QUR'ANI: Assistive Technology Based on Android to Recite Qur'an for the Hearing Impaired Children

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Abstract: Reading the Al-Qur'an is an ability that must be possessed by every Muslim, including children with hearing impairments. Conventional learning and limited assistive technologies to aid them in reading the Al-Qur'an make it even harder for them to learn. This research is aimed to solve this problem by developing assistive technology in the form of an Android application. The result of this research is the QUR'ANI application composed of a menu of Arabic letters (hijaiyah), iqro parts 1-6, juz amma, evaluation, and about the application. This application uses the Indonesian sign language system and emphasizes the visual-oral approach as well as the application of the Maternal Reflective Method. Evaluations from experts in media, design, and materials indicate that QUR'ANI is considered to be good. General testing with students indicate that this application may be used for easy learning of the Al-Qur'an, but a number of dimensions of specific practice needs to be considered in the next stage of testing.

1 INTRODUCTION

Based on Law Number 12 of Year 2012, Islamic Religious Education (*Pendidikan Agama Islam* – PAI), which includes lessons on reading the Al-Qur'an, is a part of the National Education Curriculum in Indonesia. PAI is a required subject for every Muslim student, and students with hearing impairments in special education are no exception. Teaching children with hearing impairments is a serious issue (Sládek, Bednárová and Miléřa, 2011). Their inability to hear affects their difficulty in pronouncing letters, which becomes their primary impediment to be able to read well, let alone reciting the Al-Qur'an fluently (Ishak, 2016). Research conducted by (Kyle and Cain, 2015) also indicate that the reading ability of children with hearing impairments is lower in comparison to normal children of the same age. This condition demands a way of learning to read the Al-Qur'an that applies appropriate approaches and teaching strategies for students with hearing impairments (Ishak, 2016).

From the observation and interview carried out to student and teacher in a number of places for special education of hearing-impaired children indicate that teaching strategies for reading the Al-Qur'an for students with hearing impairments are still conventional in nature and invariant. Similarly, (Saari, 2012) who stated that teachers in special education of hearing-impaired children do not sufficiently implement varied strategies and almost in entirety use auditory methods in teaching the Al-Qur'an. These non-interactive strategies in conventional teaching have caused the learning motivation of children to remain low (Hussain *et al.*, 2014). In addition, conventional strategies will also add to the learning difficulties of children with hearing impairments (Shepherd and Alpert, 2015).

Some researches indicate that the low reading abilities of children with hearing impairments is also related to a low working memory (L. Hall and Bavelier, 2010; Nunes *et al.*, 2014; Kyle and Cain, 2015). Children with low working memory require teaching with a repetitive method (L. Hall and Bavelier, 2010; Nunes *et al.*, 2014). (Stinson, 2010; Debecv, Stjepanovič and Holzinger, 2014) explained in their researches that technology becomes the right solution to aid in a learning process that is appropriate to the characteristics of hearing-impaired children. In other researches such as (Shepherd and Alpert, 2015) showed that introducing technology to hearing-

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impaired children makes them more interested and active in learning.

In contrast with this solution, observations that the researcher conducted indicate that assistive technologies being used in teaching the Al-Qur'an in special education for children with hearing impairments are still insufficient. The lack of technological support in schools for hearing-impaired children in the learning of the Al-Qur'an is another very unfortunate fact (Ghadim *et al.*, 2013). This finding is reinforced by (Hussain *et al.*, 2014) who stated that teaching materials and learning aids in the field of Islamic studies for children with hearing impairments are still very much limited. As such, this research was conducted to provide a solution in the form of developing assistive technology for hearing-impaired children to be able to learn to read the Al-Qur'an.

Research on appropriate assistive technologies for hearing-impaired children had been done by (Kim *et al.*, 2017) showed that the majority of respondents in their research suggests that assistive technologies based on ICT and specifically mobile devices be developed. These results were also used as their basis in developing mobile applications specifically for people with hearing impairments. Another consideration why mobile applications need to be developed is because this kind of technology can very easily be used anytime and anywhere. This technology can also provide a learning resource that is appropriate and has been proven to be effective in aiding the learning process of children with hearing impairments (G. Ng'ethe, H. Blake and Glaser, 2015).

