tes. Teknik analisis datanya menggunakan teknik analisis data kuantitatif dan kualitatif. Hasil validasi ahli materi diperoleh skor rata-rata sebesar 92% dengan kriteria "sangat layak", sedangkan pada uji validasi ahli media diperoleh skor rata-rata sebesar 85% dengan kriteria "layak". Adapun penelitian ini menggunakan uji t-test dan n-gain untuk mengkaji efektivitas penerapan media pembelajaran MarBel Math. Uji ini mendapatkan informasi bahwa terdapat adanya peningkatan rata-rata hasil belajar siswa sebanyak 68% dengan peningkatan rata-rata dari yang awalnya atau pre-test sebesar 54 menjadi 85 pada posttest. Dari hasil tersebut, media pembelajaran MarBel Math dinilai mempunyai kualifikasi yang sangat layak digunakan dalam kegiatan pembelajaran dan cukup efektif dalam meningkatkan hasil belajar siswa khususnya pada pembelajaran matematika materi bangun datar kelas IV Sekolah Dasar.

ABSTRACT

The limitations in providing innovative learning media that align with the developments in Science and Technology negatively impact students, such as difficulty understanding the material, low learning motivation, and poor learning outcomes. This research aims to develop an Android-based electronic book learning media named MarBel Math for flat shapes material in the fourth grade of Elementary School. This research employs the Research and Development (R&D) method with the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. Data collection techniques utilize both test and non-test methods. The data analysis technique involves both quantitative and qualitative data analysis methods. The validation results from content experts yielded an average score of 92%, classified as "very suitable." In the validation test by media experts, an average score of 85% was obtained, classified as "suitable". The study utilized t-test and n-gain analysis to assess the effectiveness of implementing MarBel Math learning media. This test revealed an average increase in student learning outcomes by 68%, with the average increasing from the initial or pre-test score of 54 to 85 in the post-test. From these results, MarBel Math learning media is considered to have very suitable qualifications for use in learning activities and is quite effective in improving student learning outcomes, especially in mathematics learning for flat shapes material in fourth-grade Elementary School.

1. INTRODUCTION

In the current era of Industrial Revolution 4.0 and Society 5.0, science and technology (IPTEK) development is experiencing rapid progress in all aspects of life. One of the most significant influences is education. Because it includes elements of information, media for delivering educational content, and students as recipients of knowledge (Kergroach, 2017; Maulida et al., 2020), one aspect that is developing rapidly is the use of technology-based learning media. Currently, teachers are expected to deliver learning material using technology, such as PowerPoint presentations, learning videos, and interactive learning quizzes, because they significantly impact student learning outcomes. This indicates that education is making good progress over time (Hashemi et al., 2012; Joseph & Natarajan, 2022). Education in this era of globalization also holds significant benefits in determining one's future (Ananda et al., 2021; Endiawan et al., 2021). Individuals are expected to possess critical thinking skills, literacy and numeracy skills, and

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problem-solving abilities that will be useful in their future lives. To realize this, the emergence of the *Merdeka* Curriculum has replaced the previous curriculum, namely the 2013 Curriculum.

The *Merdeka* Curriculum replaces the Curriculum 2013, which emphasizes character education, literacy, and numeracy skills, and the use of technology for data processing and interpreting digital information (Jamilah & Indana, 2024; Sidiq, 2022). The *Merdeka* Curriculum focuses on flexible learning models tailored to students' abilities and developmental characteristics. The characteristics of the *Merdeka* curriculum emphasize the learning process, including project-based learning to develop soft skills and character based on the Pancasila student profile and a concentration on essential materials to facilitate the learning process, emphasizing literacy and numeracy skills (Ledia & Bustam, 2024; Payu et al., 2022). Its implementation also focuses more on applying 21st-century skills such as communication, critical thinking, creative thinking, and interpersonal relationships among college students (Putri et al., 2022; Ramdhani et al., 2023). Bearing this in mind, students are expected to be active during the learning process to achieve the goals of implementing the *Merdeka* Curriculum. To achieve this, student-centered learning is necessary. Therefore, the role of the teacher is crucial in facilitating this process.

