

Research Article

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Author for correspondence:

Anton Adi Suryo Kusuma

✉ q300220010@student.ums.ac.id

✉ Universitas Muhammadiyah Surakarta, Indonesia

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B'Math: An Alternative Android-Based Learning Media for Mathematics to Enhance Elementary Students' Early Counting Skills

Anton Adi Suryo Kusuma^{ID}, Utama^{ID}, Harsono^{ID}, Ahmad Muhibbin^{ID}, Zohaib Hassan Sain^{ID}

Abstract

Background/purpose. Several previous studies have attempted to develop Android learning media for elementary students beginning to learn counting. However, no media with a levelled adventure theme exists. The purpose of this research is to develop an android-based learning media, B'Math, to improve elementary students' counting skills.

Materials/methods. This type of research is research and development using the ADDIE model: 1) Analyze, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation. B'Math is an Android-based learning media-themed adventure game with levelled counting material, including number symbols, comparing, matching, addition, and subtraction, the results of which come to less than 20. The research subjects were 184 grade one students from two elementary schools in Indonesia. Data collection techniques included observation, interviews, and tests. Data analysis was conducted using descriptive and inferential statistical methods.

Results. This research successfully developed B'Math, an Android-based learning media designed to improve the early calculation skills of elementary school students. The results of this study showed that the learning outcomes of students who learnt using B'Math were higher than those of students who learnt using conventional learning approaches. This proves that the B'Math learning media have been effective in enhancing students' initial counting skills at the elementary school level.

Conclusion. The study's results illustrate a need to develop learning media to improve elementary school students' initial counting skills.

1. Introduction

Every child learns early numeracy skills, encompassing various abilities and concepts integrated into an interconnected system of knowledge (Panel, 2008; Purpura & Lonigan, 2013). Counting skills are essential for children to develop, as they can be applied in their daily lives (Rijt et al., 2003; Kiss et al., 2019). According to Clements and Sarama (2020) and Ginsburg et al. (2008), children's counting skills need to be developed from an early age to stimulate their thinking patterns and prepare them for further mathematics learning in the future. However, studies show that some children have difficulty naming the numbers 1 to 10 upon seeing the number symbols, and some feel confused when their teacher asks them to associate number symbols with objects (Pimm, 2019; Sowder, 2020). This is due to teachers' failure to use adequate learning media in the process of teaching basic arithmetic skills (Shikuku & Mwangi, 2023).

Learning media is a tool that supports the learning process and effectively delivers material to achieve learning objectives optimally (Hidayati et al., 2023; Pangestu & Setyaningrum, 2020). Learning media can assist teachers in delivering material, transforming abstract concepts into more concrete ones, and simplifying complex topics to make them easier to comprehend (Abdulrahman et al., 2020; Lin et al., 2020). One such tool that is frequently used nowadays is Android-based learning media, which refers to learning media that utilizes the features available on Android devices (Novaliendry et al., 2020). Using Android features can result in an attractive design, which helps capture students' attention and increases their interest in the media (Eliza et al., 2023).

According to Hidayat et al. (2023) and Sarifah et al. (2022), Android-based media can increase students' interest in participating in learning, especially learning arithmetic. Android-based learning media are highly suitable for teaching basic arithmetic skills at the elementary school level (Juhanaini et al., 2024; Verawati et al., 2022) because such programs can present material interactively, engagingly, and in a way that is easy for students to understand (Liono et al., 2021; Perwitasari & Rofi'i, 2024). Android-based learning media can also integrate audio, visual, and animation elements to support students' learning processes, thereby enhancing their concentration and motivation to learn (Cotiangco et al., 2024; Hamimi et al., 2024; Malik et al., 2024). Here, we present B'Math, an interactive learning media that can be used to teach basic counting skills.

B'Math is an Android-based learning media that features a level-based adventure game with introductory arithmetic content, including number symbols, comparison, matching, addition, and subtraction, the results of which total less than 20. B'Math is an acronym for Based Mathematics, which refers to basic mathematics material that must be mastered by elementary school students, especially in the lower grades. The word "Based" refers to a fundamental concept or foundation, which in the context of education means the fundamental skills that serve as the foundation for higher-level learning. This philosophy aligns with Lang (2021), who stated that mastering fundamental concepts such as addition, subtraction, and number comparison will help students tackle more complex materials in the future. The B'Math application is designed to support this philosophy by offering adventure-themed, level-based games that provide a holistic learning experience. It also enables students to learn independently or with guidance from teachers or parents. Thus, the name B'Math not only represents fundamental mathematical concepts but also reflects the hope that students will develop a strong foundation in logical and numerical thinking.

1.1. State of The Art

We reviewed several studies related to early numeracy skills and categorized them into two main groups: 1) studies on the ability to understand basic mathematical concepts and 2) studies on the ability to solve mathematical problems.

The studies in the first group concluded that 1) realistic mathematics education (RME) can enhance students' cognitive abilities in understanding mathematics (Laurens et al., 2017); 2) Visual Basic for Applications (VBA) for Excel can enhance students' understanding of mathematics (Bernard & Senjayawati, 2019); studies have found that including elements from students' local culture improves teaching results (Yeh et al., 2019).

