

Development of Augmented Reality Technology as an Android-Based Learning Medium for Hijaiyah Letters and Makharijul Huruf (Case Study: SD IT Cendekia Darussalam)

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ARTICLE INFORMATION

Received: February 00, 00
Revised: March 00, 00
Available Online: April 00, 00

KEYWORDS

Augmented Reality, Learning Media, Hijaiyah Letters, Makharijul Letters, Android

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ABSTRACT

The Quran is the holy book for Muslims, serving as a vital guide for all aspects of life, including education. Proficiency in reading the Quran is cultivated from an early age, particularly among primary school students, who require mastery of Hijaiyah letters, correct articulation points (makhraj), and the proper application of *Tajwid* rules. However, implementation faces several challenges, such as a lack of innovative teaching aids, limited visualization capabilities, and waning student enthusiasm amidst rapid technological advancements. This study aims to develop an interactive learning tool utilizing augmented reality (AR) technology to assist students in recognizing Hijaiyah letters and understanding their pronunciation through the ABATA method. The study employs the Research and Development (R&D) approach using the ADDIE model, limited to the development stage. Results indicate that the analysis stage identified a student need for interactive visual media; the design stage successfully produced a storyboard and application interface design; and the development stage yielded an Android-based application capable of displaying 3D visual representations of Hijaiyah letters accompanied by audio demonstrating correct articulation (makhraj). Validation by media and subject matter experts awarded the product a 100% feasibility rating ("highly feasible"), a result supported by highly positive feedback from 22 student users via questionnaires. Integrating AR technology proved effective in stimulating interest and enhancing student understanding regarding letter shapes and pronunciation accuracy. Consequently, AR-based learning media holds significant potential as an innovative alternative to support an enjoyable Quran learning experience at the primary education level.

INTRODUCTION

As divine revelation revealed to the Prophet Muhammad (peace be upon him), the Quran holds a central place in the lives of Muslims. This holy book serves as a comprehensive guide governing human relationships with God, with others, and with the surrounding environment.[1] Composed in Arabic with unparalleled literary excellence, the Quran consists of 30 chapters, 114 suras, and 1,236 verses. The first verse revealed is Surah Al-Alaq, verses 1-5, which explicitly commands humans to read and seek knowledge. This emphasizes that reading and learning are the primary foundations for deepening Islamic teachings, particularly through Quranic study.

The importance of Quranic education is also legitimized by Indonesian government regulations, including Government Regulation No. 55 of 2007 concerning religious education and religious studies.[2] This regulation opens up space for the implementation of formal and informal Quranic education, with a curriculum that can be adapted to the context and needs.[3] In its application, learning to read the Koran includes two main elements, namely recognition of the hijaiyah letters, understanding the makhoriul letters and mastery of the rules of tajwid as the foundation for good and correct reading competence[4]

Even so, the implementation of Al-Quran teaching at the primary education level still faces a number of significant obstacles. One of the main problems that often arises is the lack of learning facilities that can adapt to technological advances that attract the attention of students today [5]. Teaching methods that still rely on print media and blackboards are considered less capable of generating learning motivation [6]. Apart from that, the lack of adequate visualization regarding the shape of the hijaiyah letters and their pronunciation is an obstacle in understanding the makhoriul letters accurately [7]. The ability to read the Al-Quran is not only influenced by internal aspects of students, such as interest, enthusiasm, and language skills, but is also greatly influenced by external aspects such as teaching methods and the quality of the media used.[8] Therefore, innovation in the development of learning tools is very necessary to create a learning atmosphere that is more effective, interactive, and enjoyable for students.[9]

In line with rapid progress in the fields of science and technology, the integration of digital technology in the world of education has now become a necessity. Among various promising technological innovations, Augmented Reality (AR) appears as a relevant option to be applied in a learning context [10]. AR technology can combine virtual elements with the real world directly, providing a more immersive learning experience and increasing user participation [11]. In the Al-Quran learning process, the use of AR provides the ability to see the hijaiyah letters in three dimensions, complete with a pronunciation guide, so that students can more easily understand the makhoriul letters correctly and accurately.[12]

Regarding this problem, this study is aimed at creating a tool for learning hijaiyah letters and makhoriul letters using Augmented Reality technology with the ABATA method approach.[13] The resulting tool is expected to be able to increase enthusiasm for learning and provide a more interactive, effective and enjoyable learning experience for students at the elementary school level. Through this research, it is hoped that there will be real developments for innovation in sustainable digital technology-based Al-Quran learning media [14].

