Development and Evaluation of a Mobile Learning Application for Behavioral Modification in Children with Autism Spectrum Disorder

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Abstract. In order to promote the aspect of behavior modification in special education, this study aims to produce an innovative and useful tool that examines the development and assessment of a mobile learning application targeted at behavior modification in children diagnosed with autism spectrum disorder (ASD). The study develops a mobile application integrating chaining techniques for daily activities using a Research and Development (R&D) methodology with the Multimedia Development Life Cycle (MDLC) model. Findings indicate that the application significantly improves adaptive behaviors in children with ASD. However, limitations include the small sample size and the focus on specific behavioral issues, which may affect generalizability. This research contributes original value by providing a specialized educational tool designed to enhance the learning experiences and behavioral outcomes of children with ASD, supporting educators and parents in inclusive education settings.

Keywords: mobile learning, autism spectrum disorder, behavior modification, chaining techniques, inclusive education, special needs education.

1 Introduction

The implementation of inclusive education is a crucial focus in many educational systems, driven by legal frameworks that mandate equal access to education for all students, including those with special needs. In Indonesia, this is reinforced by several regulations, including Permendiknas No. 70 of 2009 and the National Education System Law No. 20 of 2003. These regulations ensure that children with physical, emotional, mental, or social disabilities, as well as those with exceptional intelligence and talents, have the right to inclusive education tailored to their needs and abilities [1].

ICIESC 2024, September 17, Medan, Indonesia

DOI 10.4108/eai.17-9-2024.2353080

Children with special needs often face significant challenges adapting to social environments, leading to maladaptive behaviors that hinder their social development and integration [2]. These behaviors do not only affect the children themselves but also present challenges for parents and educators in inclusive settings. Behavioral modification techniques, therefore, become essential tools in transforming these maladaptive behaviors into more adaptive, socially acceptable ones [3].

With the growing role of technology in education, there has been an increasing interest in leveraging digital tools to support behavioral interventions for children with special needs [4]. Research has shown that Computer-Aided Instruction (CAI) is an effective evidence-based practice for students with autism spectrum disorder (ASD), particularly in improving academic performance [5]. The predictability and non-intrusive nature of electronic devices makes them ideal for children with ASD, who may struggle with the complexities of social interactions [6].

This study aims to develop and evaluate a mobile learning application explicitly designed for behavior modification in children with special needs, focusing on those diagnosed with ASD. By integrating proven behavioral techniques into a digital platform, the application seeks to provide an innovative and effective tool for educators, parents, and professionals in special education. This research builds on existing studies that highlight the potential of digital literacy and EdTech in bridging educational and social gaps for special needs students, offering a new approach to inclusive education that is both accessible and adaptable.

2 Method

This research uses the Research and Development method by Borg & Gall [7], combined with the model of the Multimedia Development Life Cycle (MDLC) by Luther [8], as shown in **Figure 2**. This study aims to create a product and assess its performance. Researchers carried out the research up to the product testing phase and then refined the product until the final version was developed. The flow of this research is depicted in the following **Figure 1**.

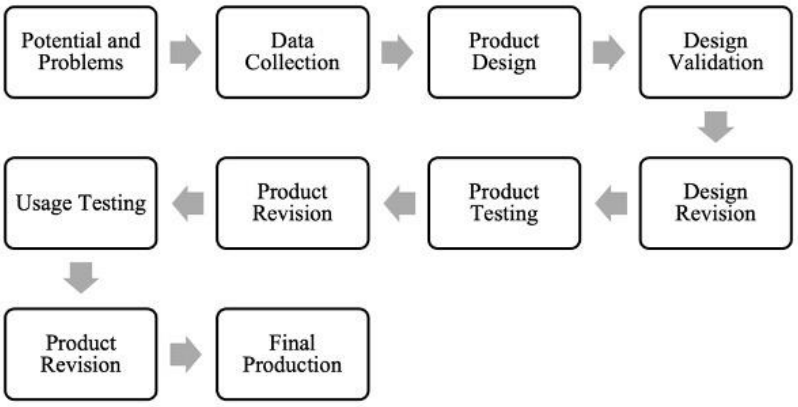

Fig. 1. Phases of the research and development method (Borg and Gall)

Meanwhile, six stages make up the MDLC itself: concept, design, assembly, testing, distribution, and material collection. The illustration of these stages is shown in the Figure 2 below:

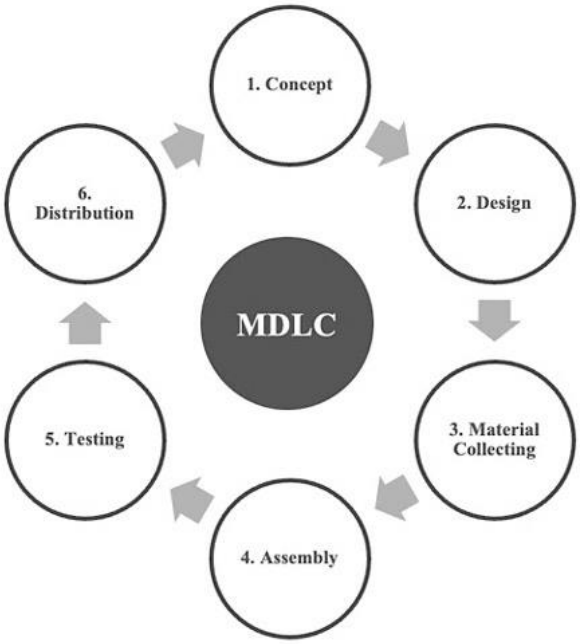

Fig. 2. Luther's MDLC development model

The Multimedia Development Life Cycle (MDLC), proposed by Luther in 1994, provides a systematic and specialized strategy for developing multimedia applications. The main benefit of this approach is its clear and systematic methodology, which guarantees that each stage of the project is carried out methodically, minimizing mistakes and omissions [8]. The model is highly versatile, making it well-suited for diverse multimedia projects. It prioritizes the integration of several media formats, including text, audio, and video, to provide a unified and coherent result [9]. In addition, the MDLC prioritizes improving user experience and incorporates iterative testing to enhance the product continuously.

Another notable advantage of the MDLC is its focus on documentation and evaluation at every stage of the development process, which helps handle intricate projects and facilitate future modifications. The model's distinct stages enhance the effectiveness of project management by facilitating optimal resource allocation, meticulous timetable management, and alignment with project objectives. In summary, the MDLC offers a robust structure that facilitates the effective creation of multimedia applications by integrating user-centered design, iterative testing, and detailed documentation.

3 Results and discussion

3.1 Results

Data analysis. Data analysis involves dissecting a data system into its fundamental elements to recognize and comprehend challenges, possibilities, obstacles, and needs and to recommend enhancements [10]. This system consists of 2 types of users, namely teachers and parents of students. The teachers can register a new account for the parent and track the student's learning results. The parent's account can access the learning material and give feedback on the learning materials. This study uses the Unified Modeling Language (UML) to achieve optimal application design by minimizing common coding mistakes and enhancing the efficacy and efficiency of software development [11]. The users' roles can be seen in the following use case diagram, as shown in Figure 3 below:

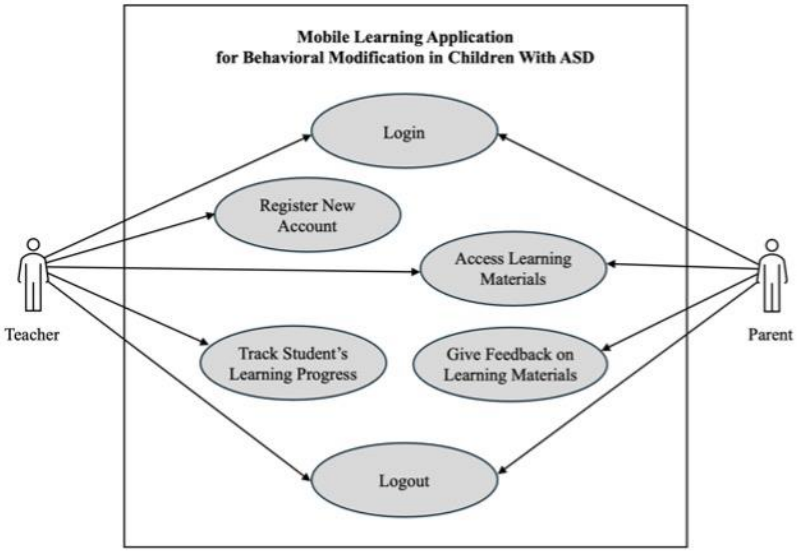

Fig. 3. The use case diagram of the mobile learning application

Based on the use case diagram in **Figure 3** above, we can see the interactivity between users in the application. Teachers are assigned to register new accounts for the parent so that he/she or the student's guardian can access the application from home. Teachers can also access the learning materials so that students can learn the materials at school under the guidance of the teachers. After finishing learning the materials that contain the tutorial video, parents or teachers can give feedback on the materials; if the students need more time to learn the materials, they can repeat the materials, and the application will record it as feedback to track how many time the student can afford and implement the materials.