Studies in the second group concluded that 1) discovery learning based on Batak Toba local culture can improve students' mathematical problem-solving abilities (Simamora et al., 2019); 2) learning using the problem-based learning (PBL) model is effective in enhancing mathematical problem-solving skills in everyday life (Firdaus et al., 2017); and 3) ethnomathematics learning is effective in improving students' problem-solving skills (Imswatama & Lukman, 2018).

Through examining these studies, we identified several areas that require further investigation, including elementary school students' ability to understand basic mathematical concepts and how to improve their problem-solving capabilities to enhance their early numeracy skills. Figure 1 illustrates previous research and our future research plans.

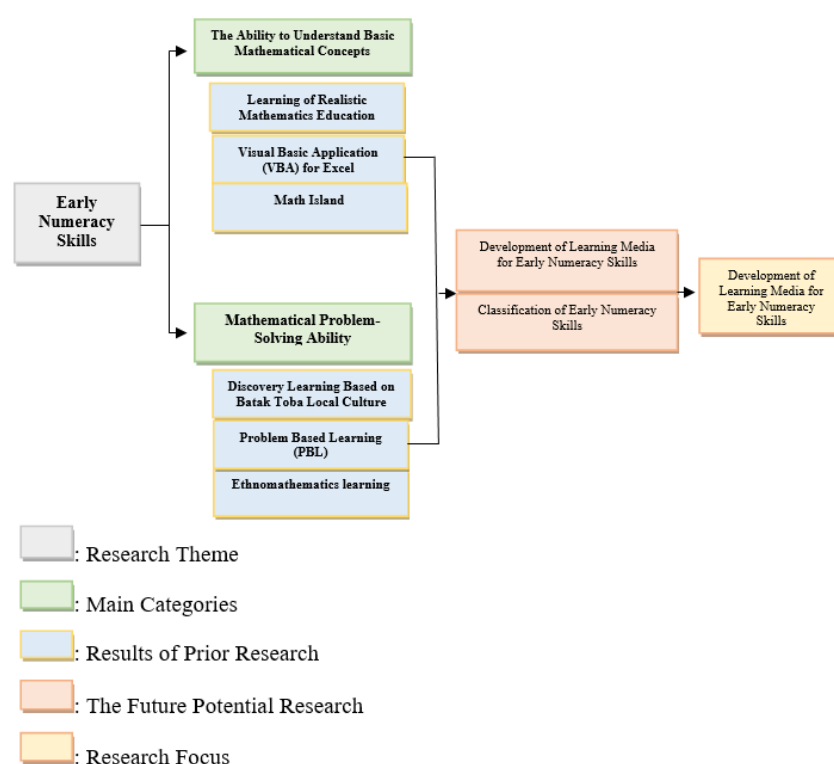


Figure 1. Research position

This research will explain how the development of B'Math learning media in improving the early counting skills of elementary school students. Several previous studies have examined initial counting skills (see Figure 1); however, there has been no research that explicitly develops B'Math android-based learning media in improving elementary school students' beginning counting skills. This research develops android-based learning media on the material of students' initial counting skills in elementary school which includes number symbols, comparing, matching, addition and subtraction material whose results are less than 20, and is equipped with adventure-themed games. This condition needs to be researched and explored further because early counting skills are very important to build a strong foundation in mathematics, especially in the early stages of education in elementary school. The main focus of this research is to provide an understanding of how the use of technology-based learning media can improve primary school students' initial counting skills. The results of this study are expected to provide a clear picture of the extent to which learning media can help students in the learning process. This research also has the potential to be a foundation for further research that

focuses on the development of technology-based learning media on other materials at the elementary school level.

This research question is, how does the process of developing android-based learning media “B'Math” improve the initial counting skills of elementary school students? The purpose of this research is to develop B'Math, an android-based learning media, to improve elementary school students' beginning counting skills. This learning media is expected to be able to change the way students think about the mathematics learning process. If initially students consider it difficult and boring, then with this media, students can feel happy when participating in the learning process. At the same time, it is an effort to develop early counting skills. As revealed in various studies, early numeracy skills are very important to support children's cognitive development and become the basis for understanding more complex mathematical concepts in the next level of education (Danilov & Mihailova, 2022; Mascia et al., 2021; Nogues & Dorneles, 2021). Therefore, this research is one of the important steps in improving initial counting skills at the elementary school level. The hypothesis of this study is that B'Math learning media is effective in improving the initial counting skills of elementary school students.

2. Literature Review

2.1. Learning Media

The word media comes from the Latin medium, which literally means intermediary or introducer (Capuno et al., 2019). According to Salomon (2012), media is also defined as something that carries information and knowledge during interactions between educators and students. Learning media is a tool that supports teachers in delivering material, making abstract concepts more real, and simplifying complex material to make it easier to understand (Nugroho et al., 2024). Media has an important role in teaching, specifically in explaining abstract things and can represent a means of communicating learning material (Risnawati et al., 2018). Learning media functions as a conduit of information, helps students understand the subject matter, and can be used to make learning more interesting (Patry et al., 2023). Smaldino et al. (2004) classified instructional media into four categories based on the technology used, namely 1) visual media (which includes images, diagrams, charts, posters, and maps); 2) audio media (such as voice recordings, radio broadcasts, and music); 3) audiovisual media (including films, videos, and television, which combine sound and visual elements to create a more interactive learning experience); and 4) interactive media (such as computer applications, CD-ROMs, and the internet, which allow students to engage directly with digital technology-based learning materials). The main principle that must be considered in the use of instructional media is that it should facilitate students' learning and their efforts to understand the lesson material (Nicolaou et al., 2019).

