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Implementation of Augmented Reality and Integrated Video as Interactive Learning Media for Mentally Disabled People in Recognizing Numbers and Letters based on the MathAlfa Application

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ABSTRACT

Law No. 20 of 2003 on the National Education System mandates inclusive education for children with special needs (ABK) in order to optimize their potential. However, the learning process for kids with mental retardation is hampered by the lack of new learning resources. Thus, a solution is provided by the MathAlfa program with Integrated Video Augmented Reality (AR). In addition to promoting the use of technology in inclusive education, MathAlfa is intended to improve the learning achievement, comprehension, and engagement of children with mental retardation. It is anticipated that features like materials, AR films, and quizzes that rely on visual recognition and direct interaction will be able to give students with mental retardation a more engaging, inclusive, and adaptive learning environment. One technology that has great potential in supporting learning for students with intellectual disabilities is Augmented Reality (AR). AR is a technology that combines virtual objects with real environments in real-time, providing a more immersive interactive experience. By using AR, students can interact directly with learning materials that are visualized in the form of 3D objects, videos, or animations, which can help them understand abstract concepts more concretely and visually.

Keywords: Augmented Reality; Inclusive Education; Mental Retardation

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1. INTRODUCTION

Education is the process of gaining knowledge to improve, strengthen, and perfect all human potential. Everyone gets an equal opportunity to undergo the learning process, including children with special needs. In accordance with the provisions of Law Number 20 of 2003 concerning the National Education System, Article 5 paragraph (2) states that individuals with differences in physical, emotional, cognitive, mental, or social rights receive education that is tailored to their needs [1,2].

Children with special needs (ABK) are children who have physical, mental, emotional, or social limitations, who require special learning approaches to support their development. One type of ABK is children with intellectual disabilities, who experience delays in intellectual development and have difficulty understanding abstract concepts. Therefore, they need more concrete, visual, and interactive learning methods to help them understand the subject matter [3,4].

In Indonesia, there are 144,621 students with special needs who are currently studying in special educational institutions. Of that number, 82,326 are elementary school students, 36,884 are junior high school students, and 25,411 are high school students. Special schools face challenges in providing innovative and effective learning media for students with intellectual disabilities. The available learning media are still limited to conventional methods, such as textbooks and simple teaching aids, which are less able to attract attention and improve students' understanding. Therefore, innovation is needed in learning media that can provide a more interactive, adaptive, and interesting learning experience for students with intellectual disabilities [5,6].

One technology that has great potential in supporting learning for mentally retarded students is Augmented Reality (AR). AR is a technology that combines virtual objects with real environments in real-time, providing a more immersive interactive experience [10,11]. By using AR, students can interact directly with learning materials that are visualized in the form of 3D objects, videos, or animations, which can help them understand abstract concepts more concretely and visually.

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MathAlfa is an AR-based learning application specifically designed to help mentally retarded students recognize letters and numbers [8,9]. This application integrates video and AR technology to provide a more visual and interactive learning experience. With features such as AR video materials and interactive quizzes, MathAlfa is expected to be able to increase the engagement, understanding, and academic achievement of mentally retarded students.

Through this innovation, it is hoped that SLB can provide a more inclusive and adaptive learning environment for mentally retarded students, so that they can achieve their maximum potential in the teaching and learning process.

2. RESEARCH METHOD

The method used in this study is ADDIE (Analyze, Design, Development, Implementation, and Evaluation). The ADDIE method has 5 stages, namely analyze, design, development, implementation, and evaluation. All stages are carried out sequentially so that it is more structured.



Fig 1. ADDIE

1. Analyze, is the initial stage in all activities in the research development process. The focus of the analysis stage is to identify possible causes of performance gaps. These causes can be influenced by various parties, including teachers, students, education staff, and others.
2. Design, the next stage is design, in this design phase it is arranged by determining the learning skills needed by participants when following the learning program or media created. The purpose of the design phase is to determine whether the educational activities or platforms designed can intervene in the problems of performance limitations experienced by students [12].
3. Development, the purpose of this development step is to create a platform according to expectations. This stage consists of:
   a. Learning Platform Development
      This stage refers to the steps of creating and developing an educational platform as a means of assistance for teachers in implementing it in Letter and Number Recognition education in the Mentally Disabled class. Researchers implement the plans that have been made in the design stage, namely materials, Augmented Reality videos, and quizzes to then be included in the learning aids that will be prepared.
   b. Assessment by Media and Material Experts
      Evaluation by media experts and material experts "MathAlfa" is used as a means to evaluate and improve the quality of the media that has been prepared before moving on to the implementation stage.
4. Implementation, This step involves testing the media that has been completed and has been validated by experts in real classroom learning situations. Activities in this step include preparing the class, educators, students, and measurement tools in the form of questionnaires.

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5. Evaluation, The evaluation stage to assess the quality of the learning media, both before and after implementation [9]. When the development stage always ends with an assessment before proceeding to the next step. The assessment implemented through the stages of analyzing, designing, developing, and implementing is a formative assessment, which aims to improve the media.

3. RESULTS AND DISCUSSION

The MathAlfa application, an interactive learning tool based on Augmented Reality (AR), was created as a result of this research to assist children with mental retardation in recognizing letters and numbers. The five steps of the ADDIE method—analysis, design, development, implementation, and evaluation—are used in the application development process.

