The Development of the myKadera System for Object Vocabulary Mastery for Students with Hearing Impairment Based on Augmented Reality

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Abstract. This study aims to: 1) design appropriate learning media based on Augmented Reality on the introduction of object vocabulary for hearing-impaired students, 2) perform the developed system. This research belongs to research and development (R&D). This developmental research refers to the stages of learning media development by Arief Sadiman, et al and the stages of the development model by Borg & Gall. This research development procedure consists of three major steps that must be passed, namely planning, development and evaluation activities. The result of this Android-based myKadera system development research is that the system has some features provided including audio, sign language videos, 3D animation, and object vocabulary quizzes that were packaged more interestingly, applicable and innovative with a more real-time visual display, supported by object vocabulary learning media books with the help of AR (augmented reality) markers. The results of the test indicate that the application meets ISO / IEC 25010 standards on aspects; (1) functional suitability; all features of the application has been successful and said to be good, which means there are no functions that fail on testing, (2) application compatibility; the application is 100% compatible with sub-characteristics of co-existence, various operating systems, and various types of devices used for testing, (3) performance efficiency; the application is successfully run using the AppAchhi test device. The application is said to be good without experiencing memory leak or application damage which results in force close or launch fail. The application shows an average time behavior of 0.063 seconds/thread, an average CPU usage of 20.39%, and average memory usage of 13.08 MB, and (4) usability testing obtained a percentage of 95.50%. These results indicate that the application is very feasible and meets the usability aspect.

1. Introduction
Education is very important to be understood as the frontline in efforts to improve the quality of Indonesian human resources based on science and technology. The implementation of education in Indonesia must be equal and can be perceived by all groups, including children with disabilities. This is as contained in Law No. 2 of 1989 article 8 paragraph 1 which states that "Citizens who have physical or mental disorders are entitled to extraordinary education"[1]. It is also stated in Law No. 20 of 2003 chapter 5 paragraph 1 of the National Education System that "Every citizen has the same right to obtain good quality education despite having physical, emotional, mental, intellectual or social disabilities, are entitled to special education"[2].
Disability or disability is a term that encompasses disruption, limitations on activities and restrictions on participation. Persons with disabilities are all people who experience physical, intellectual, mental and/or sensory limitations in the long term, who are in interacting with the society can experience obstacles and difficulties to participate fully and effectively with other citizens based on equality of rights (Law No 8 of 2016 concerning persons with disabilities)[3]. Based on a global survey conducted by the United Nations Children's Fund and the University of Wisconsin, there are more than half (52%) of children in the world aged 6-9 years have at least one type of disability condition [4]. In Indonesia, there is 8.56% of the population with disabilities.

One type of disability is a condition of having difficulty/impaired speaking and or understanding/communicating with others. In Indonesia, based on data obtained from the 2015 SUPAS result for persons with disabilities who have difficulty speaking and/or understanding/communicating with others, it nationally has a percentage of 1.52% [5]. From the results of the survey, early childhood children with disabilities are a group that is very vulnerable to society treatment in the form of "socially disabled", an event that excludes children socially. This negative condition and/or treatment is dangerous for their development, their disability can become worse physically, mentally, and socially.

In this study, the focus of the research that will be carried out focuses on people with disabilities, especially related to children with disabilities as it is referred to as children with special needs. Children with special needs is "child who has something extraordinary that significantly distinguishes from children of their normal age" [6]. The type of disability that is the object of research is the disability of hearing impairment.

Hearing impairment is a condition of someone who has a hearing disability so that it prevents the process of acquiring spoken language information through hearing with or without hearing aids [7]. In this case, seeing the condition of children who have less hearing causes children's language development to stop in the process of touch so that children cannot experience the process of imitating sound when they are still little. The process of imitation is only limited to see or visual. This condition also influences in terms of receiving and capturing information from outside, both oral and written, and even greatly affects the mastery of the vocabulary possessed by children with hearing impairment.

In Indonesia, the learning process of hearing-impaired children is carried out by SDLB in each city/district. During its implementation, the learning process carried out is still experiencing obstacles, and not yet optimal. Some of the obstacles faced in the learning process of hearing-impaired children are the lack of vocabulary owned by these children because hearing-impaired children experience obstacles in hearing function so that they do not understand the sounds of language and mastery of vocabulary becomes difficult. This condition can also cause children's ability in language and communication to be lacking so that they will only get minimal information.

Vocabulary plays a very important role in language teaching since the mastery of one's vocabulary is very influential on the quality of language skills. This is consistent with the opinion of Tarigan (2011) which states that the quality of a person's language clearly depends on the quantity of vocabulary they have, the greater language skills will be obtained [8]. The results of Lewton and Mackey's research in Edja Sadjaja (2005:5) show that retardation or developmental constraints of hearing-impaired children congregants have to do with language poverty, due to lack of information acquisition, causing the data abstraction and imagination experience obstacles [9].