Research conducted by (Çuhadar and Odaba, 2009) indicate that mobile technologies are very helpful in aiding children with hearing impairments because these provide knowledge in a spoken manner and a better learning experience. In addition, it has also been reported that people with hearing impairments can utilize and require mobile phones as is the case with normal people (Nathan, Hussain and Hashim, 2016; Singleton *et al.*, 2018). Based on this explanation, it can be concluded that mobile applications are appropriate assistive technologies to be developed for hearing-impaired children (Yue and Zin, 2013; Cumming and Draper Rodríguez, 2017).

Many mobile applications specifically for people with hearing impairments have actually been developed, but special applications for learning the Al-Qur'an are still quite limited. Thus far, mobile applications for learning the Al-Qur'an specifically for children with hearing impairments have only been developed by (Hussain *et al.*, 2014) as the application mFakih on the Android platform, while a version for the iPad had previously been developed by ('Aziah, Jomhari and Zubi, 2012) as the application iFakih. Both of these applications utilize the FAKIH method which was developed by ('Aziah, Jomhari and Zubi, 2012); this method emphasizes the utilization of a system of numbers and colors in teaching the Arabic alphabet to hearing-impaired children.

The mFakih and iFakih applications have the potential to be made into alternative solutions to solve the problem of limited assistive technologies in the learning of the Al-Qur'an by hearing-impaired children in Indonesia. The two applications were developed using English and Malay as the languages of instruction, making them less fitting to be used in special education for children with hearing impairments in Indonesia. The use of foreign languages becomes a more serious obstacle because it makes children unable to interact with the assistive technology. Because of this, the development of a similar mobile application with Indonesian as the language of instruction needs to be done. The development of a mobile application with the Indonesian Sign Language (*Sistem Bahasa Isyarat Indonesia* – SIBI) has actually been conducted by (Iqbal, Supriyati and Listyorini, 2017); the application contains features for learning sign language and providing sign language translations of written texts, but is not specifically designed to aid in learning to read the Al-Qur'an. Thus, the development of QUR'ANI as an assistive technology in the form of a mobile application that uses SIBI becomes very important in increasing the interests of children with hearing impairments to learn to read the Al-Qur'an in special education in Indonesia.

QUR'ANI on the Android platform will provide a different learning experience compared to conventional learning. Learning which utilizes Android-based mobile applications will encourage and motivate children with hearing impairments to learn, as has been reported by (Yue and Zin, 2013). (Gardner, 2007; Carrió-Pastor and Mestre, 2014) stated that motivation is the primary aspect in learning, in particular in relation to learning to pronounce letters and words. Results of research conducted by (Saari, 2012) indicated that the most significant factor that affects the mastery of students with hearing impairments in learning the Al-Qur'an is self-factors, and thus instilling and increasing motivation through the facility of assistive technology is the most appropriate method to be used.

From the observation and interview also had been done by researcher indicated that students with hearing impairments consider that mobile

applications may be developed to aid them in learning to read the Al-Qur'an. Similar results were also found in a research conducted by (Ibrahim, Alias and Nordin, 2016) that students with hearing impairments possess positive attitudes toward technology by seeing that technologies, in particular mobile technologies, have a very important role in their learning. (Rekkedal, 2012) showed that the positive attitudes of hearing-impaired children toward assistive technologies is one of the most important aspects for increasing their use of assistive technologies. The positive attitudes that students already possess as target users with their hearing impairment is expected to aid in increasing their motivation to actively learn to read the Al-Qur'an using the QUR'ANI application.

2 METHOD

This research is a research and development (R&D). The development model used in this research is the waterfall model of (Sommerville, 2011), with the following stages. The first stage, "Requirements Definition", is the stage of analysis of software needs, which are adjusted to its users. Analysis of the needs of the QUR'ANI application was done by looking at the field conditions in a number of special education institutions for hard-of-hearing children on their methods of teaching the Al-Qur'an. Through the process of interview and direct observations of hearing-impaired children, a detailed picture is obtained regarding the specifications of the system that needs to be developed.