A. Analyze

At this point, the SLB Swasta Syafiq mentally handicapped kids' learning needs were identified. It was discovered through observations and instructor interviews that there were still few and uninteresting learning resources available to students. More visual and interactive media are therefore required to aid students in understanding the course content.

B. Design

Creating a learning flow that incorporates AR technology is the task at hand. Children with intellectual disabilities will find the user interface design appealing and simple to use. The offered educational resources include interactive films and 3D objects that represent letters and numerals.

Application Design :



Fig 2. Logo Design, Home Feature View

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Fig 3. Content Display



Fig 4. Augmented Reality Video Display

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Fig 5. Quiz View

C. Development

At this point, EasyAR and Unity 3D were used to create the MathAlfa application. providing 3D objects, including instructional films, and providing interactive tests to gauge students' comprehension were all part of the development process. The outcomes of the application testing are as follows:

Table 1. Black Box Test Results

No	Case/Tested	Test Scenario	Expected Result	Test Result
1	Splash screen page	Opening the application	Successfully displaying the splash screen with a waiting time of 3 seconds	Success
2	Main menu	Login after splash screen	Successfully logged in to the main page	Success
3	Close application button	Select exit button	Successfully closed application	Success
4	Mute sound button	Click mute sound button	Successfully mute back sound	Success
5	AR Interaction	Point camera at marker	Show 3D object	Success
6	Interactive quiz	Answering questions	Showing evaluation results	Success

D. Implementation

SLB Swasta Syafiq implemented the MathAlfa application. To make sure the program could be used correctly and offered the anticipated benefits, teachers and students participated in the application trial. The application was highly appreciated by users, as evidenced by the average SUS rating of 85, which was acquired during usability testing using the System Usability Scale (SUS) [10].

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Table 2. SUS Test Results

Respondents	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Calculation Result Score	Value (Amount x 2.5)
1	3	4	4	3	4	3	4	3	4	4	35	87.5
2	4	4	4	4	3	4	3	4	4	3	36	90
3	3	3	4	4	4	3	4	4	3	3	35	87.5
4	4	4	3	3	4	4	3	4	4	3	36	90
5	3	4	4	4	3	4	4	3	4	4	36	90
6	4	4	3	4	4	3	4	4	3	4	37	92.5
7	3	3	4	4	4	3	4	3	4	4	36	90
8	4	3	4	3	4	4	4	4	3	3	36	90
9	3	4	3	4	4	3	4	4	4	3	36	90
10	4	4	4	3	3	4	4	4	3	4	36	90
Total												893.5
Average												85

Each respondent's score is then calculated using the SUS formula, and the total is calculated as 85. The average SUS score is then calculated by dividing the total by the number of respondents. This indicates that the application is deemed acceptable as the average SUS evaluation of 85 respondents is higher than the lowest value shown in the problem limits. Based on these findings, it can be said that the user can understand the program with ease.

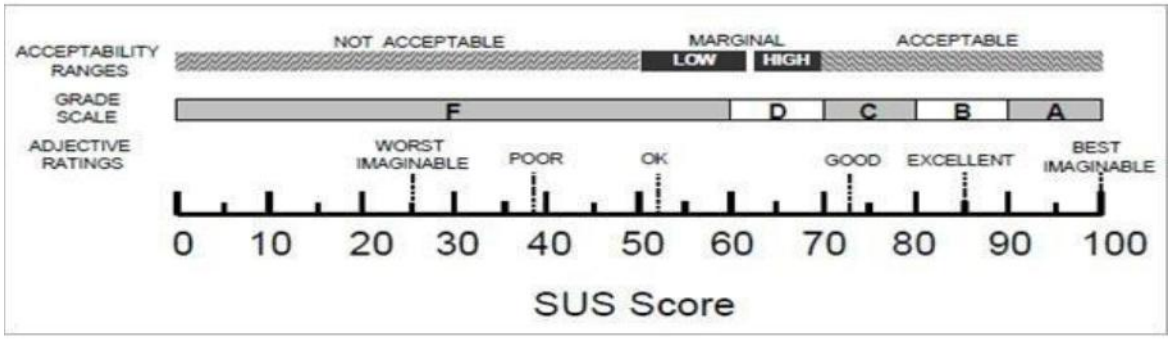


Fig 6. SUS score result interpretation scale

E. Evaluation

Teachers' and students' feedback is gathered in order to complete the evaluation step. The evaluation results indicate that this application can improve kids' interest in and comprehension of studying letters and numbers. The evaluation findings from tests conducted by media and material experts are as **follows:**

Table 3. Test Results by Media Experts and Material Experts

Testing Aspect	Media Expert	Materials Expert
Eligibility	91%	85%
Legibility	89%	83%
Involvement	92%	88%

Feedback from Teachers and Students:

a. Teachers: This application is very helpful in the learning process and makes students more enthusiastic.

b. Students: Learning becomes more fun and they find it easier to remember letters and numbers.

4. CONCLUSION

All things considered, the MathAlfa software has been successful in reaching its objective of improving the efficiency of letter and number learning for kids with intellectual disabilities. For kids with specific disabilities, augmented reality technology not only makes learning more engaging, but it also makes it simpler to comprehend. Particularly in institutions that educate students with exceptional needs, this application holds enormous promise for use in inclusive education. User evaluation reveals a high degree of acceptability and the effectiveness of the application in raising motivation for learning. Therefore, MathAlfa may serve as a template for future technologically based learning materials.

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