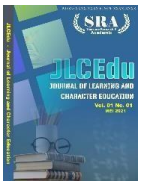

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SMART LEARNING APP FOR MATHEMATICS: ANDROID-BASED MEDIA FOR EARLY PRIMARY STUDENTS

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Abstract

The low interest and motivation of students in mathematics learning at SD Negeri 1 Gunung Terang is caused by conventional learning methods and the lack of use of interactive media. To overcome these problems, this research aims to develop an Android-based Smart Learning application as an innovative and interesting learning medium for students in grades I to III of elementary school. The research method used is the Waterfall Model which includes the stages of needs analysis, design, implementation, and testing. The app is developed using the Thunkable platform with an interface design that is interactive, simple, and in accordance with the characteristics of elementary school-age children. The test results showed that the Smart Learning application was able to increase students' learning motivation, strengthen understanding of basic mathematical concepts, and obtain positive responses from teachers and students. From these results, the application of Smart Learning is not only effective as an interactive learning medium, but also has the potential to be an innovative solution in improving the quality of mathematics learning in elementary schools. The novelty of this study lies in integrating the smart learning approach with the characteristics of elementary school students in one Android-based platform that is contextually designed and oriented towards increasing learning motivation.

Keywords: Smart Learning, Android, math learning, elementary school, educational innovation

I. INTRODUCTION

Education in Indonesia has made significant progress since independence, with various efforts to improve the accessibility and quality of learning. (Hasanuddin and Akhadiah 2019; Pratama, Al-ghozali, and Cirebon 2019) However, challenges such as the quality gap between regions, curriculum relevance, and equitable access to education are still major concerns. Along with the times, the integration of technology in the world of education has become a strategic step to increase the motivation and effectiveness of the learning process. The use of technology as a learning medium not only expands learning resources, but also creates a more interactive and efficient learning experience. Currently, the implementation of the Independent Curriculum is a form of adaptation of the national education system to these changes. This curriculum is oriented towards character building, mastery of essential competencies, and the development of individual potential of students as a whole. In this context, teachers are required to be more creative and innovative in designing learning that

suits the characteristics of students. One approach that can be done is through the use of interesting and contextual learning media, because the media has an important role in facilitating the understanding of concepts and increasing student motivation and participation in the teaching and learning process in elementary schools.

Technological advances in the world of education are reflected in the use of learning media, which plays an important role in helping teachers deliver material more effectively to students. In the direct learning approach, learning media functions as a means of delivering information, where teachers play the role of the main facilitator. (Fauziyyah, Purwaningsih, and Maryam 2023; Mirawati and Endah 2021) Choosing the right media is the key to encouraging students' cognitive, affective, and skill development to optimize the learning process. In the era of globalization, the development of technology-based media is a challenge as well as a necessity for educational institutions in implementing 21st century learning, which not only emphasizes the mastery of literacy and knowledge, but also on skills, attitudes, and optimal use of technology (Kirana, Hartati, and Susanto 2023)(Widiastika, Hendracipta, and Syachruroji 2020; Wijaya, Mundilarto, and Wilujeng 2024). Modern learning media and an independent curriculum are essential for education, especially in primary schools. State Elementary School 1 Gunung Terang, as one of the Basic Education Institutions in the Bulok District, Tanggamus Regency, has an important role in forming the foundation of education for the younger generation. In the context of this study, SDN 1 Gunungterang was chosen as the research object for several strategic reasons. First, this school reflects the general condition of basic education in Indonesia with all its dynamics and challenges. Second, SD N 1 Gunungterang has the potential to become a model in the application of innovative learning media, especially in the subject of Mathematics, in addition, SD N 1 Gunungeterang also has unique characteristics that are relevant to the focus of this research.

Based on the results of previous research studies, there have been significant developments in the development of technology-based mathematics learning media from 2021 to 2024. In the early period, the research focused on the development of Android-based media using Smart Apps Creator to support interactive learning. Furthermore, the research shifted to the application of the Smart Game Thinking approach and the analysis of initial needs through the ADDIE model as the basis for the development of more contextual media and according to the characteristics of students. (Annus and Petrova 2024; Brown and Green 2023; Rosmiati et al. 2023; Stevani and Putri 2025) The direction of the research is increasingly specific with the emergence of Smart Learning applications that are integrated with the STEAM approach, emphasizing on increasing motivation and understanding of mathematical concepts at the elementary school level. This trend shows the evolution of research from the development of simple technology to learning media innovations that are adaptive to the curriculum and student needs. The novelty in this study lies in the application of a smart learning information system that not only functions as an interactive learning medium, but is also designed to integrate aspects of learning motivation, student involvement, and the effectiveness of the mathematics learning process holistically at SD N 1 Gunungterang.

