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DEVELOPMENT OF MOBILE APPLICATION TO IMPROVE THE COMMUNICATION ABILITY OF AUTISM SPECTRUM DISORDER CHILDREN

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ABSTRACT

Children with communication disabilities have difficulty communicating with others, making it difficult to socialize with the people around them. To address this issue, various assistive tools have been developed. However, most existing tools have several limitations, such as being traditional, non-portable, offering a limited selection of sentences, and being available only in English. These limitations hinder children from adding new sentences and make the tools inaccessible to non-English speakers, particularly Indonesian users. Therefore, this study aims to develop a mobile application, Katakan yang Kamu Ingin (KKI), according to the needs of children with autism spectrum disorder and to assess changes in their communication skills after using the application. This study employed Richey and Klein's Design and Development Research method to develop the mobile application KKI. The participants were two nonverbal children with ASD from a special education school. The resulting product was an Android-compatible APK featuring customizable sentence categories and user-friendly audio-enabled communication options. The application also contains menu items such as a selection of sentences commonly used for communicating in a school environment, and the function of adding sentences by the user. Following validation by three expert evaluators, the results indicate that the product is highly feasible, with revisions based on expert suggestions. Observational data on communication performance in subjects A and B show improvements in communication skills across the initial baseline, intervention, and final baseline phases. These findings demonstrate that the KKI mobile application can positively impact the communication abilities of nonverbal ASD children, making it an effective tool for supporting communication in a school setting.

Keywords: mobile application, augmentative and alternative communication, communication skills, children with communication disabilities, autism spectrum disorder

INTRODUCTION

Children with Autism Spectrum Disorder (ASD) often experience significant challenges in communication, which affect their ability to interact socially and express their needs effectively

(Brignell et al., 2018; Sturrock et al., 2021). These communication difficulties can lead to issues such as social isolation, anxiety, and problematic behaviors (Shattuck et al., 2014; Sturrock et al., 2021). To address these challenges, augmentative and alternative communication (AAC) methods have been widely used, ranging from low-tech solutions like the Picture Exchange Communication System (PECS) to high-tech mobile applications. However, existing high-tech AAC applications often lack flexibility, particularly in allowing users to add new communication items.

Effective interventions for autistic children involve a personalized approach combining AAC systems with verbal therapy, promoting social and functional communication skills (Brignell et al., 2018; Sturrock et al., 2021). While AAC interventions have been proven to enhance communication skills, their implementation in Indonesia remains limited, with a predominant focus on low-tech AAC methods. Furthermore, existing mobile AAC applications often lack adaptability, restricting users from customizing their communication tools according to their needs. By addressing these gaps, this study seeks to contribute to developing an innovative and user-friendly AAC solution that children with ASD and their caregivers can widely adopt.

This study will focus on the design, development, and evaluation of the KKI mobile application. The application will be designed to function on low-spec Android devices, making it accessible to a broader user base. Key features will include a simple user interface, voice output for communication items, and an option for users to add personalized content. The research will assess the application's usability, effectiveness, and potential impact on the communication abilities of children with ASD.

LITERATURE REVIEW

Communication Challenges in Children with ASD

The communication abilities of children with Autism Spectrum Disorder (ASD) need to be improved due to various factors. One of these factors is the relationship between communication and sensory processing, which can trigger anxiety in children with ASD (Khaledi et al., 2022). Children who rarely interact with their peers are at risk of experiencing social isolation (Downing, 2005; Therrien et al., 2016). Additionally, communication limitations can lead to repetitive behaviors, obsessive activities, and difficulties in forming social interactions (Nida, 2013). Communication is also one of the three main challenges affecting learning and participation (Saggers et al., 2019). Impairments in communication development are a common characteristic found in children with ASD (American Psychiatric Association, 2013). Besides communication barriers, children with ASD also face various challenges in daily life, such as an inability to take care of themselves (Suryati & Apriliana, 2022), limitations in expressive language (Fahertanessa & Budiyanto, 2021), anxiety in school environments (Perihan et al., 2022), as well as attention problems and aggressive behavior (Park et al., 2021).