2.2. Interactive Learning Media

Interactive learning media is a technology-based tool designed to improve the quality of learning through two-way interaction, active participation, and varied presentation of material to enrich the learning experience and motivate students (Kurnia et al., 2023). According to Sudarsana et al. (2019), interactive learning media is a form of technology-based learning media that involves students' active participation in every learning stage. It serves as a tool that can improve the quality of learning by facilitating students' active participation (Septiani et al., 2020).

According to Tuma (2021), interactive learning media have multiple benefits, including 1) enhancing learning motivation (by incorporating visual, audio, and interactive elements that capture students' attention); 2) facilitating the comprehension of material (by presenting information in various formats, such as text, images, animations, and videos, which can help students understand abstract concepts more easily); 3) increasing active participation (by encouraging students to become

involved in activities such as answering questions, completing simulations, or playing educational games); 4) enhancing collaboration and communication (through interactive learning media designed for group learning); 5) providing immediate feedback (allowing students to assess their understanding of the material immediately); and 6) developing technological skills (interactive learning media help students develop important skills for the digital era, such as software usage, digital navigation, and technology-based problem-solving).

2.3. Mathematics

Mathematics combines logical, deductive, and abstract thinking patterns to understand order, explore ideas, and solve problems through symbolization and systematic reasoning (Nurlaelah et al., 2024). Mathematics aims to train students' mindsets to solve problems critically, logically, carefully, and quickly (Rozi, 2023). In abstract mathematics learning, students need tools in the form of media and props that can clarify what the teacher conveys so that it is more readily understood (Widada et al., 2018). According to Chen et al. (2020), every abstract concept that students learn needs to be immediately reinforced so that it settles in their memory and will be embedded in their mindset and pattern of action. School mathematics lessons, from the basic education level, require teaching standards that produce students who have the ability to think, the capacity for mathematical reasoning, and useful life skills (Marasabessy, 2021).

2.4. Beginning Counting

Every child develops basic numeracy, including various concepts and skills that are integrated into a system of interrelated knowledge (Chinn, 2020). Developing numeracy skills in children is very important, as these skills are useful in their daily activities (Singh et al., 2021). According to Palupi (2021), numeracy skills in children should be honed early to stimulate their thinking and prepare them to understand more advanced math later in life. A person's cognitive development in numeracy develops slowly. According to Bruner in Arumsari et al. (2024), an individual's cognitive (and, by extension, numeracy) development occurs through three stages: 1) the enactive stage (a person engages in activities to understand their surrounding environment, meaning that in understanding the world around them, children use motor knowledge, such as biting, touching, and grasping); 2) the iconic stage (a person understands objects or their world through images and verbal visualization; in other words, children learn about their surroundings through analogies and comparisons); and 3) the symbolic stage (a person is able to develop abstract ideas or concepts, which are highly influenced by their language skills and mathematical logic).

3. Methodology

3.1. Research Design

This research was conducted using the R&D method. According to Bennett et al. (1984), R&D is a systematic process used to develop and validate products, particularly in the context of education. This method not only focuses on creating new products but also involves testing the effectiveness and quality of the products through a series of structured steps. We used the ADDIE model for development, which integrates descriptive, evaluative, and experimental methods (Spatioti et al., 2022). The ADDIE model is a systematic approach to learning design consisting of five main phases: Analysis, Design, Development, Implementation, and Evaluation, designed to guide the development of effective and efficient learning (Branch, 2009). The ADDIE model was chosen because it provides a structured and flexible development process, along with an evaluation phase that allows for optimizing learning media based on students' needs. The selection of this model aligned with our established research objectives. The stages of this research can be seen in Figure 2.