Low interest and motivation of students in learning mathematics at SD N 1 Gunungterang. This condition is allegedly caused by a learning approach that is still conventional and does not involve media that is interesting to students. Therefore, this study focuses on the design and implementation of smart learning information systems as an innovative learning medium that is expected to increase student engagement and create a more interactive and enjoyable learning process. In addition, this study also examines the effectiveness of the application of the system in improving the quality of mathematics learning in elementary schools. The purpose of this study is to develop and implement a smart learning information system as a mathematics learning medium in SD N 1 Gunungterang. In particular, this study aims to describe the process of designing and implementing the system in teaching and learning

activities, as well as analyzing its effectiveness in increasing student motivation, participation, and learning outcomes in mathematics subjects.

II. RESEARCH METHODS

2.1. Data Collection Techniques

This study uses three main techniques in data collection, namely literature study, field observation, and interviews, which are designed in a complementary manner to obtain accurate and in-depth data. Literature studies are carried out by examining various scientific sources, such as journals, books, and research reports relevant to smart learning topics, in order to build theoretical foundations and understand trends and innovations in the development of technology-based mathematics learning media. Field observations were carried out directly at SD Negeri 1 Gunung Terang to identify the real conditions of the learning process, student behavior, and teachers' strategies in teaching mathematics. This observation data is a reference in adjusting the system design to suit the needs and context of the school. Meanwhile, interviews were conducted with mathematics teachers and a number of students to explore qualitative information about obstacles, needs, and expectations for interactive learning media. Through the combination of these three techniques, the data obtained is not only theoretical, but also empirical and contextual, so that it is able to provide a comprehensive picture that strengthens the validity of research results and supports the design of Smart Learning applications in a more targeted manner.

2.2. System Development Methods

The development of an Android-based Smart Learning information system in this study uses the (Fitriyanti, Djimadi, and Uloli 2023) (Muhamad Muslihudin, Fauzi 2021; Pressman 2001)Waterfall model, which was chosen because it has a systematic and sequential workflow, so that each stage can be carried out in a structured manner according to the needs of educational application development. The stages of system development are explained as follows:

1. Requirements

The initial stage begins with a needs analysis that aims to identify the features and functions that should be available in the Smart Learning application. The analysis was carried out through literature studies, observation of the teaching and learning process at SD Negeri 1 Gunung Terang, and interviews with teachers and students. As a result, functional needs such as the selection of difficulty levels based on grades (I–III), the provision of basic math exercises (addition, subtraction, multiplication, division), the provision of feedback in the form of scores and educational animations, and the child-friendly and easy-to-use interface.

2. Design

At this stage, the structure and flow of the system were designed using Unified Modeling Language as a visual aid. The design includes a use case diagram, activity diagram, and user interface design. The goal of this stage is to describe the relationships between system components, application logic, and ensure that the design fits the user's needs.

3. Implementation

The results of the system design are then translated into the form of program code using the Thunkable platform. The implementation stage includes the creation of key modules such as the main menu, interactive practice questions, an automatic scoring system, and an educational animation display. Each module is tested separately (unit testing) to ensure its function is running according to specifications.

4. Verification

System testing is carried out using the Blackbox Testing method, which focuses on testing key functions without looking at the internal code. In addition, a limited trial was conducted with end users (teachers and students) to assess the aspects of functionality, ease

of use, and attractiveness of the application's display. The test results show that the application is able to run well and correspond to the needs of mathematics learning in elementary schools.

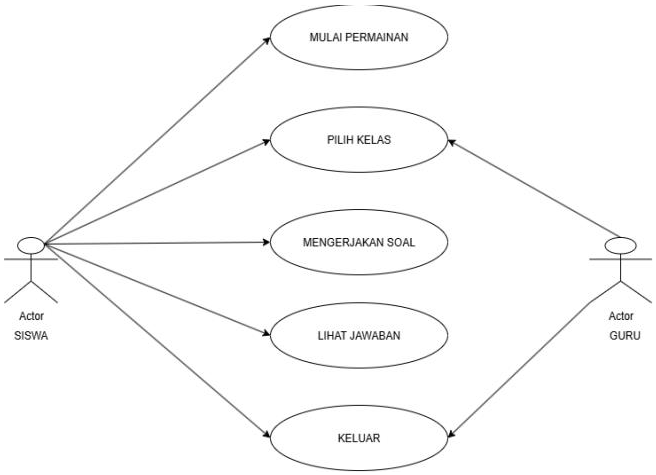
5. Maintenance

The final stage includes system maintenance activities to maintain the stability and performance of the application. These activities include bug fixing, feature updates based on user feedback, and optimizing the interface to make it more interactive and responsive. In addition, periodic evaluations are carried out on the effectiveness of the application in supporting the improvement of student motivation and learning outcomes.