Children with ASD communicate in various ways, including using body language, facial expressions, and verbal speech. Their communication abilities can be classified into verbal and nonverbal communication. Verbal communication includes pronouncing single words and repeating sentences they have heard (Febriantini et al., 2021; Ibrahimagic et al., 2021; Sari, 2012). Meanwhile, nonverbal communication involves following simple instructions, responding when their name is called, making eye contact, and using gestures (Febriantini et al., 2021; Ibrahimagic et al., 2021; Mutia Rahmi Pratiwi et al., 2019; Sari, 2012). Studies suggest that nonverbal communication is often more dominant among children with ASD in daily interactions (Taufik, 2015).

The Role of Augmentative and Alternative Communication (AAC) for ASD

Communication disorders can cause various problems for children with ASD, such as difficulties in interacting with peers (NIH, 2016). Limitations in understanding and using different forms of language and communication, including body movements and facial expressions (Charman & Stone, 2006), may lead to problematic behaviors such as self-harm, aggression, and tantrums (Bott et al., 1997). Therefore, enhancing the communication abilities of children with ASD is a priority in interventions, one of which is through Augmentative and Alternative Communication (AAC) (Murray, 2014).

AAC is commonly used to assist children with ASD who experience verbal apraxia, speech and language delays, intellectual disabilities, genetic disorders such as Down syndrome, vocal surgery, intubation, and language limitations (Green, 2018). AAC allows children with ASD to participate in standard communication using alternative methods, such as sign language or computer-based communication devices with voice output (Beukelman & Mirenda, 2013). The use of AAC has also been proven to improve the communication skills of children with ASD (Benazir et al., 2013; Futuhat et al., 2018).

High-Tech and Low-Tech AAC in Different Contexts

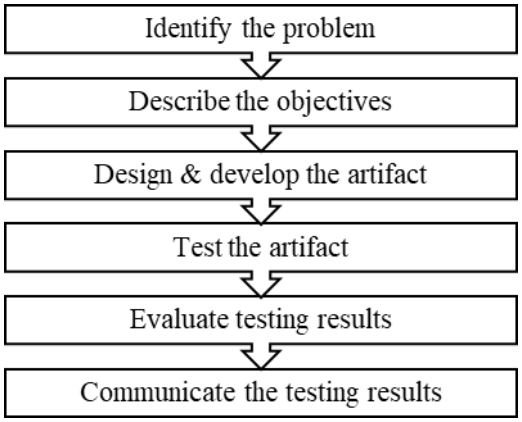
Studies have shown differences in the use of AAC between developed and developing countries. For example, in Spain, a developed country, high-tech AAC is more commonly used to support individual communication (Leonet & Orcasitas-Vicandi, 2020). In contrast, in Brazil, a developing country, low-tech AAC such as the Picture Exchange Communication System (PECS) is more widely used (Nunes & Walter, 2018). Additionally, research indicates that children feel happier when interacting using high-tech AAC than low-tech AAC (Holyfield & Lorah, 2023). High-tech AAC also provides benefits such as improving literacy skills, reducing stress during interventions, and enhancing more effective intra-verbal responses (Ariwijaya, 2020).

Previous research has shown that AAC is more commonly used by children with ASD who have verbal communication abilities (Ahmad & Zulkharnain, 2020; Atyabi et al., 2017; Benazir et al., 2013; Chapin et al., 2021; Fuad et al., 2019; Juniayanti & Susila, 2022; Septiari et al., 2015; Srinivasan et al., 2022) compared to nonverbal children with ASD (Caron et al., 2021; Futuhat et al., 2018; Pertiwi et al., 2016). In Indonesia, research on the use of low-tech AAC, such as PECS (Futuhat et al., 2018; Juniayanti & Susila, 2022; Septiari et al., 2015) and picture cards (Benazir et al., 2013; Pertiwi et al., 2016), is still more dominant than studies related to high-tech AAC based on mobile applications (Ahmad & Zulkharnain, 2020; Fuad et al., 2019).