The second stage, "System and Software Design", covers the design of a prototype to allocate the needs of the QUR'ANI application such as hardware and software, creation of a wireframe, and design of the QUR'ANI application using Adobe Photoshop CS 7 by forming the architecture of the system in its entirety. Results of documentation of this stage cover a Usage Case Diagram in Figure 1 and Class Diagram can see in Figure 2.

The third stage, "Implementation and Unit Testing", is the stage of creating the application and writing the code to create the prototype design in the form of the Front End design of the application using XML. After the Front End design is completed, this is followed by writing the code for the program in Java using the IDE (Integrated Development Environment) of Android Studio 2.0. Testing involves the verification that each unit of the program fulfills the specifications.

The fourth stage, "Integration and System Testing", covers the union of the design and program units for the QUR'ANI application, which is then combined with other programs and tested as a complete system to ensure whether or not they are appropriate with the needs of the software. After going through this stage, the QUR'ANI application may be distributed to users in order to test the product. Testing of the system is composed of two parts, which are expert validation (by experts in design, media, material, and religion) and user testing. The media expert also conducts a testing technique using a black box to test the functionality of the system (the software engineering aspect).

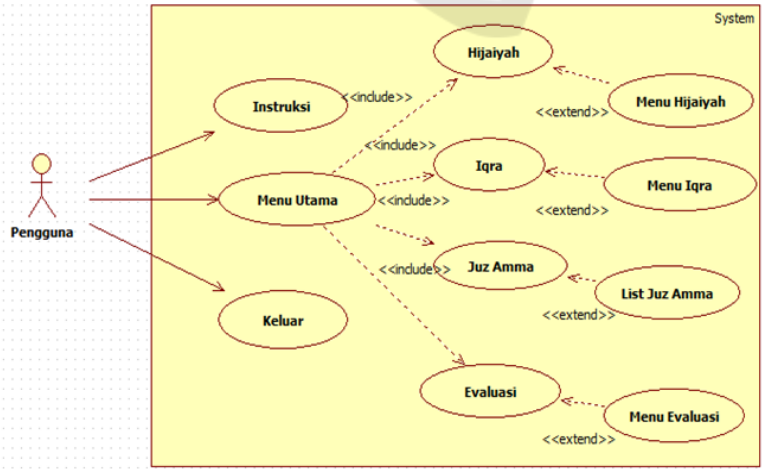

Figure 1: Use case diagram of QUR'ANI.

