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Mobile Learning Application on Two-Dimensional Figure Material with ADDIE Model for Children with Intellectual Disabilities

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Abstract: Mobile learning apps are widely acknowledged for their effectiveness in enhancing learning results. This study aims to develop and validate a mobile learning app for computer-generated two-dimensional figures. Using the user-friendly Figma platform known for visual programming, it integrates interactive modules and multimedia for diverse learning styles. The study adopted a Research and Development approach following the ADDIE model (analysis, design, development, implementation, and evaluation). The research was conducted at SKh YKDW 02 Tangerang and involved 6 students. The outcomes pertaining to validation experts' percentage scores are as follows: The aspect of media and design received a score percentage of 91,25%, affirming its very validity. Students' responses the average percentage for the four assessment aspects, clarity of material, motivation, interest, and easy of use navigation, reached 91,10%**,** placing it in the very good category. The development of this mobile learning application for two-dimensional figure material for children with intellectual disabilities material demonstrates significant potential as an innovative educational tool.

Keywords: Application; intellectual disabilities; mobile learning; two-dimensional figure

INTRODUCTION

Basic mathematics skills in today's society are the main requirement for daily life, and they are one of the functions of being independent. This skill is very important because it is used in real-life situations such as reading time and shopping activities (Schöld, 2024). One group of individuals who struggle to obtain adequate basic mathematical knowledge and skills to have a good quality of life are those with intellectual disabilities (ID). ID is defined based on three categories: 1) individuals who have an IQ of less than 70, 2) individuals who experience impairment in a person's social and personal ability to adapt to standards that apply in their environment or adaptive behaviour, and 3) individuals who have impairments during development (before age 18) (World Health Organization, 2019).

Children with intellectual disabilities (ID) tend to experience difficulties in mastering basic motor skills, associated with cognitive deficits that interfere with skill acquisition. ID desperately needs systematically designed applications that have proven beneficial for children with ID. Applicability criteria were identified for future iterations of the error reduction approach in training children with ID motor skills (Capio, 2024). Technology offers an alternative learning method for children with intellectual disabilities, enabling them to surmount their challenges and enhancing their prospects for social engagement and overall quality of life. Contemporary electronic technologies, including computers, cell phones, the internet, and tablets, empower individuals with intellectual impairments by affording them equal possibilities to engage with their environment, perform tasks at home, and cultivate societal relationships (Karabıyık, 2024). Materials containing multimedia objects make it possible to repeat the teaching process and involve more than one person, supporting the learning of individuals with intellectual disabilities and effectively overcoming the difficulties encountered in the process (Cheng, 2020).

Problems in learning for children with intellectual disabilities are often related to difficulties in understanding abstract concepts, including two-dimensional figure material. Conventional teaching methods are often ineffective in meeting their needs, making it necessary to innovate learning media that are more interactive and easier to

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understand. The use of mobile learning applications has the potential to be a solution that can help improve their understanding of two-dimensional figures. However, further research is needed on how the application is designed, its effectiveness in enhancing students' understanding, and user responses to the application.

The development of a mobile learning application for teaching two-dimensional figures to children with intellectual disabilities offers significant theoretical and practical benefits. Theoretically, this research contributes to the advancement of inclusive education by integrating technology into special education. It provides insights into the application of instructional design models, such as ADDIE, in developing digital learning tools tailored to the needs of children with intellectual disabilities. Additionally, it enriches the field of educational technology by demonstrating how interactive and adaptive learning media can improve concept comprehension for students with cognitive challenges.

Practically, this study benefits various stakeholders, including students, educators, and educational technology developers. For children with intellectual disabilities, the mobile learning application serves as an engaging and accessible tool that enhances their understanding of two-dimensional figures through interactive and visually stimulating content. For teachers and caregivers, the application functions as a valuable instructional aid that supplements traditional teaching methods, making learning more effective and enjoyable. Furthermore, for educational software developers, this research provides a reference for designing inclusive learning applications that align with the cognitive and learning needs of students with disabilities, ultimately promoting equal educational opportunities for all learners.