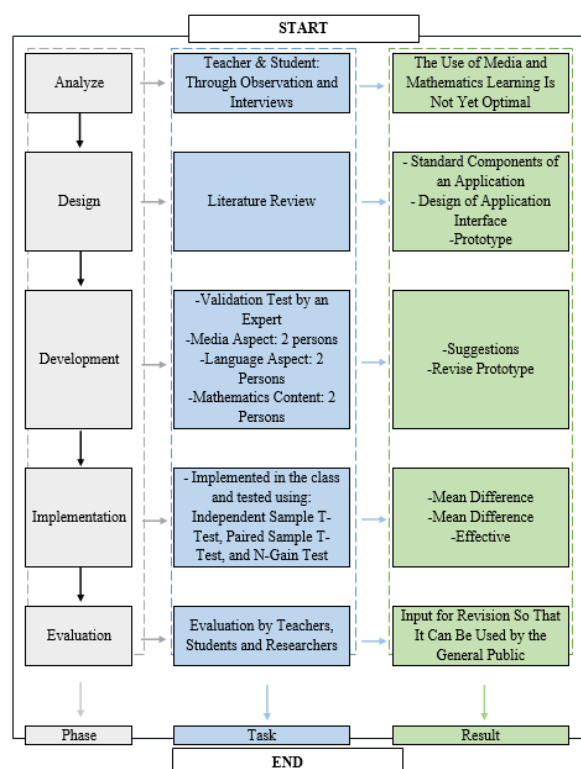


Figure 2. Research and development steps using the ADDIE model

In the first stage, namely Analyze, we collected information through observations of early numeracy skills in first-grade classes and conducted interviews with first-grade teachers at SD Muhammadiyah Program Khusus Surakarta and SD Muhammadiyah 1 Surakarta. This information served as a reference for developing the B'Math learning media product. Our activities included conducting a needs analysis based on competencies identified from our observations and interviews at the two schools. Next, in the second stage, Design, we designed a learning media product based on the needs analysis. Then, in the third stage, Development, we created B'Math, a learning media product to enhance early numeracy skills. This stage was followed by a product validation process, which included content, media, and language validation. The validation process was carried out using assessment instruments from expert validators, including one media expert, one mathematics expert, one language expert, and three education practitioners from SD Muhammadiyah Program Khusus Surakarta and SD Muhammadiyah 1 Surakarta. The validators suggested revisions, including adjustments to colour combinations based on colour psychology theory and student-level characteristics, an option to skip levels, and the inclusion of instructional sentences explaining commands to students. We made revisions to the B'Math application in accordance with the validators' feedback. The fourth stage, Implementation, involved employing the improved product after revisions based on the validators' evaluations in the previous stage. In this phase, we tested the product on an experimental student group, who learned early arithmetic skills using the B'Math media, while a control group was taught the same material without using B'Math. This was done to gather feedback on the use of the learning media. The fifth stage, Evaluation, involved making further improvements based on the results of the previous stage.

3.2. Participants and Research Setting

The research subjects consisted of 184 students from Muhammadiyah Program Khusus Surakarta and SD Muhammadiyah 1 Surakarta. A total of 93 students used the media in the learning process, while 91 students did not. Student participation in this study was voluntary, based on their willingness to take part in the research activities.

3.3. Data Collection Techniques

Qualitative and quantitative data were used in this study. Qualitative data were collected using observation and interviews with first grade teachers at SD Muhammadiyah 1 Surakarta and SD Muhammadiyah PK Kottabarat Surakarta to gather information about students' problems and needs in mathematics at the primary school level. The qualitative instruments used in this study were observation guidelines and semi-structured interviews developed based on indicators of student needs and initial mathematics competencies. The observation and interview guidelines were validated by three experts from Universitas Muhammadiyah Surakarta. Data validity was tested through technical triangulation and source triangulation. Technical triangulation was conducted by comparing data obtained through observation and interviews. Meanwhile, source triangulation was conducted by comparing information obtained from teachers and first-grade students at SD Muhammadiyah 1 Surakarta and SD Muhammadiyah PK Kottabarat Surakarta. The observation process was documented with photos and videos to provide a visual description of the activities observed, while the interviews were recorded using audio devices to ensure accuracy in transcribing and analyzing the content of the conversation in more depth.

Quantitative data were obtained using a test in the form of higher-order thinking skills (HOTS)-based early arithmetic ability questions, which were used in both the pre-test and post-test stages. HOTS-based questions were chosen to assess students' critical and analytical thinking skills. The test material covered the topic of recognizing numbers 1–20. The test consisted of ten HOTS-based essay questions at each stage, pre-test and post-test, developed based on the syntax of HOTS-based mathematics question construction for the elementary school level. The questions were validated by one media expert, one mathematics expert, and one language expert from Universitas Muhammadiyah Surakarta, as well as three education practitioners from SD Muhammadiyah Program Khusus Surakarta and SD Muhammadiyah 1 Surakarta in Indonesia. Cohen's Kappa reliability test was used to measure inter-rater agreement, which was fairly strong. Furthermore, content validity testing was conducted based on Aiken's coefficient, where each question received a score above 0.8, indicating its validity (Retnawati, 2016). Additionally, the reliability of the questions was tested using ANATES V4 software, producing a reliability value of 0.64, falling into the "high" category (Bendig, 1954). Therefore, each tested question was declared valid and suitable for use in both pre- and post-tests.

3.4. Data Analysis Techniques

This research uses two analysis techniques. First, using descriptive analysis that serves to describe in detail the qualitative data obtained from observations and interviews using the Miles & Huberman data analysis method, which includes data reduction, data presentation, and data conclusion/verification. Second, it used inferential analysis, which serves to assess, estimate, and conclude based on available quantitative data. In the inferential analysis, several tests were carried out on students' pre-test and post-test scores to verify the hypothesis: the independent samples t-test, the paired sample t-test, and the n-gain score test (Zulfiani et al., 2020). These tests were carried out with the help of SPSS version 23. The data analysis steps can be seen in Figure 3.