Database design. According to the above requirements, a database design is implemented to store transaction data in the system. Subsequently, the design outcomes will be incorporated into the MariaDB engine server. Initially derived from MySQL, MariaDB is a database

management system designed to handle massive datasets and deliver fast data processing efficiently. It has been successfully utilized in production applications for many years. MariaDB is an ideal database server for web applications due to its excellent connectivity, high speed, and robust security features [11]. The interconnection between the tables of the mobile learning application can be shown in the Entity Relationship Diagram (ERD) depicted in **Figure 4**.

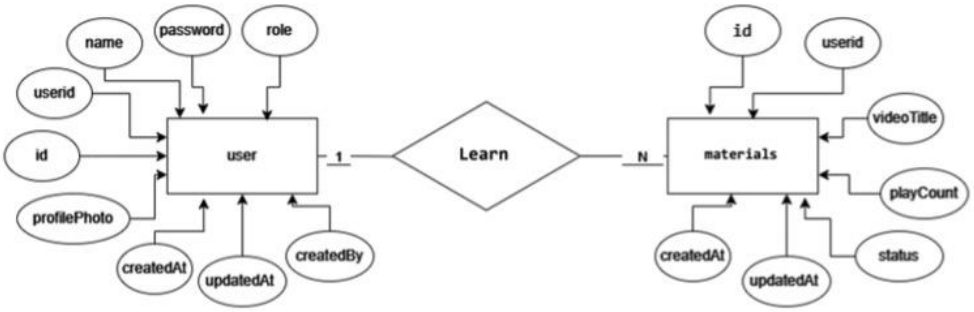

Fig. 4. Entity Relationship Diagram of the application

The Entity-Relationship Diagram (ERD) shows the structure and relationships between the "user" and "materials" entities within the database based on the provided diagram (**Figure 4**). All user-related information, including identifiers like userid and id and properties like name, password, role, profile photo, createdAt, and updatedAt, is centrally stored in the user table. The createdBy attribute makes it easier to track who created the content by connecting the user to particular records. A single user (1) can be connected to many materials (N) by the userid attribute, which links the materials table to the user. Specific details about each learning resource, including its title, the number of times it has been played, and its current status (active or inactive), are stored in the materials database using attributes like id, videoTitle, playCount, status, createdAt, and updatedAt. A one-to-many relationship (1:N) between users and materials is represented by the learn associative entity, which allows one user to manage or learn from several materials. Nevertheless, every content has a backlink pointing to a single user. With the help of this ERD, user and learning material data is efficiently organized, facilitating efficient data management, retrieval, and system interaction.

The user interface designs. The application user interface is designed to be web-based and mobile-oriented using the React JS programming. ReactJS is a front-end library developed by Facebook and used to support web frameworks. It has several advantages, including speed, simplicity, and scalability [12]. Although using laptops or tablets is still advised to obtain a more ideal and broader view from the eye's position, this application design uses a responsive approach that allows users to interact anywhere with their mobile devices or even smart TVs. The application takes advantage of Web 3.0 technology, which enables computers to recognize and handle data on web pages through mechanisms inherent to them [13].

Welcoming page. This page is designed to greet users as they enter the application. This page features a warm introduction, including a brief welcome message and branding visuals. As shown in **Figure 5**, a prominent “Play” button is available on this page, which users can click to proceed directly to the learning materials section, where they can access and interact with educational content.

Fig. 5. Design of welcoming page

Authentication page. All users access the application through the authentication page, depicted in **Figure 6**, to access the data they have created and the dashboard according to their user type. The user needs to enter their previously created login and password.

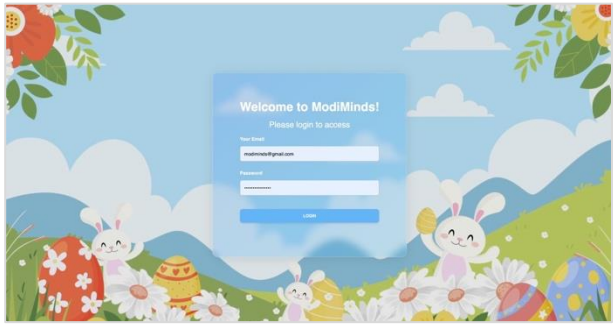

Fig. 6. Design of authentication page

Learning materials page. The learning materials page, as shown in **Figure 7**, provides a user-friendly interface for accessing video-based educational content. The design features a prominent video player, allowing users to easily engage with the learning materials through a single click on the play button. Surrounding the video, a vibrant and colorful layout offers a welcoming and visually appealing environment that enhances the learning experience. On the left side, users can navigate between different modules or chapters, making it simple to access various topics. This layout emphasizes interactivity and ease of use, encouraging users to

explore educational content in a relaxed and visually stimulating setting. The combination of clear navigation and an aesthetically pleasing design creates a comfortable learning atmosphere that feels intuitive and engaging for the users.