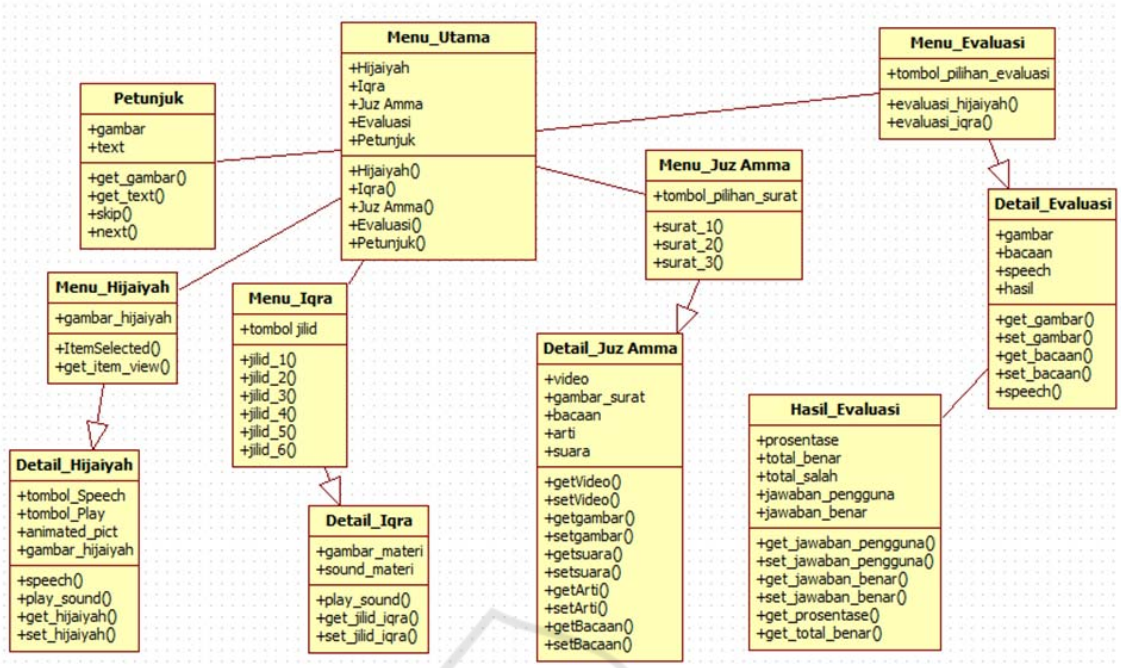

Figure 2: Class diagram of QUR'ANI.

The instruments used in testing the system are expert validation forms utilizing the Likert scale from 1-5 and student response questionnaires. Data in this research consist of both quantitative and qualitative data. Quantitative data were obtained from calculating the numerical average of every component of statements. Qualitative data were in the form of suggestions and commentary given by the experts and target users. Results from this testing would be used as a basis to implement a number of improvements for the QUR'ANI application.

The fifth stage, "Operation and Maintenance", covers the process of fixing errors that did not appear in previous stages and adjusting to the needs of users. Addition of another menu was also adjusted with the needs of users for application development, to enable them to more easily learn the Al-Qur'an.

3 RESULTS AND DISCUSSION

The resulting product of this research is the QUR'ANI application, which is developed to assist hearing-impaired children in reading the Al-Qur'an well. QUR'ANI is a mobile application on the Android platform with multimedia components that cover text, pictures, audio, animation, and video. Audio, video, animation, and text are a few of the important requirements that must be considered for a mobile application specially designed for children with hearing impairments (Nathan, Hussain and Hashim, 2016). The multimedia technology in this application is intended to be able to accommodate all learning styles of children with hearing impairments.

(Nathan, Hussain and Hashim, 2017) in their research discovered the fact that children with hearing impairments tend to require applications containing more pictures and multimedia content because it is easier for them to adapt with technology without being left behind. The same results were also discovered in a research conducted by (Liu *et al.*, 2010) that people with hearing impairments more often suggest video as an addition that could be inserted into an application. This indicates that visual orientation is very important in the design of a mobile application specific for individuals with hearing impairments. Results of research conducted by (Sládek, Bednárová and Miléřa, 2011) indicated that visual information has been proven to be more effective compared to information received through sound for children with hearing impairments. However, (Knoors and Marschark, 2014) explained that while children with hearing impairments possess the characteristic of not very much relying on hearing, this does not necessarily make them learners with a visual style rather than an auditory one. Findings of research by (Ibrahim, Alias and Nordin, 2016) also stated that hearing-impaired children prefer visual learning, but others also prefer learning through

verbal/auditory channels. This is what underlies our intention to still include audio content in the QUR'ANI application.

Although audio can be said to be less important in learning carried out by children with hearing impairments, audio content in this application is intended to provide greater access to children with only minor hearing impairments (who can still hear). (Motlhabi *et al.*, 2013; G. Ng'ethe, H. Blake and Glaser, 2015) also explained that audio is considered as a less important aspect, but adding audio content to an application can provide benefits for communication between people with hearing impairments and those with normal hearing. Visual and auditory content may also eliminate the "juggling" that many hearing-impaired students experience while learning in the classroom (Shepherd and Alpert, 2015).

The icon of the application can be seen in Figure 3. The splash screen (Figure 4) appears when the application is accessed and before entering the primary screen shown in Figure 5. On the primary screen, there are the menu items "Hijaiyah Letters", "Iqro Volume 1-6", "Juz Amma", "Evaluation", and "about the Application". The contents for each of these have unique and differing lessons that adjust to the needs of hearing-impaired children.