METHODOLOGY

The development research method used in this research is Design and Development Research (DDR). Richey and Klein (2005) define DDR as the systematic study of design, development, and evaluation processes to establish an empirical basis for creating new or enhanced products, instructional and non-instructional tools, and models that govern their development. DDR consists of six main stages. These stages are shown in Figure 1 below.

Figure 1: Flowchart of DDR Stages (Ellis & Levy, 2010)



The location of this research is SLB N 1 Kubung in Kab. Solok, West Sumatra. This school has nonverbal ASD students who have difficulty communicating. Communication difficulties experienced by nonverbal ASD students can be supported by the use of augmentative and alternative communication

(AAC) tools. However, the school currently only has an AAC tool in the form of PECS, which has limitations in supporting communication in the school environment.

The subject of this study was determined using purposive sampling, based on specific developmental goals set by the researcher. The study involved two nonverbal ASD students who:

- ➔ Have communication difficulties,
- ➔ Can understand instructions,
- ➔ Are able to read,
- ➔ Own and can operate Android devices.

Data collection techniques included observation, interviews, questionnaires, and performance observation.

Table 1: DDR Stage Application in This Study

Identify the Problem	Limited communication tools for nonverbal ASD students.
Describe the Objectives	Develop and test a digital AAC-based tool
Design and Develop Artifact	Create AAC communication tool for Android
Test the Artifact	Try out with two ASD students in SLB N 1 Kubung
Evaluate Testing Result	Expert validation and student usage tracking
Communicate the Results	Share findings in research publications

Data Analysis:

R&D research data were analyzed using descriptive statistics (Gengatharan et al., 2021). Data included:

1. Expert validation results of the AAC product,
2. Observation logs tracking students' successful use of AAC,
3. Teacher reports identifying frequency and patterns of use,
4. Monitoring improvements in student performance across multiple sessions.

Descriptive statistics were used to summarize the data, including graphs, charts, percentages, and tables (Sugiyono, 2016).

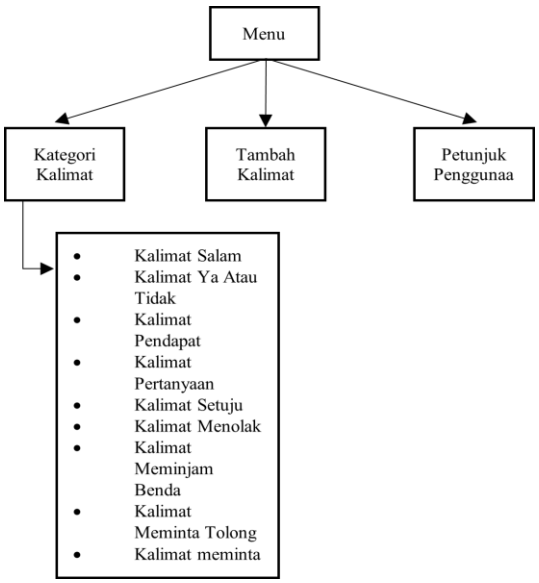
RESULTS AND FINDINGS

The product produced in this study is a mobile application called "Katakan yang Kamu Ingin (KKI)", which functions to help nonverbal ASD children communicate in the school environment. The developed application consists of the forms of sentences used and instructions for use. On the menu, children use sentence categories such as greetings, opinions, questions, and others. At the same time, the user manual menu contains instructions on how to use this application. This application makes a sound when pressed on an image or sentence in the application. In addition, there is an additional sentence menu in the sentence category menu that can be used to add new pictures and sentences that the child wants.

This application was developed using the design and development research (DDR) development model. DDR is carried out in 6 stages, namely:

1. **Identify the problem**
   This stage is carried out to find out the problem of communication skills experienced by nonverbal ASD children. Researchers conducted observations and interviews with students' teachers and parents. Based on the results of observations and interviews, the purpose of developing the "Katakan yang Kamu Ingin (KKI)" mobile application is to focus on functional communication skills that occur in the school environment.
2. **Describe the objectives**
   Qualitative analysis was carried out based on observations, interviews, and video recordings to determine what functional communication is needed by nonverbal ASD children. The selected functional communications are saying greetings, expressing an opinion on a thing or things, asking for something from someone else, asking permission to go to the toilet during class, asking something, asking for help, saying thank you, and saying farewell.
3. **Design & develop the Artifact**
   As a reference in developing the KKI mobile application, the flowchart database for the design of the KKI mobile application is as follows:

Figure 2: KKI Mobile Application Database Flowchart



Then, this application was designed using Android Studio with a minimum Android version that can use this application, which is Android 5.0 (Lollipop), and a minimum RAM of 2GB.