From interviews conducted with SDLB teachers, it is known that there are 45 vocabularies that must be mastered by hearing-impaired children according to the curriculum, namely 15 fruit names, 15 vehicles names, and 15 animal names. The condition that occurs is that most children who are shown pictures of fruits, vehicles and animals are only able to name 16 to 20 names of the fruits, vehicles or animals. Referring to the demands of the 1994 SDLB curriculum, it states that children with hearing impairment must have vocabularies of at least 9000 vocabulary words for children with hearing-impaired grade IV. The reality is
quite the opposite, there are many hearing-impaired children have a little vocabulary, both for mastering the vocabulary of objects and other vocabularies. Hearing-impaired children only understand concrete vocabulary and basic vocabulary. Based on the information obtained, during the learning process, children who have hearing impairment often forget the vocabularies. This causes the learning outcomes to be below the KKM (Minimum completeness criteria). Hearing-impaired children have difficulty remembering vocabularies that have been taught and it is only limited to surrounding objects which are often encountered by children.

Several studies related to the development of learning processes for children with hearing impairment have been conducted. Dhoni, Herman and Agi (2018) in his research entitled "Android Board-Based Communication Board Application Design as Learning and Communication Media for Deaf Children, explains the Prototype Application PankoTuli" which is designed to help reduce the difficulties faced by hearing and speech impaired people. The results of this study stated that the Prototype Application "PankoTuli" provides a method of Learning and Communication of Indonesian Sign Language for the hearing and speech impaired quickly and practically because it uses the Android-based application tools on smartphone devices [10]. Furthermore, Ardiyani and Bachtiar (2014) researched on analysis of user interface for learning vocabulary introduction for hearing-impaired children. The results of this study are interface designs in the form of mockups and interface model simulators for learning media of vocabulary recognition for hearing-impaired children that built using Balsamiq mockup and Microsoft Tools Expression Blend 4 + sketchflow. By applying the total communication component in the delivery of vocabulary material and conducting every step of the UCD method, it can be concluded that the interface design produced is appropriate with the needs and conditions of hearing-impaired children and provides convenience to understand abstract vocabulary [11]. In Ilona research, which is about sign language learning application for hearing-speech impaired using Android-based image and Audio Visual Media. This research is in the form of Sign Language Learning Application for hearing-speech impaired patients using image-based audio and audio visual media can provide information and learning and it can help users to get sign language learning, especially in word recognition [12]. In addition, other research by Kautsar, Bordan and Sulistyawati (2015) regarding Sign Language Learning Applications for hearing-impaired-based Android users with the Bisindo method. In this research, it was built with a method of developing a multimedia system to produce multimedia-based products in the form of applications that can display learning and games that are equipped with pictures, audio and video sign language [13].

From the studies that have been described, the researcher observes that the studies conducted have not provided new innovations for the hearing-impaired learning media. Based on research reviews, the researchers offer a new system innovation in the form of an android-based learning media application, with the use of Augmented Reality technology. Augmented Reality technology is a breakthrough and innovation in the developing multimedia and image processing fields. This technology is able to lift an object that is previously flat or two-dimensional as if it is real or in real-time to be united with the surrounding environment. According to Ronald T Azuma from research published in a journal with the title "A Survey of Augmented Reality", Augmented Reality is a variation of the Virtual Environment or better known as Virtual Reality. Augmented Reality technology which is a development of Virtual Reality has a different concept [14]. Through the use of Augmented Reality technology, the presentation of learning media, especially vocabulary, is more real or in real-time. Therefore, the use of Augmented Reality technology has the potential to be developed into learning media using Android as support for hearing-impaired children in the process of object vocabulary learning.

Furthermore, in this study, the researchers packaged the learning media system application with a new media called the myKadera application (Recognizing Object Vocabulary based on Augmented Reality). myKadera is a system application development that is packaged as an android-based learning media by combining Augmented Reality technology with features provided including audio, sign language video, 3D
animation, and object vocabulary quizzes that packaged more interestingly, applicable and innovative with a display visual is more real-time, supported by the object vocabulary learning media books with the help of AR (augmented reality) markers. myKadera is expected to be an alternative for teachers as a learning medium to foster children's memory and children's interactive media as relevant learning resources for hearing-impaired students to improve their vocabulary mastery of objects.