Teachers are the main actors in the educational process and significantly impact the creation of quality education (Ningrum & Awi, 2023). Their influence can be seen in improving the quality of learning under the *Merdeka* Curriculum. Under the *Merdeka* Curriculum, teachers are free to design learning experiences according to the characteristics of their students. The Minister of Education, Culture, Science, and Technology, urges educators to create engaging student learning environments (Ningrum & Awi, 2023; Rahmawati et al., 2023). Engaging learning is referred to as student-centered learning. Student-centered learning can encourage students to collaborate cooperatively, both among themselves and with the teacher. Learning models aligned with student-centered learning include Problem-Based Learning (PBL), Project-Based Learning (PjBL), Cooperative Learning, and others. In addition, teachers can use engaging learning media to enhance students' motivation and learning outcomes in the *Merdeka* Curriculum (Fanani et al., 2022; Nabella et al., 2023). The learning media used should be tailored to the characteristics of students and the current era's developments.

Previous study explains that learning media is a physical tool for delivering learning materials (Dirgantara et al., 2022). The existence of instructional media can facilitate teachers in transferring their knowledge to students. In addition, learning media plays a crucial role in the learning process and the outcome of the learning process. Currently, the development of instructional media is leveraging advancements in science and technology, and there are many types available, one of which is e-books. Digital books or e-books are one of the instructional media that can be used to deliver learning materials. Digital books, also called e-books, contain text and images in digital format (Permata & Zulherman, 2023; Tambunan & Sundari, 2020). A teacher needs to use instructional media such as e-books to deliver learning materials in an engaging and easily understandable manner for students. One of the subjects that can be implemented in e-book instructional media is mathematics.

Mathematics is one of the sciences that plays a crucial role in life, particularly in education. The significant role of mathematics in education can be understood from the fact that mathematics underpins the emergence of other sciences such as chemistry, physics, economics, astronomy, and various other disciplines (Shams et al., 2011; Susanti & Sholihah, 2021). Mathematics is taught at various levels of formal education, which have been adapted accordingly, ranging from elementary school to higher education institutions. Mathematics in school education helps enhance students' thinking patterns to become critical, systematic, logical, and creative (Qodr et al., 2021; Turnip & Karyono, 2021). With such thinking patterns, it is hoped that students can read, process, and address everyday life issues, including those encountered when solving mathematical problems in school subjects. However, mathematics remains a common challenge for most students, such as difficulty understanding the material and achieving low learning outcomes.

Based on observations and interviews with teachers and students of the 4th grade at SD Negeri Jatibarang 03, a problem was found, particularly regarding mathematics learning outcomes. In this mathematics subject, most students experience unsatisfactory learning outcomes. The Semester 1 exam results, when compared to the minimum completeness criteria (KKM) for mathematics, which is 70, show that 72% or 18 out of 25 students in the 4th grade at SD Negeri Jatibarang 03 have scores below the class average or have not met the standard. The issue is suspected to be due to teachers' and students' minimal use of interactive and engaging instructional media despite the school having supporting facilities such as LCD projectors in each classroom, several laptops, and Wi-Fi (S. Z. Dewi & Hilman, 2018; Suwartono & Anuranti, 2019; Syaifuddin, 2017). Furthermore, SD Negeri Jatibarang 03 has also implemented literacy activities for students but its implementation has yet to be fully optimal. This is because many students sometimes find reading books that need more variety. The school has tried to provide reading materials for students in the library. However, these books have often been read by students, leading to a shortage of new

reading materials until now. One solution to these issues is for teachers to provide engaging learning experiences. One way is to present instructional media using technology and provide interesting reading materials for students, such as e-books or digital books. In this study, the researcher developed a book media that can be accessed via a gadget because students usually only read paper-based books. The development of this e-book requires an application for its creation. The applications used by the researcher are Canva, Flip PDF Corporate, and Website 2 APK. The e-book was developed by focusing on one subject, namely mathematics, specifically on the topic of flat shapes. Many students still need help understanding the material due to time constraints in research, and there were time constraints for the research.