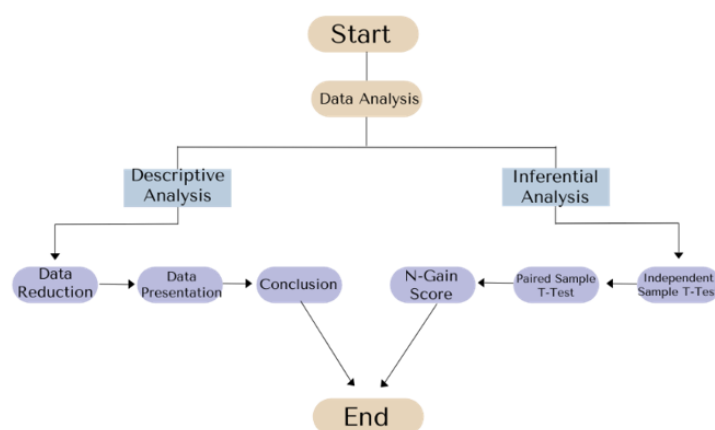


Figure 3. Data analysis steps

4. Results

4.1. Analyze Phase

4.1.1. Observation and teacher interview

We observed and interviewed first-grade teachers at SD Muhammadiyah in Surakarta and SD Muhammadiyah PK Kottabarat Surakarta. The interviews revealed that teachers used self-made worksheets as a teaching guide. The teachers also explained that while learning media have been used in the teaching process, they remain relatively simple.

We also found that teachers usually use the lecture method combined with assignments and student discussions. Teachers stated that mathematics lessons begin with presenting general concepts, followed by sample problems and their solutions. After that, students were given exercises to complete independently. They also mentioned having used simple application-based learning media, but it was not utilized to its full potential. As a result, students had limited opportunities to explore their knowledge.

4.1.2. Observation and student interview

We carried out observations to gather information related to the issues and needs of students learning mathematics at the elementary school level. The analysis was conducted through observations and interviews with first-grade students at SD Muhammadiyah in Surakarta and SD Muhammadiyah Program Khusus Surakarta regarding the mathematics learning process and the instructional media used. The results of the observations and interviews were as follows: 1) some students are less focused than others when the teacher explains the lesson; 2) it is not uncommon for students to play rather than work during class; 3) students have not yet fully utilized technology-based learning media as a learning tool; and 4) students find it difficult to understand basic arithmetic concepts because they cannot visualize the material presented in the worksheet.

One possible solution to address the abovementioned issues is an innovative technology-based learning medium that can enhance students' early numeracy skills.

4.2. Design Phase

The design phase focuses on planning and organizing all aspects necessary for product development. It begins with gathering requirements and determining the design concept, then moves on to implementing initial steps that support the formation of a learning media prototype. This phase aims to ensure that every designed element aligns with learning objectives and is relevant to user needs. We conducted a literature review to gather information for developing an innovative application-based learning media. The information obtained served as a reference for creating the

B'Math media. The following references were used as guidelines in the development of the B'Math application: 1) the 2022 learning outcomes guidelines established by the Education Standards, Curriculum, and Assessment Agency of the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia regarding the learning outcomes of subjects; 2) the book Basic Concepts of Elementary School Mathematics, published in 2019; 3) teacher and student books for Grade 1, published by the Center for Books, Ministry of Education, Culture, Research, and Technology in 2022; 4) the book ArGeo Math Application for Elementary School, published in 2023; and 5) national and international journals relevant to the research topic.

By conducting the literature review, we determined that a learning media must feature several standard components, including:

4.2.1. Initial page display

The application's initial page serves as the first point of interaction between the user and the system. An effective initial page design should combine visual aesthetics with intuitive functionality to provide an optimal user experience. We presented the text "Welcome to B'Math" on the initial page to create a communicative impression with the user. Figure 4 shows the menu display.



Figure 4. The B'Math media's home page

4.2.2. Instructions menu

The instructions menu in the B'Math application is designed to provide users with guidance on using the application. This menu consists of several sections that facilitate navigation and access to the available features. The guidance menu's interface can be seen in Figure 5.