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2. Research Method

Method used in this study is a research and development (R&D) method by Borg & Gall which consists of 10 development steps, namely: 1) Research and information collecting; 2) Planning; 3) Develop preliminary form of product; 4) Preliminary field testing; 5) Main product revision; 6) Main field testing; 7) Operational product revision; 8) Operational field testing; 9) Final product revision; and 10) Dissemination and implementation. In this study, the researchers also adopted several expert opinions including the stages of developing learning media by Arief Sadiman et al. and also the stages of developing learning media by Borg & Gall. The procedures carried out in this study go through 3 important stages, namely planning, development, and evaluation. Development procedures include (1) planning phase; the activity carried out includes a needs analysis by doing a class observation to determine the most essential material to be developed and research planning by determining the research population. (2) development phase; the activity was carried out by doing a product development planning which consists of making a Storyboard and Interface Design to illustrate the workflow and detailed details in the display and to develop a measuring instrument of success/instrument, product development/program making, pouring the planned media design in the form of products and product trials through media validation by media experts, material experts, subject teachers and tested on students as users. (3) Evaluation phase; it was carried out to test the media in the experimental class and the control class.

Software testing conducted using ISO/IEC 25010 standard tests categorizes product quality into 8 (eight) characteristics, namely: Functional suitability, Performance efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. Based on the eight characteristics above, in this study, the software testing phase only uses 4 of the 8 characteristics in the ISO 25010 standard from Ben David's opinion. Testing mobile software in ISO 25010 uses four aspects of testing including Functional suitability, Compatibility, Performance efficiency, and Usability [15].

3. Development and Implementation

3.1. General Description of the Application

This system application works by detecting the pattern of a marker. Markers used in designing this application are in the form of images and video barcodes. After the marker pattern is detected, a 2D or 3D object will appear directly above the marker. Besides displaying 2D or 3D objects, users can also see details of the objects and videos that are displayed. This application is equipped with instructions for its use, so that it can help the user to follow the steps in the instructions.
Figure 1. Block diagram of the Mykadera application system

The block diagram of the Mykadera application system, as seen in Figure 1, starts from the user running the application in the form of a scanning marker process to capture objects, followed by the detection process, ID marker, later the system will recognize data and markers in the form of 2D or 3D objects display, audio, video and information text. In the process of detecting markers, there is no internet connection needed on the smartphone used, because the database used in this application uses a local database.

3.2 Implementation
The implementation phase is the continuation stage of the system design activities to implement or create software to be feasible to operate. The activity carried out at this stage is moving or translating the logic of the program that has been made into the programming language and Java script so that it can produce interesting applications based on the planned objectives.

4. Results and Discussion
MyKadera was developed through the stage of testing the quality of the software so that it can be seen whether the software can be categorized as good software and there are no errors when used by users. At the testing stage that carried out to determine the quality of the software for this system is testing using ISO/IEC 25010 software quality standards. ISO/IEC 25010 testing becomes an international testing standard made by the International Organization for Standards (ISO) and Electrotechnical Commission (IEC) [16]. The product quality model categorizes the quality of product into 8 (eight) characteristics, namely functional suitability, reliability, performance efficiency, usability, security, compatibility, maintainability, and portability [17].

The myKadera system application was tested using ISO/IEC 25010 software quality testing standards by implementing 4 aspects of mobile device testing by Ben David including functional suitability, compatibility, performance efficiency, and usability. Applications must meet all aspects of these standards in order to be declared feasible.

The results of this study are sorted by testing phase. The test kits used are 5 devices available at Firebase Test Lab. The devices are Samsung-SM-J710F, YU-YU5010A, Huawei-FRD-L02, Samsung-SM-J710FN, and OnePlus-ONE A2003. The devices were chosen because they meet the operating system, memory, and device diversity criteria. In addition, the application also uses a virtual test device available at Firebase Test Lab to get general test results. Material testing is done by observation to assess whether the application content is up-to-date or not. The result of the material test is that the application is feasible to use with the
addition of several explanations of several terms. The application functional suitability test was conducted by 4 programmers from various IT professions who understand the systematic development of software.

The test results are 100%. These results indicate that all application functions can run well so that it meets the functional suitability aspects. Co-existence sub-characteristic test was done by observation. The types of applications used in this test include Play Store, Google Chrome, Joox, Google Maps, Facebook, Grab, Instagram, Lightroom, WhatsApp, and Telegram. All applications were run together with the myKadera system application in one device. The results of this test are 100% so that it can be concluded that the myKadera application can run with other applications and meets the criteria very feasible on the aspect of compatibility co-existence. Testing the compatibility of the operating system was done using AppAchhi. The operating system used is Android 4.4 KitKat up to Android 8.0. Oreo The results of this test are 100%, which means the myKadera system application meets the compatibility aspect of the operating system. The compatibility testing of various types of devices was done the same as the compatibility test devices of various operating systems. The test results are 100%

Results of performance efficiency testing used the same device as the previous test and performed automation using tools from AppAchhi. The results of the application performance efficiency test showed an average time behavior of 0.063 seconds/thread, an average CPU usage of 20.39%, and an average memory usage of 13.08 MB. From these results, the myKadera system application was declared well without experiencing a memory leak or damage resulting in a force close or launch fail. Usability testing used USE Questionnaire which amounts to 10 items and was given to 10 respondents. The test results obtained by the percentage of 95.50%. These results indicate that the application is very feasible and meets the usability aspect.