For the menu item "Hijaiyah" (Arabic Letters), the letters alif to ya', which number to 28 in the alphabet, is shown in Figure 6, where children will choose one of the letters to learn, alif being one example. The "Hijaiyah" menu is very important, because learning of the Al-Qur'an usually begins by learning the basics of the Arabic alphabet, or the consonants and vowels that make up the text of the Al-Qur'an. With this content, children will learn how to pronounce the letters by tapping the microphone button, which will then show the word being pronounced can see in Figure 7. The content is also supplemented by sounds that play and hand signs in the form of animations that appear on the screen. This speech-to-text system can increase the accessibility for hearing-impaired children (Subhaashini *et al.*, 2015). This system also allows the possibility for users to be able to interact with other people, including people with normal hearing, in a comfortable and efficient manner while using the application (Chiu *et al.*, 2010).

Figure 3: Icon.

Figure 4: Splash screen.

Figure 5: Primary screen.

Figure 6: Menu item "Hijaiyah".

Figure 7: Menu item "Hijaiyah" is supplemented by microphone and animation.

For the menu item "Iqro" (Readings), this is divided into "part 1 to 6" in Figure 8 where children will pick the content of one of the parts of Iqro 1-6; each part contains approximately 30 pages in Figure 9. The Iqro content is supplemented by a system of sounds and example signing animations. Animations are an important aspect that must be considered in developing an application specially designed for children with hearing impairments (Adamo-Villani, 2007). Results of a research conducted by (Nathan, Hussain and Hashim, 2016) showed that children with hearing impairments need applications that are eye-catching to them, and one of the criteria is animation. With the presence of animation, children will become interested to learn more actively with this application.

For the menu item "Juz Amma" in Figures 10, its content comprises short chapters of the Al-Qur'an with Arabic text, translation, and transcription in Roman script to make it easier for children to learn. The menu item is supplemented by video learning content integrated in the application (Figures 11). The advantage of these videos is that they are also supplemented with the Indonesian Sign Language, *Sistem Bahasa Isyarat Indonesia* (SIBI), which has been legalized by the Government of the Republic of Indonesia. This use of sign language is as a learning tool for memorizing and understanding the meaning of the Al-Qur'an with hand signs.

Findings of a research conducted by (Ibrahim, Alias and Nordin, 2016) showed that videos are a learning resource that is selected by a majority of children with hearing impairments. The use of videos for learning has been proven to be effective for hearing-impaired children (G. Ng'ethe, H. Blake and Glaser, 2015). (Ahmadi, Abbasi and Bahaadinbeigy, 2015) explained that the use of learning videos encourages hearing-impaired children to learn in an effective manner. Another advantage of the use of videos is that students who do not understand the material being delivered can repeat the videos to better understand them.

Although there are researches that suggest that learning to read the Al-Qur'an using sign language is hard to master by students who are hearing-impaired (Hussain *et al.*, 2014), this application still uses sign language. This research follows the findings of the research conducted by (Muhn and Juhn, 2015) that videos of sign language in special education for children with hearing impairments is very important. These findings are reinforced by (Ibrahim, Alias and Nordin, 2016) who indicated that a majority of students with hearing impairments prefer to use sign language in aspects of communication. Sign language is the most natural form of communication for many people in hearing-impaired communities. Sign language and the oral method are the most appropriate ways of communicating for children with hearing impairments (Kim *et al.*, 2017). As such, the videos in this application utilize sign-language translations in order to make it easy for children to understand their contents. Understanding of sign language is an important predictor of the understanding of texts by children with hearing impairments (Dockery, 2013).

Figure 8: Menu item "Iqro".

Figure 9: Menu item "Iqro" each part.

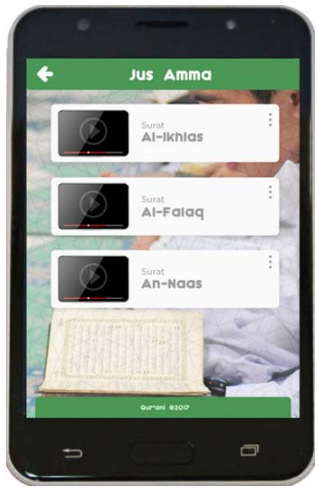

Figure 10: Menu item "Juz Amma".

Figures 11: Menu "Juz Amma" with Video.

Figure 12: Menu item "Evaluation".

Figures 13: Result of evaluation.