Based on the literature and background above, the researchers development of a two-dimensional figure mobile learning application for children with intellectual disabilities to improve the abilities of elementary school students, especially intellectual disabilities children. The aim of this research is to explain and represent the development of a valid and practical two-dimensional figure learning application for intellectual disabilities children.

LITERATURE REVIEW

Mobile Learning Application

Mobile learning applications offer a diverse range of benefits, including the ability to deliver personalized and adaptive learning experiences, foster spontaneous and informal learning opportunities, and enable ubiquitous access to educational resources (Rodríguez-Arancón et al., 2013) (Murray et al., 2012).

Two-Dimensional Figure

A two-dimensional figure, much like a geometrical sphere, can be considered an abstract ideal, a formally determinable entity that can be rigorously defined and explored. At the same time, these figures possess distinct shapes, textures, and other figural properties that lend them a tangible, almost tactile quality, making them intriguing subjects for both mathematical and artistic inquiry (Khatin-Zadeh et al., 2017).

Intellectual Disabilities

Children with intellectual disabilities (ID) tend to experience difficulties in mastering basic motor skills, associated with cognitive deficits that interfere with skill acquisition. ID desperately needs systematically designed applications that have proven beneficial for children with ID. Applicability criteria were identified for future iterations of the error reduction approach in training children with ID motor skills (Capio, 2021).

METHOD

Research Design and Procedures

The research methodology used in this study is the Research and Development (R&D) method, which is used to create specific products and assess their effectiveness. The development process involves creating a learning design using the ADDIE approach which stands for Analysis, Design, Development, Implementation, and Evaluation. The following development design is presented in Figure 1.

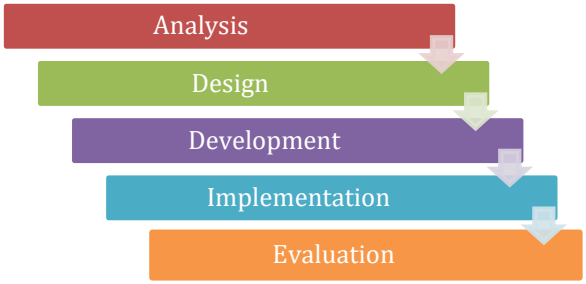

Figure 1. ADDIE Model

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In Figure 1, the ADDIE model consists of five main stages in instructional development. The Analysis stage focuses on identifying learning needs, student characteristics, and learning objectives. Next, the Design stage involves planning instructional strategies, selecting appropriate media, and designing a suitable user interface. The Development stage includes the creation and integration of learning materials into the mobile learning application. After that, the Implementation stage is carried out by applying the application in a real learning environment and training educators on its use. Finally, the Evaluation stage aims to assess the effectiveness of the application, both formatively during the development process and summatively after implementation, to ensure that the learning objectives are achieved.

Population and Sample

The sample in this research was 6 sixth grade students at SKh YKDW 02 Tangerang in the odd semester of the 2024/2025 academic year**.**

Instruments

The validity instrument incorporates both media validation and material validation. Media validation includes a questionnaire that has been developed and validated by specialists in the sector with the aim of establishing the appropriateness of the media for the defined educational objectives. In the course of conducting material validation, a questionnaire authenticated by experts in the specific field was used to evaluate the material coverage and its effectiveness in achieving the desired competencies.

Data Analysis

This research aims to develop mobile learning application two dimensional figure that are valid and effective. The analysis of the validity and effectiveness of the mobile learning application two dimensional figure was conducted through various studies, including the validation of other products, the practicality of the product when used in learning, and the analysis of student responses to its use. The validity analysis involves calculating the average total validation score from four validators: two lecturers and two teachers. The product's validity is determined by comparing the validation score from the experts to the maximum possible score. The results of these calculations are then evaluated against predefined criteria on a specific scale to assess the validity level of the mobile learning application two dimensional figure. The validity criteria are presented in Table 1.