5. Discussion
Based on the results of research conducted by previous researchers, there are still some shortcomings, including: on the design of Communication Board Applications Based on Android Tablets as Learning and Communication Media for hearing-impaired children, explaining the Prototype Application "PankoTuli" which is designed to help reduce the difficulties faced by the hearing and speech impaired. Communication Board application is already based on an android tablet that displays sign language text and video by entering vocabulary in the form of sign language, however, the application has not been able to display vocabulary in the form of images to help memory and mastery of children. It has not provided complete information to children with hearing impairment related to the desired vocabulary and the design of the application is still standard, not yet sophisticated and less attractive. Other research is on user interface analysis of learning media for vocabulary recognition for hearing-impaired children. The results of this study are interface designs in the form of mockups and interface model simulators for learning media for vocabulary recognition for hearing-impaired children which are built using Balsamiq mockup tools and Microsoft expression blend 4 + sketchflow. This vocabulary recognition application for children with hearing impairment implements three total communication namely sign video, finger alphabet and speech reading on the delivery of vocabulary recognition material. However, this application still has shortcomings because the tools used are outdated to be done on children with hearing impairment. It has not been able to display images or animations on the interface design, so it has not provided simplicity in vocabulary understanding, it is less interactive and it has less attractive features.

Previous research is on Sign Language Learning Applications for Hearing Speech impairment Using Android-based Image and Audio Visual Media. This research is in the form of Sign Language Learning Application for Hearing-Speech impaired Patients Using Android-Based Image and Audio Visual Media. It can provide information and learning and it can help users to get sign language learning, especially for word introduction. This application has weaknesses in the resulting video as the video is still less clear, lack of learning the words displayed, the menu design and application features are still not interesting, the
explanation of sign language is still in the form of images, quizzes provided by the application are less varied and not user friendly. Another research is about sign language learning application for hearing impaired people based on Android with the Bisindo method. In this research, it was built with a method of developing a multimedia system to produce multimedia-based products in the form of applications that can display learning and quizzes that are equipped with pictures, audio and sign language video. However, the application menu design is still standard and less attractive, bisindo letter video list view is less interactive and does not yet provide features that are actual and more informative, and the use of technology used is still not optimal for the innovation of a learning media (not actual).

Based on the problems above, the researchers provide the learning media system application with new media, namely myKadera (Knowing the Vocabulary Objects based on Augmented Reality). The application of augmented reality technology in the development of the Android-based myKadera system is seen from the features developed in the form of audio, sign language videos, 3D animations, and object vocabulary quizzes that are packaged in an interesting, applicable and innovative way with a more real-time visual display. It is the same with the provision of media vocabulary learning books which are supported by the help of AR (augmented reality) markers. MyKadera system is effective in the learning process and allows children to learn by looking at objects or two-dimensional images that are lifted up (augmented). This technology seems as if it eliminates the three-dimensional virtual world, integrated with the real world.

In the future, it is hoped that this system can become a breakthrough in the education world, especially for children with special needs to help to master the vocabulary of objects for hearing-impaired students. Generally, myKadera is expected to be an alternative for teachers as a learning media to help develop children's memory and as a relevant children's interactive media, as a learning resource for introductory learning to improve object vocabulary mastery of hearing-impaired children.

6. Conclusion
Based on the results of research and discussion, it can be concluded that the design of the myKadera system application can be used and has been running well on several android devices with different hardware versions and specifications. The myKadera system application is designed by utilizing augmented reality technology based on android in the introduction of object vocabulary to be more interesting, appropriate and innovative, because it can help hearing impaired children to recognize and see object vocabulary in real-time.

Based on the performance of the system developed, the myKadera application is feasible from the test results, through analyzing the quality of the application, the test results show that the functional suitability aspects of the application features have been successful and said to be good. Meanwhile, the compatibility aspect is very feasible because the application can run in conjunction with other applications. It can run on various operating systems and on various devices. In the aspect of performance efficiency, application is declared to be good without experiencing a memory leak or application damage resulting in force close or launch fail, with an average calculation of 0.013 second/thread time behavior, an average CPU usage of 20.39%, and average usage 13.08 MB memory.

Finally, the usability aspect test of the application has met the very feasible criteria with a percentage of 96.50%. Therefore, in general, it can be concluded that the application of the myKadera system is very interesting, easy to operate, efficient, innovative, and very suitable for use in the learning process for mastering vocabulary objects for hearing impaired students.

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