The researcher found several previous studies investigating e-book instructional media development during the literature review. The first previous study on the development of e-books using the Book Creator application based on QR codes was conducted. The developed e-book obtained an average percentage of media and a content expert validation of 85.3% with the criteria "very good/very valid" (Palupi et al., 2022). The difference between this previous study and the current researcher's study lies in the subject matter investigated. Another study, focused on developing a mathematics e-book to enhance students' critical thinking skills, specifically in linear equations (Naufal & Kurniasari, 2022). In this study, validation testing resulted in a percentage of 97.85% with the criteria "very suitable" from practitioner validators and 90% with the requirements "very suitable" from expert validators. The difference between the researcher's study and this previous study lies in this school level investigated. Another study, focused on Problem-Based Learning e-books for Mathematics material on solid shapes for 6th-grade elementary school students (I. D. A. M. P. Dewi & Bayu, 2022). The developed e-book obtained an average percentage of content expert validation of 93.75% with the criteria "very good", instructional design expert validation of 98.21% with the criteria "very good", and media expert validation of 92.31%. Then, the effectiveness testing resulted in a value of 1.729, indicating that this media is effective for implementation. The difference between the previous studies and the researcher's study lies in the school level investigated. After reviewing the previous studies, the researcher concludes that using e-book learning media effectively enhances students' learning outcomes in understanding school subjects.

The researcher intends to compile this article with a specific purpose based on the observations, interviews, research, and literature review. The purpose is to analyze teachers with insights regarding using the latest technology-based instructional media to facilitate lesson delivery. Additionally, it aims to convey information about the concept of developing *MarBel* Math e-book instructional media and its significant impact on improving the learning outcomes of 4th-grade students in mathematics, specifically on flat shapes. Therefore, the novelty of this study provides knowledge references regarding the development of technology-based instructional media for teachers, especially for 4th-grade elementary school teachers in mathematics.

2. METHOD

This research method used is research and development (R&D). Research and development is a research method focused on producing a product, followed by testing to determine the effectiveness of the product (Susanti & Sholihah, 2021). Furthermore, this study employs the ADDIE model, which consists of 5 steps: analysis, design, development, implementation, and evaluation (Handiar & Zulherman, 2023). The independent variable in this study is the E-Book instructional media. Meanwhile, the dependent variable is the learning outcomes of the students. The population in this study is all 25 students in the 4th grade at Jatibarang 03 Elementary School. The data sources for this research are primary data and secondary data. The primary data sources are class 4 students in Semester 2 and class 4 teachers. Meanwhile, the secondary data source is in the form of written notes such as the Semester 1 exam scores of grades 4 elementary school students. The researcher employs several methods to gather data, including interviews with class teachers, classroom observations, filling out needs questionnaires, and documentation. The researcher developed an Android-based E-Book instructional media, which, over time, has been tested for its suitability by media experts and subject matter experts in the field of elementary school education. The research instrument grids for experts and media experts can be seen in Table 1 and Table 2.

Table 1. Material Expert Assesment Instrument Grid

No.	Aspect	Indikator
1.	Competence	Conformity of mathematical content with learning outcomes
2.	Suitability	Suitability of mathematical content with interactive e-book media based on and application, suitability of mathematical with evaluation of learning
3.	Language	Clarity of language

Table 2. Media Expert Assessment Instrument Grid

No.	Aspect	Indikator
1.	Suitability	The media is relevant to the learning topic
2.	Appearance	The design appearance is visually appealing, the quality or standard of media Presentation
3.	Usage	The media is easy to use for both students and teachers
4.	Superiority	The media is understandable by the users

The data analysis techniques used are both qualitative and quantitative. Qualitative data collection is conducted during interviews and observations. In contrast, quantitative data collection is carried out during the media validation phase by media experts, content validation by content experts, and small and large-scale trials in the form of pretest and posttest results. The data is analyzed using the SPSS 24 for Windows program.

3. RESULT AND DISCUSSION

Result

The result of the research and development effort is an Android-based e-book on two-dimensional shapes for fourth-grade elementary school mathematics learning. This Android-based e-book media can provide an engaging atmosphere for students' classroom and home learning activities. This is because the media incorporates a combination of visual elements and quizzes to assist students in understanding the material more deeply. The explanation of each stage of the ADDIE model in this research and development is as follows. The analysis stage involves identifying problems or determining learning needs, such as business or educational needs, specific problems that need to be addressed through learning or training, conducting needs analysis through interviews, and filling out needs questionnaires with classroom teachers and students. Based on the interview results and the completion of the needs questionnaire, it can be concluded that fourth-grade elementary school students require engaging and interactive learning media to assist in their understanding of lesson material, activate student participation in learning, and facilitate teachers in delivering complex two-dimensional shapes topics. The design stage is the phase of designing learning media in the form of an Android-based e-book before it is developed. The researcher designs the production of the product by outlining the media program to determine the learning outcomes, learning objectives, and curriculum-aligned materials for the *Merdeka* curriculum. Additionally, the researcher creates a storyboard to determine content placement within the e-book.