Table 1. Validity Criteria

No.	Precentage	Criteria
1	90% - 100%	Very Valid
2	80% - 89%	Valid
3	60% - 79%	Enough Valid
4	0% - 59%	Not Valid

The effectiveness of using the mobile learning application two dimensional figure material was assessed through student response questionnaires. Data on student responses were collected by having students fill out questionnaires, with assistance from teachers, after using the mobile learning application two dimensional figure. The questionnaire included 15 items designed to assess students' perceptions, interests, motivations, and reactions to using the mobile learning application two dimensional figure material. The data from the student response questionnaires were calculated to determine the percentage of positive responses to the mobile learning application two dimensional figure material. The student responses were calculated by dividing the total score by the maximum possible score and then multiplying the result by 100%. The obtained percentage was then grouped according to the criteria presented in Table 2.

Table 2. Student Response Criteria

No.	Precentage	Criteria
1	90% - 100%	Very Good
2	80% - 89%	Good
3	0% - 59%	Good Enough
4	0% - 59%	Not Good

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RESULT

The ADDIE model consists of five systematic stages used in instructional design and learning development: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis stage, learning needs, objectives, and target users are identified to ensure the effectiveness of the instructional content. The Design stage involves creating a structured learning plan, including content selection, instructional strategies, and media requirements. The Development stage focuses on producing and integrating learning materials, such as multimedia elements, interactive content, and assessments. During the Implementation stage, the developed learning materials are deployed and tested in real learning environments. Finally, the Evaluation stage assesses the effectiveness of the instructional design through feedback and performance analysis, allowing for improvements and refinements in future iterations.

Analysis Stage

At the Analysis stage, initial data collection was conducted through interviews and observations with teachers and students to assess the current state of the school and classroom environment regarding the use of learning media. This process aimed to identify existing challenges in the teaching and learning process, particularly in mathematics. By engaging directly with educators and students, valuable insights were gathered on the difficulties faced in understanding mathematical concepts, as well as the limitations of traditional instructional methods. These findings served as the foundation for designing an effective and engaging learning solution.

The selection of two-dimensional figures as the focus of the learning material was based on the observed difficulties students encountered, especially those with intellectual disabilities, in recognizing and understanding concrete examples of geometric concepts. Teachers highlighted that many students struggled with visualizing and differentiating between various shapes when taught through conventional methods. This led to the decision to develop an alternative, more interactive approach to facilitate better comprehension. The choice of subject matter was validated through discussions with teachers, ensuring that the new learning media aligned with the curriculum and addressed the specific learning needs of students.

Design Stage

At this point, a flowchart is created to determine the order and organisation of the learning media. Additionally, the storyboards help to define the template scheme and the design of the interface. The flowchart serves as the basis from which the storyboard is created and helps to prepare the design outline that relates to the structure of the media. Storyboards provide a supplement to the future design of instructional materials in terms of content, layout and components to be integrated. This storyboard serves as basic material for the development of the interface design that is the conversion of the storyboard into the actual framework. This stage precisely considers the specific features of the learning media.The first step in the design phase involves the preparation of the flowchart for the learning media, which is illustrated in Figure 2 below:

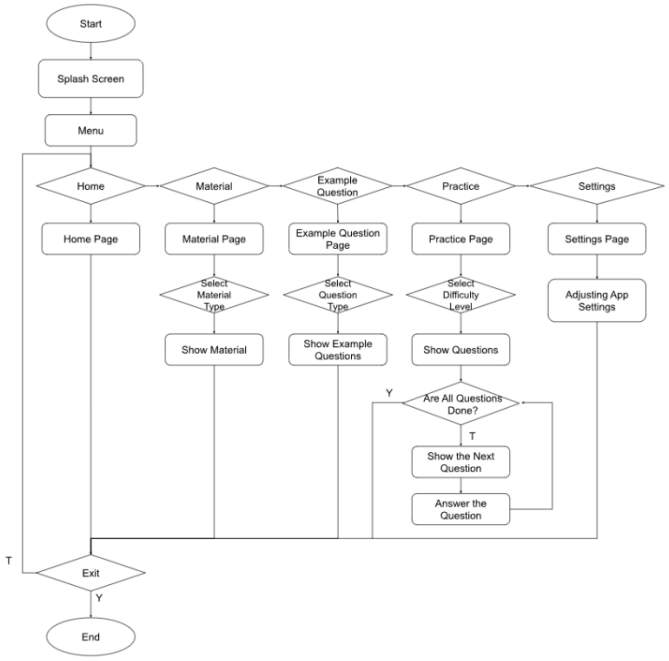

Figure 2. Flowchart of Mobile Learning Application

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In Figure 2, this flowchart illustrates the navigation flow within a mobile learning application for two-dimensional figure learning. The process begins with Start, followed by the Splash Screen, after which users are directed to the Main Menu that provides several navigation options. Users can select Home to return to the main page, Material to choose and study different types of learning materials, Example Question to view example questions based on the selected type, Practice to work on exercises by selecting the difficulty level, or Settings to adjust the application's settings. In the Practice mode, the system will continue displaying the next question until all questions are completed. If the user selects Exit, the application will prompt for confirmation; if approved (Y), the application will close (End), whereas if declined (T), the user will return to the main menu. This flowchart clearly illustrates how users interact with the application from start to exit.

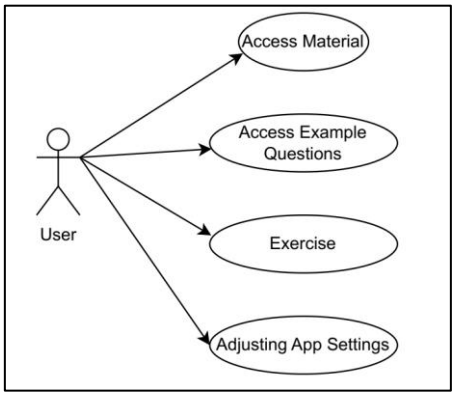

Figure 3. Use Case of Mobile Learning Application

In figure 3, the use case diagram shown represents the interactions between a user and a mobile learning application. The actor (user) has four primary interactions: Access Material, where the user retrieves learning materials; Access Example Questions, where they review sample questions; Exercise, which allows them to practice answering questions; and Adjusting App Settings, where they modify application preferences. Each interaction is represented as an oval, showing distinct functionalities that the system provides. This use case diagram helps in understanding the system's scope, ensuring that all user requirements are clearly defined for development.

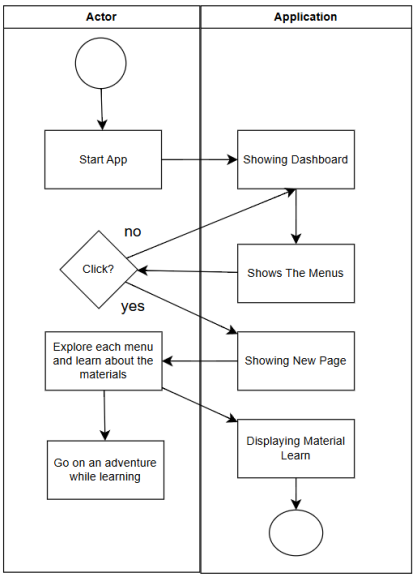

Figure 4. Activity Diagram of Mobile Learning Application

In figure 4, the activity diagram of the mobile learning application illustrates the step-by-step interactions between the actor (user) and the application. The process begins when the user starts the application, prompting the system to display the dashboard. From there, the system presents the menu options, allowing the user to decide whether to interact with them. If the user does not click, they remain on the menu screen. However, if they choose to explore, the system displays a new page containing learning materials. The user can then navigate through the

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materials and gain knowledge. Ultimately, the process concludes with the user engaging in an interactive learning experience. This diagram helps visualize the flow of actions within the application, ensuring an intuitive and structured learning process.