Test the artifact

1. Expert validation of the developed product
   After the initial product development is complete, experts carry out validation. The following is the profile of the validator expert in this study:

Table 2: Validator Expert Assessment Results

No.	Validator Expert Name	Validator Expert Position	Validation Results
1.	Nur Azizah S.Pd, M.Ed., Ph.D, as a material expert	Lecturer in Special Education at Yogyakarta State University	100 % Worth using with revisions as suggested
2	Dr. Ulfia Rahmi, M.Pd, as media a expert,	A Lecturer in the Department of Education Curriculum and Technology, Padang State University	97.5% Worth using the revisions suggested with as
3	Purwaningsih, S.Pd., practicing teacher	Teachers of SLBN 1 Kubung	89.3% Worth using revisions suggested with as

Based on the product validation for the developed application, the application was improved according to the suggestions and input given by the validation expert. The suggestions and input given by validator experts are as follows:

Table 3: Validator Expert Suggestions and Feedback

No.	Validator Expert	Suggestions and Feedback
1.	Nur Azizah S.Pd., M.Ed., Ph.D	● The display of sentence categories is made on one screen. ● Vocabulary made simple. ● Sentence categories, yes or no, agree, and refuse are made into one category. ● Images are adapted to the statement and are also consistent with other images. ● The picture represents one sentence. ● Sentences are made neutral. ● The added sentence menu is placed in the sentence category. ● Fix bugs.
2.	Dr. Ulfia Rahmi, M.Pd	● The application has not been equipped with an identity. ● Applications should include clear, detailed guidelines. ● The application must also describe the "about" application, including usage, the user, etc.

continued

3.	Purwaningsih, S.Pd	● Use more appropriate images. ● Guidelines for using the application are clarified again. .

The developed application product is then improved according to the suggestions and input given by the validator expert to correct errors and deficiencies that exist in this product. The appearance of the AAC mobile application that has been repaired is as follows:

a. Observation of the performance of nonverbal ASD students' communication skills
The initial stage is to measure the communication skills of nonverbal ASD students, which is carried out in coordination with the SLB class teacher. Coordination is carried out by explaining how to use the mobile application and explaining the design procedures for implementing the AAC mobile application. Evaluation researchers evaluate by recording the communication process that occurs with these students.

Table 4: Scenario of Implementation of Communication with Students

No.	**Implementation Scenario**	**Implementation**
1.	Implementation of communication	Teacher and student
2.	Implementation procedure	The design procedure for implementing the AAC mobile application has been described.
3.	Study Time	1 hour, 4 times the intervention Performance observation was carried out the next day
4.	Process documentation for evaluation	Video footage taken using a cellphone camera directed at the executor.

Evaluate testing results

a. Evaluation of product validation results developed

   Based on the results of the product validation that has been carried out, it was found that from the results of the validation carried out by material experts, namely 100%, the product was in the very feasible category, and the results of the validation were suitable for use with revisions according to suggestions. The validation carried out by media experts produced 97.5%, which means that the product is in the very feasible category, with validation results suitable for use with revisions according to suggestions. The validation carried out by practicing teachers gave results of 89.3%, which means the product is in the very feasible category, and the validation results are suitable for use with revisions according to suggestions.
b. Evaluation of the results of observations of the performance of ASD children's communication skills

   Based on the results of the performance observations, it was found that there was a change in communication skills. This is evidenced by the difference in results between the pretest, intervention, and posttest.