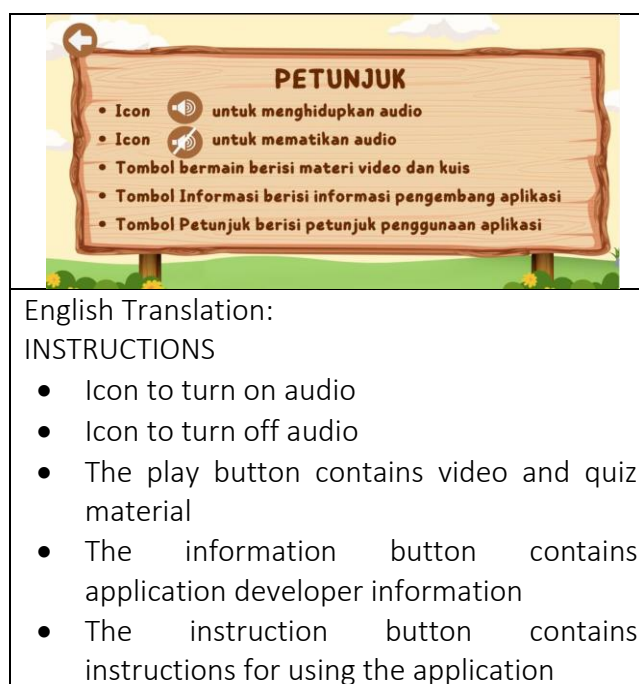


Figure 5. Instruction menu display

4.2.3. Play menu

The B'Math application features educational videos, animations, and engaging educational games, each designed specifically for the program. The educational games in B'Math are structured as level-based adventures, covering fundamental arithmetic concepts such as number recognition, comparisons, matching, addition, and subtraction, the results of which total under 20. The play menu interface can be seen in Figures 6 and 7. Additionally, this play menu provides a graduation certificate as a form of recognition awarded to users upon successfully completing all levels. The certificate includes the recipient's full name based on the application's user data. This certificate not only serves as proof of achievement but also acts as motivation and appreciation to boost users' confidence. The graduation certificate interface can be seen in Figure 8.



Figure 6. Video display of the material

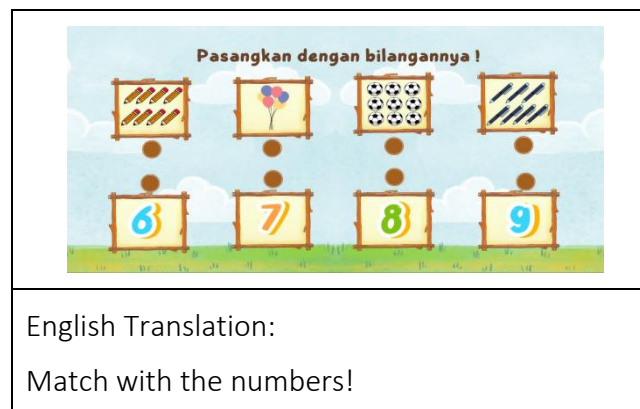


Figure 7. Game display



Figure 8. The graduation certificate display

4.2.4. Information menu

The information menu provides details about the developers who created the B'Math media. This menu aims to recognise and appreciate the developers while also building users' trust in the application. The information menu interface can be seen in Figure 9.

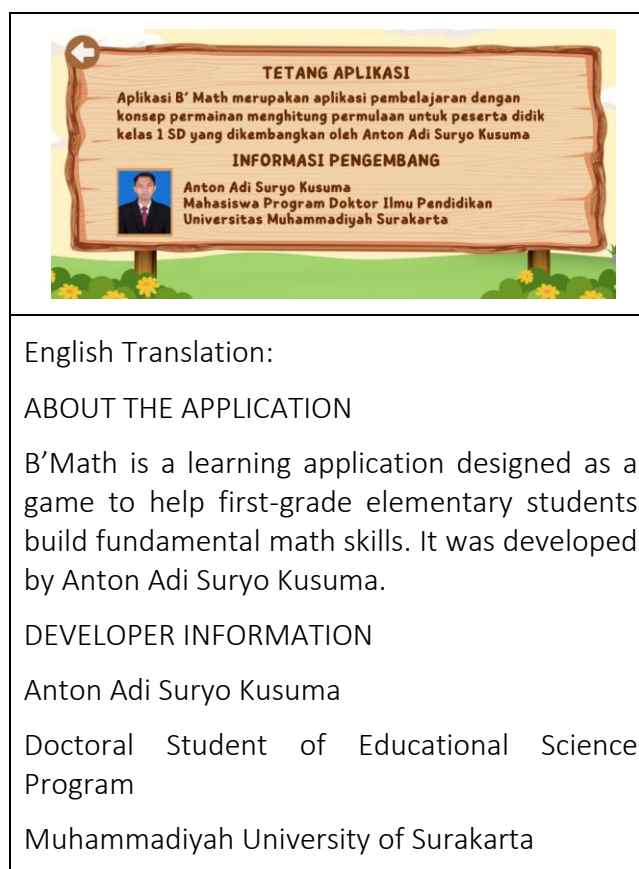


Figure 9. B'Math's developer information display

4.3. Development Phase

The next step after product development is product testing, which was conducted by two instructional media experts, two subject matter experts, and two language experts. This testing served to assess the feasibility of the B'Math application as a learning medium for first-grade elementary school students. This test helped identify what needed improvement to perfect the application. The media experts' validation results reached 79.38%, categorizing the application as highly feasible. These validation results covered several aspects: efficiency (the learning media's workflow is easy to understand and it is simple to use), appearance (the media usage instructions are clear, its features are consistent, the design is attractive, the program's images and effects are appropriate, colors have been skillfully selected and mixed, all text is legible, and images enhance rather than distract from, the text), technical quality and program effectiveness (the learning media is not boring, the evaluations in the practice menu are accurate, the learning pathway is presented systematically and concisely), and software aspects (maintainability, usability, and reliability).

The validation by language experts resulted in an average score of 85.56%, which falls into the "highly appropriate" category. This validation by language experts covered five aspects: clarity (accuracy of sentence structure, sentence effectiveness, and correctness of terminology), communicativeness (comprehensibility of messages/information), dialogical and interactive qualities (ability to motivate students), suitability to student development (alignment with students' intellectual and emotional development levels), and adherence to language rules (accuracy of grammar and spelling).