Table 3. Media Program Outline

No.	Learning Outcomes	Indicators	Content	Format Media
1.	Students can describe the characteristics of various two-dimensional shapes (quadrilaterals, triangles, polygons). They can compose and decompose various flat shapes in multiple ways.	<ul style="list-style-type: none"> - Through activities utilizing the <i>MarBel</i> Math media, students can accurately analyze the properties of two-dimensional shapes, the perimeter of two-dimensional shapes, and the area of two-dimensional shapes (C4) - Through group discussion activities, students can manage information regarding the perimeter measurements and the area of objects around them. (P5) - After completing the worksheets (LKPD) in groups, students can confidently present the results of their discussions. (P5) 	<ul style="list-style-type: none"> a. Properties two-dimensional shapes b. the perimeter of two-dimensional shapes c. the area of two-dimensional shapes 	Text, image, and animation

The next step after the design stage is the development stage. The development stage is the product materialize phase. The researcher proceeds with the development, creating the e-book cover, menu section, content section, and bibliography. The creation uses the Canva application; then file is downloaded in PDF

format. The PDF file is uploaded to the Flip PDF Corporate application to insert multimedia elements, such as adding buttons according to the predetermined features. The result of this editing process is published in a folder on the laptop in HTML5-Flash format so that it can be turned into an Android application. The HTML5-Flash file is converted into an Android application using the Website 2 APK Builder Pro application. The Android-based e-book media, which is now ready, undergoes immediate testing. The validity of the media was tested by experts in the field, including subject matter experts and media experts. The testing is conducted through a validation questionnaire to determine the level of media suitability. The results of the media validation test can be seen in [Table 4](#).

Table 4. Table of Media Feasibility Test

Responder	Percentage	Indikator
Content expert	92%	Very worthy
Media expert	85%	Worthy

[Table 4](#) shows the percentage of average score acquisition from the validation questionnaire filled out by the media and content experts. The content expert validation test obtained an average score of 92%, with the criteria "very worthy". In contrast, the media expert validation test obtained an average score of 85% with the criteria "worthy". Considering the level of suitability, it can be concluded that the e-book media is deemed suitable for use by fourth-grade students in learning mathematics, specifically two-dimensional shapes. However, the media expert provided some revision notes, including at the beginning of the application, the UNNES logo and additional information such as the class need to be displayed; the text type in the menu display needs to use a font that is easy to read because the text is in Latin, which requires more understanding from the students. Then, the content expert also provided some revision notes, such as the need to include the sources used, and the examples of questions and answers should be systematic. The display of the media after revision is shown in [Figure 1](#).