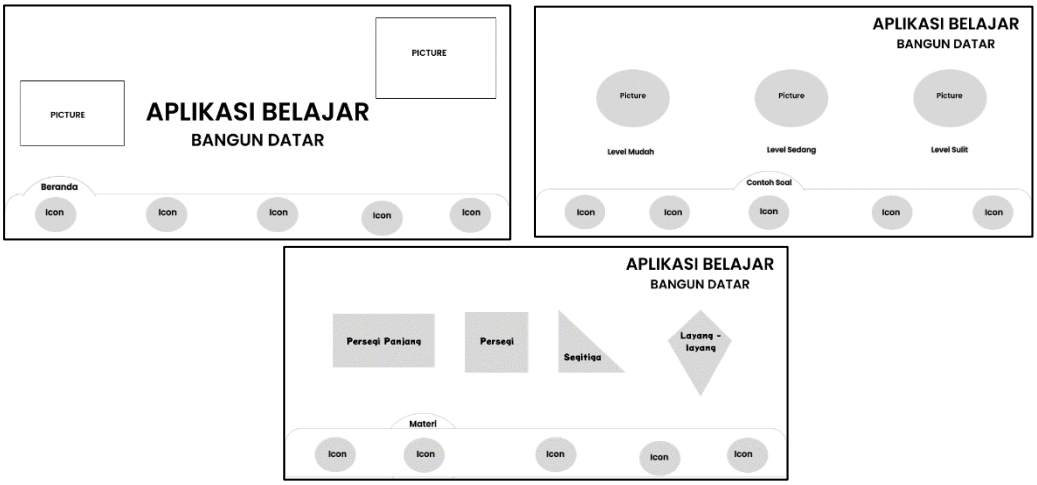

Figure 3. Storyboard of Mobile Learning Application

Figure 3 illustrates the storyboard used in developing the mobile learning application. The storyboard serves as a visual blueprint, outlining the application's structure, user interface design, navigation flow, and interactive elements. It includes key screens such as the main menu, instructional content, exercises, and feedback mechanisms tailored for children with intellectual disabilities. By mapping out the user experience in a sequential manner, the storyboard ensures that the application is engaging, accessible, and aligned with the learning objectives. This step is crucial in the design and development process, allowing developers to refine the interface and interactions before the actual implementation.

Development Stage

The development stage follows the design stage and serves as a foundation for developing the mobile learning application. In this stage, the application is specifically designed to meet the needs and characteristics of children with intellectual disabilities. The choice of media and learning materials is carefully tailored based on the analysis conducted during the design stage and the storyboard creation process. The goal is to ensure that the design aligns with the educational requirements and learning preferences of the target students. Below is an overview of mobile learning application design.

Figure 4. Mobile Learning Application Display

Figure 4 represents the interface of the application with the title ‘Aplikasi Belajar Bangun Datar’ and its theme. At the upper part, there are illustrations of students interacting with shapes which is more engaging and

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educational. A big flat font that emphasizes the focal point of the application is placed in the centre of the screen projecting the app name. A menu is placed at the bottom of the screen in a form of icons each representing their functions as well, such as, the home symbol used to return to the homepage, the book and pen symbol which represents the learning material, the clipboard sign for questions or assignments, the number sign for practice or evaluation, and lastly the settings symbol meant for customizing the app according to the requirements of the user. This design uses bright colors and is visually pleasing for children and emphasizes the simplicity of moves to facilitate the child in learning two dimensional figure.

Interface design for a learning application with a flat-shaped theme. In this image, the user is on the material page, with four flat shapes, each equipped with cute characters to give an interactive and interesting impression. The plane shapes displayed include rectangles, squares, triangles, and kites. Each flat figure is designed with striking details, and the characters around it provide an educational touch that makes learning more fun and engaging for users. This design aims to create an informative and entertaining learning experience, encouraging children to be more enthusiastic about studying mathematical material regarding geometric shapes.