Communicate the testing results

a. Based on the evaluation results of the AAC mobile application products that have been developed and product tests carried out in the form of product validation, it is found that the developed mobile application products are very feasible to use, with validation results of 100% from material experts, 97.5% from media experts, and 89.3% from practicing teacher.
b. Furthermore, based on the results of the evaluation of performance observation results, positive changes were found in the communication skills of ASD children, this was evidenced by an increase in the results of performance observations, it was known that the communication skills of subject A and subject B before using this mobile application were 0% with an inferior category. After the intervention, the results of Subject A's communication ability were 56.65% in the sufficient category, while Subject B obtained 53.75% in the adequate category. At the final baseline, when the posttest was conducted, the results of the communication skills of Subject A and Subject B after using the KKI mobile application were 80% and 77.8%, which were in the good category.

DISCUSSION

The results of this study demonstrate that the use of the KKI mobile application significantly improved the communication skills of nonverbal ASD children. The initial hypothesis that AAC intervention could enhance communication abilities in nonverbal ASD children was supported by the findings, as evidenced by the increase in communication ability from 0% at the pretest stage to 80% and 77.8% at the posttest stage for subjects A and B, respectively. These results indicate that the KKI mobile application is an effective tool for facilitating communication in a structured and accessible manner.

The study's findings align with previous research on AAC interventions for ASD children with ASD. Studies by Boster & McCarthy (2018) and Wendt et al. (2019) emphasize the effectiveness of AAC in supporting communication development among children with ASD. Furthermore, this study provides additional insights into the importance of high-tech AAC solutions in educational settings, particularly in developing functional communication skills necessary for daily interactions. Unlike previous mobile AAC applications, the KKI application includes a customizable feature that allows users to add new words and sentences, addressing a standard limitation in existing AAC applications (Fuad et al., 2019; Muslikhah, 2020). This feature enhances the flexibility and usability of the application, making it more adaptable to individual user needs.

A comparison of findings also highlights differences in AAC usage between developed and developing countries. In Spain, high-tech AAC is more commonly implemented (Leonet & Orcasitas-Vicandi, 2020), whereas in Brazil, low-tech AAC, such as PECS, is preferred (Nunes & Walter, 2018). In Indonesia, AAC research is still predominantly focused on low-tech solutions, such as PECS and picture cards (Futuhat et al., 2018; Juniayanti & Susila, 2022; Septiari et al., 2015), whereas studies on high-tech mobile AAC applications remain limited (Ahmad & Zulkharnain, 2020; Fuad et al., 2019). The positive outcomes of this study suggest the potential for broader implementation of high-tech AAC in Indonesia to support children with ASD.Despite these promising findings, several limitations should be acknowledged. The study was conducted with a small sample size, limiting the generalizability of the results. Additionally, the intervention period lasted only four weeks, which may not be sufficient to assess the long-term effectiveness of the application. Future research should consider a larger participant group and extended intervention periods to evaluate the sustained impact of the KKI application. Another limitation is the reliance on subjective assessments through observations and interviews, which may introduce bias. Incorporating objective measures, such as eye-tracking technology or automated speech analysis, could provide a more comprehensive evaluation of communication progress.

CONCLUSIONS

The study findings confirm that the KKI mobile application is efficacious in improving the communication skills in requesting and expressing the feelings of nonverbal ASD children. The application provides a structured approach to functional communication, allowing children to interact more effectively in educational settings. The ability to customize sentences addresses a key limitation in previous AAC applications, enhancing the adaptability of the tool for individual users. The results indicate a significant improvement in communication ability, supporting the study's hypothesis and demonstrating the potential of high-tech AAC solutions in special education. However, further research with larger sample sizes and more extended intervention periods is needed to validate these findings and explore the long-term benefits of the application.

RECOMMENDATIONS

a. Wider Implementation
   Schools and special education centers should consider integrating high-tech AC solutions, such as the KKI application, into their communication intervention programs for nonverbal ASD children.
b. Further Research
   Future studies should focus on evaluating the long-term effects of the KKI application and its effectiveness in different educational and social settings.
c. Customization and Expansion
   Additional features, such as multilingual support, more extensive vocabulary options, and personalized user profiles, should be explored to enhance the application's usability.

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