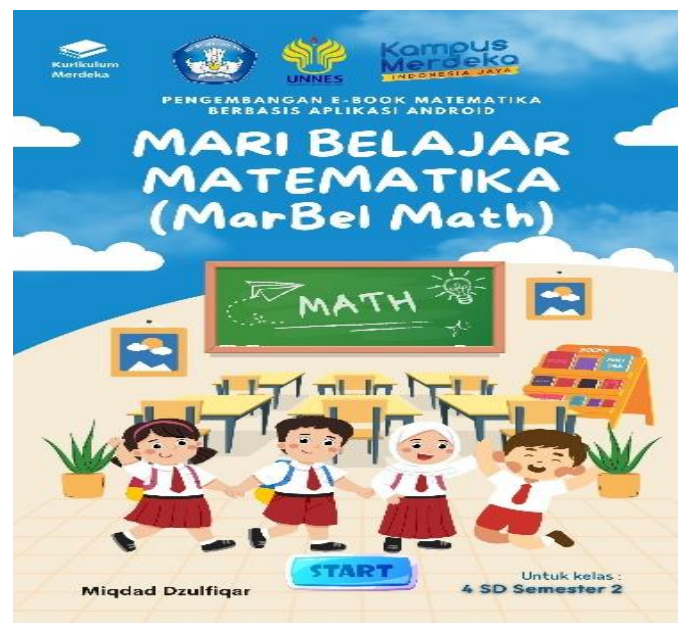


Figure 1. Cover Appearance After Revision

The implementation stage is the fourth stage of the ADDIE development model. In this stage, the researcher implements the use of the media product that the media and content experts have validated. The developed media is then implemented with the fourth-grade students of SD Negeri Jatibarang 03 to test its effectiveness and suitability. The feasibility and effectiveness are assessed through pre-test and post-test evaluations. Pre-test assessment is conducted before the learning session, while post-test assessment is conducted after the learning session. The feasibility and effectiveness of the testing results on learning outcomes through t-tests using SPSS 24 can be observed in [Table 5](#).

Table 5. Large Group Cognitive Learning Outcomes

Action	Average	The highest score	The lowest score	Average difference
Pre-test	54	75	25	30
Post-test	85	100	67	

Based on [Table 5](#), it can be seen that there is an average difference between the pre-test and post-test scores of 30. This indicates an improvement in students' learning outcomes after the t-test evaluation. The fifth stage of the ADDIE development model is the evaluation stage. The evaluation stage is where the researcher revises each of the other development stages. Therefore, the researcher determines it by conducting an n-gain test. The results of the n-gain testing can be seen in [Table 6](#).

Table 6. N-Gain Test Result

Test Result	Average	Average difference	N-gain	Category
Pre-test	54			
Post-test	85	30	0.68	Effective enough

After examining in [Table 6](#), it is known that the n-gain result is 0.68. This indicates that the Android-based e-book learning media effectively improves students' learning outcomes. The researcher used a problem-based learning model to help achieve the objectives of developing Android-based e-book learning media.

Discussion

This research develops a learning media product, an Android-based electronic book named *MarBel Math*. In its development, *MarBel Math* focuses on two-dimensional shapes, covering the understanding of two-dimensional shapes, the properties of two-dimensional shapes, the perimeter of two-dimensional shapes, and the area of two-dimensional shapes. The *MarBel Math* media obtained high validation from media and content experts and good results from t-test and n-gain tests. The research findings are presented in several tables of t-test and n-gain test results and analyses. The test results and analysis indicate that an Android-based mathematics e-book (*MarBel Math*) needs to be further developed as a learning medium because there is still a need for such e-books available in schools, especially in elementary schools ([Ariadiny & Bektiningsih, 2023](#); [Nurjamilah et al., 2022](#)). The test results and analysis were obtained from several processes, including validation by media and content experts and the results from pre-test and post-test evaluations. In detail, it is known that the validation results with media experts yielded a score percentage of 85% with the criteria "suitable", while the validation results with content experts yielded a score percentage of 95% with the criteria "very suitable". Then, based on the test results and analysis from the pre-test and post-test processes, it is shown that the development of Android-based mathematics e-book media named *MarBel Math* obtained a score percentage of 68% with the criteria "fairly suitable" ([Febrina et al., 2020](#); [Hadiyanti, 2021](#); [Wero et al., 2021](#)).

This researcher's research shares similarities with previous studies' findings, which concluded that electronic books are highly needed to enhance students' understanding, motivation, and learning outcomes in specific subject matters. Other studies also conclude that using e-books is helpful in the school environment to enhance students' understanding, particularly among elementary school students ([Wijaksana et al., 2023](#)). Additionally, the use of e-books can also facilitate students in understanding the material because e-books present comprehensive and engaging content ([Aeni et al., 2022](#); [Lyla et al., 2022](#)). From several studies, the researcher can conclude that the use of e-book learning media is considered to enhance students' understanding, motivation, and learning outcomes because the media is packaged in the form of a digital book with attractive design presentations and utilizes technology, making it accessible using gadgets conveniently for both teachers and students.