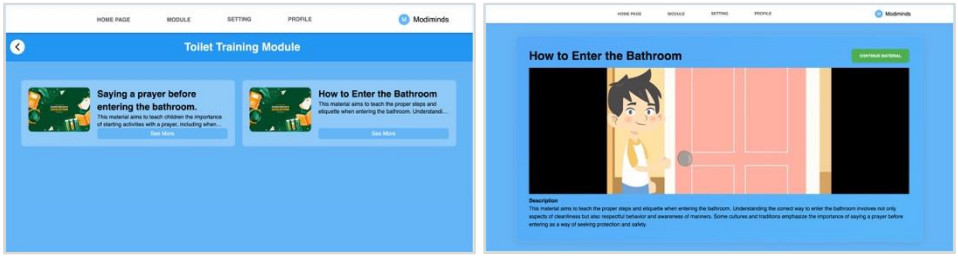

Fig. 7. Design of learning materials page

Feedback page. The Feedback page allows users to respond to a question asking if they understood the material. The interface features a friendly cartoon character holding a chalkboard, creating an engaging and approachable environment for students. The simple, clear question “Did you understand everything? Was that fun?” gives students two options, “Not Yet” and “Yes, I got it”, allowing for immediate feedback. This human-centered design helps gauge understanding in a non-intimidating way, fostering a supportive learning experience.

Fig. 8. Design of feedback page

Application testing. The application testing will be conducted using black box testing, focusing on the user interface across various aspects, including clarity, conciseness, familiarity, responsiveness, consistency, aesthetics, efficiency, and forgiveness. Each aspect will be evaluated to ensure the user interface meets the design standards and provides a seamless user experience. The results of these application tests will be summarized and presented in Table 1 below, detailing the performance and potential areas for improvement for each aspect.

Table 1. The Application Testing Result

No	Aspects	Description	Score	Result
1	Clarity	Ensures that the interface elements and information are easily understandable by users at first glance	4.4167	Very Good
2	Conciseness	Focuses on delivering essential information without unnecessary content, keeping the interface straightforward	4.4444	Very Good
3	Familiarity	Uses design elements and patterns that users are already accustomed to, making navigation intuitive	4.2222	Very Good
4	Responsiveness	Tests the interface's ability to adapt and function well across different devices and screen sizes	4.0000	Good
5	Consistency	Ensures that similar elements and interactions behave the same way across the application, enhancing usability	4.2222	Very Good
6	Aesthetics	Evaluates the visual appeal and overall design of the interface, contributing to a pleasant user experience	4.4444	Very Good
7	Efficiency	Measures how quickly and easily users can complete tasks using the interface	4.2222	Very Good
8	Forgiveness	Ensures that the interface allows users to easily recover from errors without severe consequences	4.1111	Good

3.2 Discussion

Based on the results presented in Table 1, the application testing using black box methodology demonstrates overall strong performance across the evaluated aspects. The user interface was rated "Very Good" in critical areas such as clarity, conciseness, familiarity, consistency, aesthetics, and efficiency, indicating that the design effectively meets user expectations regarding usability and visual appeal. However, responsiveness and forgiveness were rated slightly lower, with scores of 4.0000 and 4.1111, respectively, which still falls under the "Good" category. These results suggest that while the interface is generally well-received, there is room for improvement, particularly in ensuring that the application is equally practical across various devices (responsiveness) and in helping users recover from errors smoothly (forgiveness). The findings highlight the design's success in delivering a user-friendly experience but point to specific areas that require further enhancement. For instance, the responsiveness score suggests that the application may need to optimize its interface across different screen sizes or devices fully. Similarly, the forgiveness aspect could benefit from additional features that allow users to correct mistakes more easily without negative consequences. These insights provide valuable direction for future iterations of the application, ensuring that it not only meets but exceeds user expectations in all areas of interface design.

4 Conclusion

Based on the above discussion, the application has been successfully built to provide a user-friendly experience in essential areas such as clarity, conciseness, familiarity, consistency, aesthetics, and efficiency. The cheerful black box testing findings suggest that the application is adequately equipped to fulfill user requirements. Nevertheless, the application needs additional improvement in responsiveness and forgiveness to guarantee optimal performance on all devices and a smooth error recovery process. These observations highlight the potential of the application as a powerful instructional tool, with continuous improvements aimed at enhancing its flexibility and user assistance systems.

Acknowledgments. This research article was prepared and published with financial support from the 2024 grants provided by LPPM Universitas Negeri Medan. The views and interpretations expressed herein are solely those of the authors and may not necessarily represent the official perspective of the funding agency.

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