III. RESULTS AND DISCUSSION

3.1. Information System Design

The design of the information system in the Smart Learning Mathematics application is carried out in a structured manner to produce an effective, efficient, and according to the needs of users, especially students in grades 1 to 3 of elementary school. Development was carried out using Thunkable, a visual programming platform that makes it easy to create educational applications without the need for complex coding, thus speeding up the design and modification process. In the design stage, Unified Modeling Language is used to visually model the structure, behavior, and interaction between system components. Some of the UML diagrams used include Use Case Diagram, Activity Diagram, Sequence Diagram, and Class Diagram. These diagrams help illustrate the relationships between elements in the system, such as the interaction between users (teachers and students) with the application. The Use Case Diagram specifically shows how teachers and students play the role of actors who can access the system and carry out the various learning functions available in the Mathematics Smart Learning application.



Gambar 1. Use Case Diagram

The use case diagram in the Smart Learning Game Mathematics application represents a model of interaction between actors and systems to describe functional needs in a structured manner. In this context, there are two main actors, namely students and teachers, each of whom has a different role according to the principles of user-centered design. Students act as the primary users with full access to core features such as class selection, question work, review of answer results, as well as exit the app, which demonstrates the application of gamification concepts in learning to increase motivation and learning engagement. Meanwhile, teachers function as supporting actors with limited authority, such as choosing classes and managing learning activities. This use case model conceptually describes the integration between pedagogical and software engineering aspects, which aims to create an interactive, adaptive, and user-friendly learning system, while facilitating the analysis of system needs during the application development stage.

3.2. Implementation

The main page view of the MathFunn application scientifically represents a user interface designed with the principles of interactivity and high intuitiveness to support the effectiveness of the mathematics learning process. This design implements a user experience design (UXD) approach that focuses on ease of navigation, user engagement, and visually appealing content presentation. Thus, the main page not only serves as a gateway to the various features of the app, but also as a means to create a fun, adaptive learning experience and facilitate a more efficient understanding of mathematical concepts for users.

Figure 2. Home

The MathFunn app interface is designed with a simple and interactive navigation structure to make it easier for users, especially elementary school students, to access learning materials. When the application is opened, users will be redirected to the main page that displays a menu with three class options, namely Class 1, Class 2, and Class 3. The design of this page is complemented by visual icons familiar to children, such as animal images, books, and calculators, to increase attraction and motivate users to learn. In the Grade 1 display, the learning content is arranged in the form of a game of addition and subtraction problems based on fruit pictures, with a multiple-choice format accompanied by supporting visual illustrations. This approach reflects the application of edutainment principles in app development, where educational and entertainment elements are combined to create a fun and effective learning experience.

Figure 3. Examples of Practice Questions for Grade 1 and Grade 2

3.3. Research Results

The results of the study show that the development of an Android-based Smart Learning information system using the Waterfall model has been successfully implemented systematically through five stages, namely needs analysis, system design, implementation, testing, and maintenance. At the needs analysis stage, the results were obtained that students at SD Negeri 1 Gunung Terang need interactive, interesting, and easy-to-use learning media, especially to help understand basic mathematical concepts such as addition, subtraction, multiplication, and division. The design stage produces a system model using the Unified Modeling Language (UML) approach, including Use Case Diagrams, Class Diagrams, and Activity Diagrams, which help to describe the structure and flow of interaction between users and systems in a clear and measurable manner.

In the implementation stage, the application is developed using the Thunkable platform with a child-friendly interface design and adjusting the difficulty level according to the class. The results of the functional test using the Blackbox Testing method show that all the main features, such as level selection, practice questions, and scoring system, function well according to the specifications. The user acceptance test involved 30 students and 3 teachers, where 90% of respondents said the app was easy to use, 88% rated it attractive, and 85% felt the app helped them understand the material faster. The results of the effectiveness test showed an increase in the average student learning outcome from 67.3 to 82.6, or an increase of 22.7% after using the application.

Overall, the implementation of Smart Learning applications has proven to be effective in increasing student learning motivation and engagement in mathematics learning in elementary schools. Teachers consider this application to be an alternative learning media that is relevant to the spirit of the Independent Curriculum, because it encourages independent learning and contextual understanding of concepts. The novelty of this research lies in the integration of the smart learning approach with interface design based on early childhood characteristics, as well as the use of UML as a design tool to ensure the suitability of the system with user needs. Thus, this application can be used as a model for the development of digital learning media that is adaptive, educational, and applicable for basic education in the era of digital transformation.