The researcher conducted media development research based on the ADDIE development model, and several stages were passed, including the analysis, design, development, implementation, and evaluation. Firstly, the analysis stage is the initial stage, where the researcher collects preliminary data for the research process. This analysis stage is the initial and crucial phase to provide a systematic and explicit procedure for the needs analysis process ([Misesani et al., 2020](#); [Rezatatya Christy & Nanci Riastini, 2021](#)). In this stage, the researcher found the problem of insufficient provision of technology-based learning media facilities and infrastructure in elementary schools. This problem leads to other issues, such as students needing help understanding learning materials, lack of motivation, and low student learning outcomes. Schools should provide engaging learning media suitable for their students' characteristics. In Piaget's theory of cognitive development, elementary school students have entered the concrete operational stage,

where they can use logical thinking for real or concrete things (Ilhami, 2022; Sutisna et al., 2020). Then, it is necessary to use technology-based media to increase students' interest and motivation in learning, thus fostering enthusiasm, activity, and creativity in learning.

The second stage, or the design stage, is where the researcher designs the e-book media. The design stage typically includes creating storyboards, preparing program structures, interface design, illustrations, structuring a material presentation, visualization, etc (Eviyanti et al., 2022; Tambunan & Sundari, 2020). In this stage, the researcher began creating an attractive interface for fourth-grade elementary school students using Canva, then added buttons using the Flip PDF Corporate application and exported it using the Website 2 APK application.

The third stage, or the development stage, involves developing something in line with the conducted development. The development stage is also the validation stage by media and content experts regarding the developed electronic book. The validation includes improvements in the e-book media based on the criticisms and suggestions from the experts (Susilawati & Rusdinal, 2022; Widiari et al., 2023). The validation that has been conducted resulted in the *MarBel* Math learning media. *MarBel* Math was explicitly created to assist teachers in delivering learning materials and to facilitate students' learning, especially mathematics, specifically two-dimensional shapes. *MarBel* Math has several features developed from findings and analyses of previous studies, including an accessible menu for easy navigation to content pages, comprehensive feature explanations, packaged materials to facilitate student understanding, and quizzes to measure comprehension levels related to the learned material.

The next stage is the implementation stage. This stage is a trial phase aimed at determining students' responses to the use of the product, the accuracy of the learning design or instructional design, its attractiveness, the accuracy of the content, and the effectiveness of the developed product for students (Junia & Sujana, 2023; Rizkiyah, 2022). So that the fourth stage, or the implementation stage, is conducted to assess the product's effectiveness, namely the *MarBel* Math e-book, in improving the learning outcomes of fourth-grade elementary school students. The results of implementing the *MarBel* Math e-book media show an improvement in students' learning outcomes, where most students initially scored unsatisfactory grades on the pre-test but then showed significant improvement and increased scores after completing the post-test.

The fifth stage, or the evaluation stage, involves the researcher collecting data from each stage of media development for further improvement and refinement, aiming to avoid errors in the final product outcome. The evaluation stage is the final stage of the ADDIE development model research (Mardianto et al., 2022; Meliyani & Tirtayani, 2022). In this stage, the researcher has made improvements, starting with several interface revisions and refinement of features provided by the *MarBel* Math e-book learning media. Based on previous research findings, it is known that the development of electronic books based on mathematics for fourth-grade two-dimensional shapes material has yet to be previously undertaken. This indicates that this research brings innovation in developing learning media for fourth-grade elementary school students. Furthermore, the research results suggest that the Android-based learning media *MarBel* Math is suitable and valid as a learning tool and additional reading material because it can increase students' enthusiasm for learning.

This research can contribute to teachers conducting learning activities at school and can be accessed by students while studying at home. This indicates that the research results provide a reference for learning media teachers and students can use during learning activities. However, this research has limitations regarding accessing the quiz section in the *MarBel* Math learning media because it requires adequate internet connectivity. Therefore, the researcher suggests that for future research, efforts should be made to create learning media that are easily accessible even without internet connectivity. The implications of this research indicate that the electronic book learning media named *MarBel* Math can be used as a variation of learning media both in schools and at home because it is suitable and can be used to help achieve learning objectives.

4. CONCLUSION

The developmental research conducted by the researcher has resulted in an Android-based electronic book learning media named *MarBel* Math. This media has been deemed valid and suitable to facilitate and achieve the learning process, particularly in plane geometry mathematics topics for fourth-grade elementary school students. Using *MarBel* Math media can provide a new and enjoyable learning experience for teachers and students, thereby increasing student enthusiasm and improving learning outcomes.

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