Implementation Stage

After the development stage is completed, the next step is the implementation stage. During this stage, the feasibility of the mobile learning application is validated. Validation is conducted to assess the quality and effectiveness of the application, and it involves feedback from experts: two informatics engineering lecturers from Institut Teknologi dan Bisnis Bina Sarana Global and two mathematics teachers from SKh YKDW 02 Tangerang. This expert evaluation helps ensure that the application meets the required standards for usability and educational value.

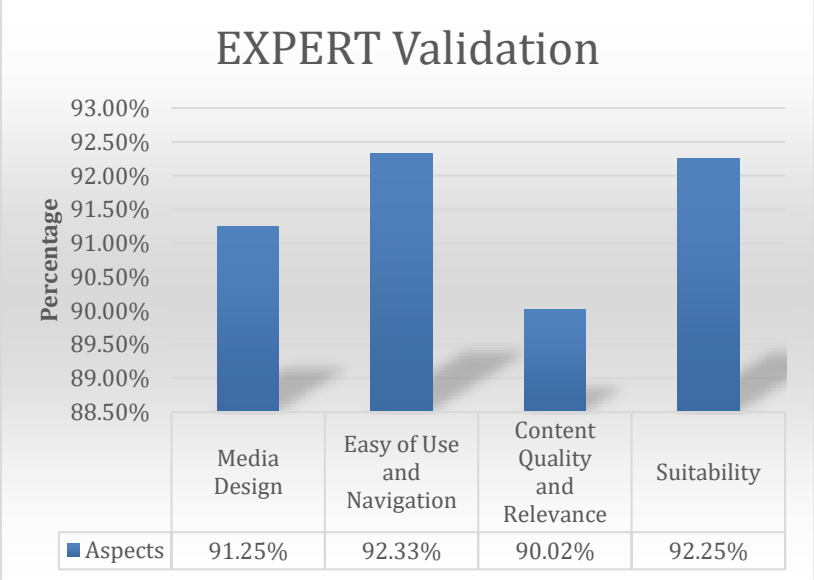

Figure 5. Expert Validation Results

Utilizing the data presented in Figure 5, the outcomes pertaining to validation experts percentage scores are as follows: The aspect of media and design received a score percentage of 91,25%, affirming its very valid. The aspect easy of use and navigation achieves received a score percentage of 92,33%, affirming its very valid. The aspect of content quality and relevance received a score percentage of 90,02%, affirming its very valid. The aspect of suitability received a score percentage of 92,25%, affirming its very valid. With a cumulative score of 91,46%, the mobile learning application is conclusively categorized as "very valid".

Evaluation Stage

The next stage after implementation is the evaluation stage, where field trials are conducted to assess student responses to the mobile learning application. To understand how they were utilizing the mobile learning application in two-dimensional figure teaching course, evaluations were carried out by respondents, consisting of six 6th-grade students at SKh YKDW 02 Tangerang. To evaluate the mobile learning application two-dimensional figure, Student responses were collected through a questionnaire. The analysis of the student response results is

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presented in figure 6, which provides detailed feedback on how the students interacted with and viewed the application in the course of learning activities. This analysis serves to assess the overall effectiveness, usability, and the mobile learning application in relation to the learning outcomes of the students.