The menu item "Evaluasi" (Evaluations) contains 2 kinds of evaluations, which are "Hijaiyah" and "Iqro" in Figure 12; these evaluations utilize the system of speech recognition, where the system of sound input becomes a good oral learning tool for hard-of-hearing people to instill habits. This content will train children to speak, and at the end of a lesson an evaluation will appear for the results and spoken answers seen in Figure 13. This content facilitates the application of the Maternal Reflective Method (MRM) as special learning for hearing-impaired children, which prioritizes the repetition of words. (Ishak, 2016) explains that children with hearing impairments always ask for the repetition of words and have problems in speaking and so they need access to communication in order to be able to read the Al-Qur'an. This menu can also optimize access to communication for them. This method has also been proven to be able to train the speaking abilities of children with hearing impairments in an effective manner (Prasetyo, 2017).

Results of expert evaluation showed an average media score between 4.7-5.0 (Table 1), an average design score between 4.3-4.8 (Table 2), and an average material score between 4.5-5.0 (Table 3). Expert evaluation showed that the QUR'ANI application is considered to be very good in terms of media, design, and material.

The practicality of the QUR'ANI application was tested by 5 hearing-impaired students and 1 teacher at the Yayasan Pendidikan Tunas Bangsa (YPTB) Malang, where it was shown that the QUR'ANI application could be easily used by both students and teachers. The students appeared to be enthusiastic in learning how to read Arabic Letters using the QUR'ANI application. When the students and teachers were interviewed for their opinions about the application, in general they stated their appreciation: "Cool… good… it makes me more spirited to learn" (Student)

Table 1: Data of expert appraisal of media.

Criteria of validity	Expert 1	Expert 2	Qualification
Software engineering	4.9	5.0	Very good
Speech Recognition	4.7	5.0	Very good

Table 2: Data of expert appraisal of design.

Criteria of validity	Expert 1	Expert 2	Qualification
Illustration	4.6	4.7	Very good
Visual communication	4.3	4.8	Very good

Table 3: Data of expert appraisal of material.

Criteria of validity	Expert 1	Expert 2	Qualification
Instruction	4.5	4.8	Very good
Substance of matter	5.0	5.0	Very good

"QUR'ANI is very interesting…visualization is very important for communication with students who possess hearing impairments…this media will also further motivate them to learn; on the other hand, this media provides us a solution to overcome the limitations of other media that are used in teaching them how to read the Al-Qur'an, and so we can reduce the amount of conventional learning" (Teacher)

The limitations in this research are the limited test subjects available for testing, and that the testing had not considered the background of the students. (Dammeyer, Lehane and Marschark, 2017) explained that differences in the usage of technology by children with hearing impairments is very much related to age, level of hearing loss, the mode of communication between children and adults, gender, and the level of education that the adults possess. At this stage of testing, students were still limited in their usage and pronunciation of the Arabic letters, without paying attention to their fluency. Fluency is an important aspect of teaching how to read, and this has not been fully explored in the field of educating students with hearing impairments. Reading fluency contributes to the abilities of hearing-impaired students to achieve a reading level that is equivalent to their colleagues with normal hearing (Luckner and Urbach, 2012).

Evaluation of the usability of the application for children with hearing impairments is usually conducted generally without paying attention to a number of specific and further-detailed criteria. This causes a number of applications that have been developed to be unable to some portion. The development stage of the QUR'ANI application has reached the stage of expert evaluation and testing, but the testing is still very much general. The next stage to be done is conducting tests that pay attention to a number of dimensions of application practicality for children with hearing impairments as described by

(Nathan *et al.*, 2017), which cover efficiency, satisfaction, ease, effectiveness, and accessibility. In addition, we would also like to pay attention to the backgrounds of students and their level of fluency in reading.

4 CONCLUSION

This research has succeeded in developing the QUR'ANI application especially for children with hearing impairments to learn to read the Al-Qur'an. QUR'ANI emphasizes on the visual and oral aspects, which will provide greater accessibility to hearing-impaired children. The Maternal Reflective Method can also be applied in this application with the presence of speech recognition content. This application has been validated by a number of experts and has been tested out on students; in general, the results showed that this application can be used to teach how to read the Al-Qur'an to students with hearing impairments.

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