The validation by subject matter experts yielded an average score of 92.385%, which falls into the “highly feasible” category. This validation covered five aspects, namely learning (the material’s relevance to learning outcomes, its alignment with learning objectives, and the adequacy of practice exercises), content (the learning media’s ease of use, its presentation clarity, the use of easily understandable language, an engaging presentation, and the effective use of images to support content understanding), accuracy (the correctness of concepts, definitions, data, facts, examples, images, and terminology), material relevance (the use of images and illustrations from everyday life and real-life examples), and encouraging curiosity (the material’s ability to stimulate curiosity and foster the ability to ask questions).

4.4. Implementation Phase

The B’Math application was implemented with first-grade students at SD Muhammadiyah 1 Surakarta and SD Muhammadiyah Program Khusus Surakarta. We divided the study subjects into two groups: experimental and control. The experimental group received instruction on basic arithmetic skills using the B’Math learning media, while the control group was taught the same material without B’Math, using conventional methods instead. Through this approach, we aimed to measure the positive impact of B’Math on students’ basic arithmetic skills, determining its ease of use and effectiveness through feedback from both students and teachers. The implementation of B’Math also provided an initial overview of potential challenges that might arise when the media is applied on a larger scale. The implementation lasted for one week in both schools.

We used the independent samples t-test to determine if there was a significant difference in the mean scores between the class that used the B’Math learning media and the class that did not. The independent samples t-test results, obtained using SPSS 23, were as follows.

Table 1. The result of the independent samples t-test

Group	Mean Score
Control class post-test	51.10
Experimental class post-test	84.09

The results presented above indicate a substantial difference between the mean post-test scores of the experimental and control classes. The average post-test score of the class using the B’Math learning media was 84.09, while it was 51.10 for the class that did not use the B’Math learning media. Thus, the class that used the B’Math learning media performed better than the class without it.

Additionally, we used the paired sample t-test to determine if there was a significant difference between the experimental class’s pre-test and post-test scores. The results of the paired sample t-test, obtained using SPSS 23, were as follows.

Table 2. The result of the paired sample t-test

Test Status	Mean Score
Experimental class pre-test	51.29
Experimental class post-test	84.09

The results of the paired sample t-test indicate a substantial difference in the experimental class’s mean pre-test and post-test scores. The experimental class’s mean pre-test score, recorded before learning using the B’Math media, was 51.29, while the mean post-test score increased to 84.09. Thus, we can conclude that the use of B’Math learning media has a positive impact on students’ scores.

Table 3. N-gain score test results

Descriptives				
Type			Statistic	Std. Error
NGain	Learning use media	Mean	76.2954	2.83649
		95% Confidence Interval for Lower Bound	55.6619	
		Mean Upper Bound	66.9290	
		5% Trimmed Mean	61.2960	
		Media	50.0000	
		Variance	748.247	
		Std. Deviation	27.35410	
		Minimum	.00	
		Maximum	100.00	
		Range	100.00	
		Interquartile Range	60.00	
		Skewness	.353	.250
		Kurtosis	-1.283	.495

The n-gain score test calculation in Table 3 shows that the average n-gain score for the class using B'Math was 76.2954 or 76.29%. Thus, the B'Math media can be included in the "effective" category.

4.2. Evaluation Phase

Based on the implementation phase, we concluded that the B'Math application was effective. However, there was still room for improvement, which needed to be addressed in the evaluation phase. During this phase, an evaluation was conducted based on feedback from teachers and students, as well as our experience while implementing the B'Math application in the classroom. Teachers suggested adding trigger sentences to encourage students' questioning skills. Students recommended that the learning videos in the play menu should be adjustable according to the user's preference, so they do not get bored during learning, as they originally had to wait for the video to finish before proceeding to the next material. Meanwhile, we found that the application's animation design needed to be adjusted to maintain the engagement of younger students. This evaluation is expected to serve as a basis for improving the B'Math application so that it can be used by a broader audience in the future.

5. Discussion

The Android-based B'Math application was proven to be an innovative and interactive learning medium. It employs current technological advancements to support learning in the Industrial Revolution 5.0 era. The application integrates animations, instructional videos, and engaging games in agreement with Adnan et al. (2017), Sudarsana et al. (2019), and Utaminingsih et al. (2024), who state that technological advancements should motivate teachers to make greater use of learning media. The B'Math media features level-based adventure-themed games covering basic arithmetic concepts, including number symbols, comparison, matching, addition, and subtraction; this approach transforms students' perception of learning mathematics, shifting it from being considered difficult and monotonous to enjoyable. According to Hendikawati et al. (2019) and Samala et al. (2023), Android-based learning media have received positive responses from users, proving to be effective and flexible, meaning they can be used for learning both at school and at home. Furthermore, the use of Android-based devices as learning tools facilitates students' learning activities without being limited by space and time, as supported by (Humairah et al., 2020).

The B'Math application contributes to enhancing students' learning independence. With its level-based adventure feature, students can explore basic arithmetic concepts according to their own pace and understanding. This aligns with research conducted by Khine (2024), which states that technology-based learning media can enhance students' intrinsic motivation and encourage them to actively explore mathematical concepts independently. Furthermore, the graduation certificate feature in this application also serves as a form of appreciation that can boost students' confidence in learning. This is in line with research by Brewer and Burgess (2005), which states that the presence of a reward system motivates students to stay engaged in learning by completing challenges within the application.