3.4. Discussion

The results of this study show that the development of Android-based Smart Learning applications for mathematics learning at SD Negeri 1 Gunung Terang has succeeded in increasing students' interest and learning outcomes. The increase in the average learning outcome from 67.3 to 82.6 shows that this learning medium makes a real contribution in strengthening the understanding of basic mathematical concepts such as addition, subtraction, multiplication, and division. In addition, the overwhelmingly positive response from teachers and students reinforces that the app is practical and can be applied directly in learning practices in elementary schools. The findings are in line with the logic that interactive learning media can reduce students' boredom and increase their active engagement.

From previous research studies, many have emphasized the benefits of Android-based media for mathematics learning. For example, research by Agus Suprianto et al. (2019) shows that mathematics mobile learning media has proven to be practical and effective in improving the learning autonomy and learning outcomes of elementary school students. (Rosmiati et al. 2023) showed that Smart Apps Creator-based interactive media obtained high validity values (87% material, 93% media) and N-gain of 0.76 in the high category for flat building materials. (Adu, Nenohai, and Rimo 2022) showed that the development of Smart Apps Creator-based media on integer material was very feasible and received a very positive response. Research on Android-based educational games by (Wardhani 2024) shows that game media is valid and practical and improves students' mathematical literacy. In terms of the concept that mobile

learning can support mathematical literacy, a study by (Hidayat and Saputra 2023) explains the opportunities and challenges of mobile learning in improving mathematical literacy. The four studies reinforce that technology-based learning media innovations have a strong empirical basis. These studies generally emphasize more on media development and validity, less on the aspect of the implementation of the information system as a whole with the stages of system development, UML design, the use of the Waterfall model, and systematic functional testing as in this study.

Analysis of the results and previous studies confirm that this research has advantages in several aspects. This research integrates the development of complete information systems including needs analysis, use case design, modular implementation, testing (unit, integration, system, usability) and maintenance that have not been found in previous research that focuses only on the development of a single media or application. It specifically targets grades I–III of elementary school, which is relatively less than the middle to upper class in the literature, thus showing high relevance to primary education. This study uses the Waterfall model and UML documentation as part of the system development methodology to make an additional contribution in the realm of educational software engineering that is rarely combined with mathematics learning media in elementary school.

Based on the above findings and discussions, the implications for mathematics learning practices in elementary schools are that schools are strongly advised to consider the adoption of Android-based learning applications that are systematically and contextually designed to meet the needs of students. Teachers need to be involved in the analysis and testing phases so that the application is truly appropriate for the context of their classroom. For follow-up research, it is recommended to explore the integration of adaptive features (e.g. automatically adjusting difficulty levels), analysis of long-term impacts on motivation and learning outcomes, and application to broader sectors or across schools to see generalizations of outcomes. This approach makes a new methodological contribution because it combines the process of needs analysis, system design, implementation, and functional testing using Blackbox Testing, resulting in a learning system that is not only technically feasible, but also effective in the context of basic education. Another novelty lies in the application of the Smart Learning concept which is specifically designed for students in grades I–III SD by paying attention to aspects of child-friendly interfaces, adaptive difficulty levels, and the integration of educational game elements. This study also strengthens the validity of the results by combining quantitative and qualitative approaches through observation, interviews, and direct field tests at SD Negeri 1 Gunung Terang. The approach resulted in empirical findings that showed an increase in students' motivation to learn and understanding of mathematical concepts. Thus, this research contributes not only to the development of interactive learning media, but also to the improvement of digital literacy and pedagogical innovation in the Indonesian elementary school environment.

IV. CONCLUSION

The development of an Android-based Mathematics Smart Learning information system at SD Negeri 1 Gunung Terang was successfully carried out systematically using the Waterfall development model which included the stages of needs analysis, system design, implementation, testing, and maintenance. The needs analysis shows the need for interactive and fun learning media to overcome students' low learning motivation in understanding basic mathematical concepts. Through the use of the Thunkable platform and the Unified Modeling Language (UML) approach, including the Use Case Diagram and Activity Diagram, the system is designed with a child-friendly, easy-to-use, and class-level adaptive interface. The results of the test using Blackbox Testing proved that all the functions of the application ran according to the specifications designed, while the results of the questionnaire with 20 respondents showed that 53% of respondents "Agreed" and 21% "Strongly Agreed" to the

effectiveness of the application, with an average increase in student learning outcomes of 22.7%. Empirically, this application has been proven to increase students' motivation, engagement, and understanding of basic math material. In terms of novelty, this research combines a software engineering approach with the development of digital learning media that is pedagogically designed according to the characteristics of low-grade elementary school students, as well as integrating the concept of Smart Learning with educational and adaptive interfaces. Thus, the Mathematics Smart Learning application not only functions as a learning tool, but also as an educational innovation that supports the implementation of the Independent Curriculum, encourages independent learning, and contributes to improving the quality of technology-based basic education in the digital era.

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