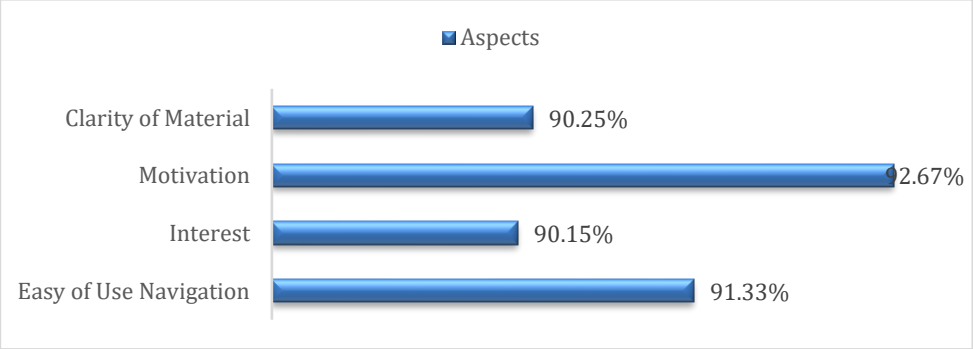

Figure 6. Student Response Results

Based on the analysis results, the average percentage for the four assessment aspects clarity of material, motivation, interest, and easy of use navigation reached 91,10%, placing it in the very good category. The clarity of material aspect received a percentage of 90,25% (very good category), the motivation aspect received 92,67% (very good category), the interest aspect received 90,15% (very good category) and the easy of use navigation aspect received 91,33% (very good category). These results indicate that the implementation of mobile learning application in mathematics has made the learning process more engaging, interactive, and effective.

DISCUSSIONS

The development of the mobile learning application has been systematically carried out using the ADDIE model, ensuring a structured and efficient instructional design process. During the Analysis phase, key issues related to learning two-dimensional figures for children with intellectual disabilities were identified, forming the foundation for the subsequent development. The Design phase involved the creation of essential components, including data flowcharts and storyboards, which guided the development of an Android-based mobile learning application. In the Development phase, the first version of the application was successfully built, incorporating interactive and accessible learning features tailored to the target users.

Mobile learning, commonly known as m-learning, entails the utilisation of mobile devices to enhance learning and information acquisition. These devices allow learners to access instructional content at any time and from any location, thus expanding learning beyond conventional classroom environments (Odabasi, 2019).The interactive characteristics of mobile learning applications have enhanced learner engagement and motivation, fostering a more profound comprehension of intricate themes (Stranger, 2023). App Figma a visual programming platform, has attracted attention for its intuitive interface, enabling anyone with minimal programming experience to develop mobile applications (Staiano, 2022). This platform allows educators and developers to create applications that address certain educational requirements, facilitating the development of interactive and engaging learning experiences (Wangenheim, 2023).

Expert validation results confirmed the effectiveness and quality of the application. The effectiveness of mobile learning applications hinges on the authenticity, accuracy, and relevance of their content in respect to the teaching objectives. Such validation processes are crucial in ascertaining that these applications do not breach the set pedagogical parameters (Perez, 2023). Mobile learning systems are typically assessed for their performance and accessibility through expert assessments, user evaluations and empirical research (Liu, 2019).

Future research should focus on expanding the scope of mobile learning applications by incorporating a wider range of mathematical concepts beyond two-dimensional figures, such as three-dimensional shapes or arithmetic operations, to further support cognitive development. Additionally, integrating adaptive learning features powered by artificial intelligence could personalize learning experiences based on students' individual progress and abilities. Ensuring multiplatform compatibility, such as developing iOS and web-based versions, would enhance accessibility and usability. Longitudinal studies should also be conducted to assess the long-term impact of the application on students' comprehension and retention. Moreover, incorporating gamification elements like rewards and interactive challenges could increase student motivation and engagement. Expanding user testing to a more diverse group of students with varying intellectual disabilities and involving teachers and parents in the learning process would provide valuable insights for further refinement.

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CONCLUSION

The development of mobile learning application has been systematically executed through the utilization of the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework. The analysis phase is dedicated to identifying and addressing issues, while the subsequent design phase generates vital components such as data flowcharts and storyboards, serving as the foundation for constructing the Android-based mobile learning. Progressing into the development phase, the initial version of mobile learning for two dimensional figure material is successfully created. The outcomes pertaining to validation experts percentage scores are as follows: The aspect of media and design received a score percentage of 91,25%, affirming its very valid. The aspect easy of use and navigation achieves received a score percentage of 92,33%, affirming its very valid. The aspect of content quality and relevance received a score percentage of 90,02%, affirming its very valid. The aspect of suitability received a score percentage of 92,25%, affirming its very valid. With a cumulative score of 91,46%, the mobile learning application is conclusively categorized as "very valid". Students responses the average percentage for the four assessment aspects clarity of material, motivation, interest, and easy of use navigation reached 91,10%, placing it in the very good category.

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