The B'Math media has been proven effective in improving elementary school students' early numeracy skills when used in the learning process; students found the media engaging and capable of creating a meaningful learning experience. This aligns with the findings of Isnaeni et al. (2021) and Iswara et al. (2023), who state that electronic media, particularly Android-based ones, can foster students' interest in learning and enhance their academic achievement. Additionally, it is consistent with the views of Suprpto et al. (2022) and Widiani et al. (2020), who argued that instructional media can help students understand abstract concepts by making them more concrete; one of the characteristics of lower-grade students is that they are still in the concrete operational stage (Ayriza et al., 2020).

The effectiveness of the B'Math application in mathematics learning is enhanced by the integration of multimedia elements, such as instructional videos and interactive animations. These features help students understand fundamental mathematical concepts in a concrete manner. This aligns with the research of Abdulrahman et al. (2020) and Ion and Popescu (2024), which suggests that the use of interactive visual and audio elements in mathematics learning can accelerate concept comprehension compared to conventional methods. Thus, this application not only serves as a practice tool but also as a comprehensive and systematic learning resource. This indicates that the B'Math application has great potential to enhance the quality of mathematics education at the elementary school level.

6. Conclusion

This research successfully developed B'Math, an Android-based learning media designed to improve the early calculation skills of elementary school students. Students who previously felt difficult and bored when learning maths can now experience a more enjoyable and interactive learning experience. The results of this study showed that the learning outcomes of students who learnt using B'Math were higher than those of students who learnt using conventional learning approaches. This proves that the B'Math learning media has been effective in enhancing students' initial counting skills at the elementary school level. B'Math showed that the use of technology in learning can increase student engagement, which makes them more motivated and excited about learning. Thus, B'Math not only contributes to the improvement of students' early calculation skills but also provides new insights into how technology can be integrated into education to enhance the overall learning experience. This research opens up opportunities for further development in creating learning media that are more adaptive to students' needs.

7. Suggestion

Based on the research results of the B'Math learning media developed to improve the early counting skills of elementary school students, it is recommended that the development of this application be continued and adapted to the needs of students at various grade levels. In addition, further collaboration with teachers and educational practitioners is also important to ensure that the media developed remains relevant, effective, and adaptive to changes in learning methods and

technological developments. Continuous evaluation through student and teacher feedback will also strengthen the quality and usefulness of this application.

Declarations

Author Contributions. Author 1: Coordinator of and responsible for the entire series of research activities, as well as the presentation of progress reports, final research reports, and journal publications.; Authors 2, 3, 4, and 5: Coordinated research data exploration and implemented workshops, peer teaching, and FGDs; assisted in the presentation of progress reports, final research reports, and journal publication.

Conflicts of Interest. The authors declare no conflicts of interest.

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Data Availability Statement. Information that supports the results of this study is private because it is bound by the ethical provisions of research on human subjects.

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About the Contributor(s)

Anton Adi Suryo Kusuma, is a postgraduate student of the Doctoral Program in Education at Universitas Muhammadiyah Surakarta. He graduated with a bachelor's degree in Mathematics Education at Universitas Muhammadiyah Surakarta in 2011 and completed a master's degree from the Department of Educational Administration, Universitas Muhammadiyah Surakarta in 2021. His research interest is technology-based learning media.

Email: q300220010@student.ums.ac.id

ORCID: <https://orcid.org/0000-0003-0258-2430>

Prof. Dr. Sutarna, is a Professor of Mathematics Education Study Programme, Faculty of Teacher Training and Education, and Dean of the Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. His research interests include mathematics learning management, social humanities, education, and education management.

Email: sut197@ums.ac.id

ORCID: <https://orcid.org/0000-0002-9006-8388>

Prof. Dr. Harsono, is a Professor of Accounting Education Study Programme, Faculty of Teacher Training and Education, and Vice Dean IV, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. His research topic expertise is in the field of education and education management.

Email: hk297@ums.ac.id

Prof. Dr. Ahmad Muhibbin, is a professor of education management at Universitas Muhammadiyah Surakarta. His research topic expertise is civic education, Pancasila and citizenship education, civic education, and citizenship education.

Email: am215@ums.ac.id

ORCID: <https://orcid.org/0000-0003-2528-1833>

Zohaib Hassan Sain, is a student and a Certified Trainer of TQM, SDGs, and Health & Safety. Interests also include Quality Management, Sustainability, and Research. Recently completed post-graduation in Quality Management from Superior University and a post-graduate diploma in Total Quality Management from Punjab University. Professional experience is regarding ISO Audits, Compliance Audits, and Health & Safety Audits and worked in different organizations. Presented research papers in different International Conferences of Malaysia, Sri Lanka, Russia, Turkey etc. Current activities are attending Trainings, Workshops and Conferences to enhance knowledge and polish skills which will be helpful in a future career.

Email: zohaib3746@gmail.com

ORCID: <https://orcid.org/0000-0001-6567-5963>

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