METHOD

This research uses a combination approach with research and development (RandD) methods. This method combines quantitative and qualitative techniques to gain more complete insight into the process of creating and assessing learning media. Quantitative techniques are used to analyze data obtained from media validation, material validation, and responses from users via questionnaires using a Likert scale. Meanwhile, qualitative techniques are used to evaluate the results of observations, interviews with teachers, and feedback from validators with the aim of improving the product being developed. This approach was taken because it corresponds to the steps of design, development and testing of educational products in real learning contexts.

The development model used in this research is the ADDIE model, which consists of five sequential stages, namely Analysis, Design, Development, Implementation and Evaluation. However, in this research, the development stage was only carried out up to the Development phase, so the Implementation and Evaluation stages were not carried out thoroughly. The ADDIE model was chosen because it provides a work process that is organized, systematic, and focuses on the needs of users, especially students at SD IT Scholar.

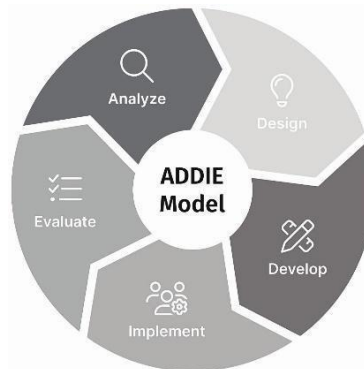


Figure 1. ADDIE Model

In this study, participants included a media expert, a content expert, and twenty-two fifth-grade students at SD IT Cendekia Darussalam who participated in testing the learning media. The focus of this study was educational media about the hijaiyah letters and makhorijul huruf based on Augmented Reality created by the researcher.

RESULTS AND DISCUSSION

The results of this study produced a product in the form of learning media for hijaiyah letters and makhorijul letters based on Augmented Reality, aimed at 22 class V students at SD IT Scholar Darussalam. The media created aims to increase students' understanding of the introduction of hijaiyah letters and the pronunciation of makhorijul letters in an interactive and interesting way. The media development process was carried out using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), but in this research, the development stage was only carried out up to the Development stage, without continuing to the Implementation and Evaluation stages. The stages carried out are as follows:

Analysis

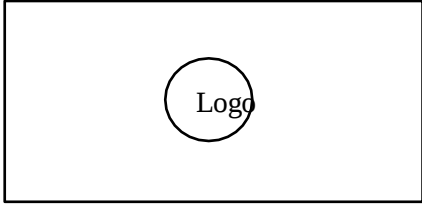
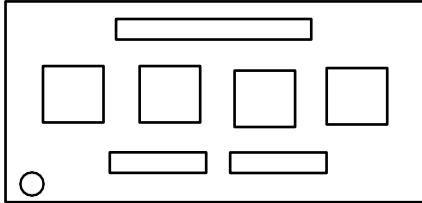
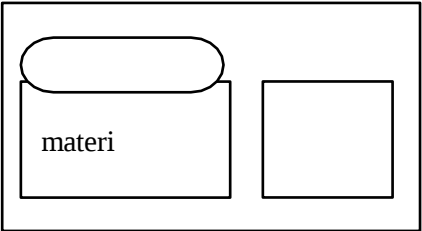
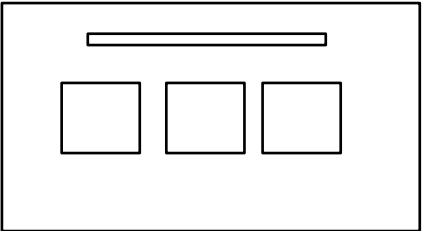
In the initial phase of the ADDIE model, a needs analysis was carried out to find the main problems that emerged in the process of learning hijaiyah letters and makhorijul letters at SD IT Scholar Darussalam. This analytical data collection was carried out through direct observation in the classroom to see the conditions, environment and atmosphere of student learning when Al-Quran material was taught. Observation results show that daily learning methods still use traditional media such as printed books and lecture methods. Even though teachers sometimes use more interactive approaches such as group division, quizzes, or educational games related to hijaiyah letters, there is still very little variation in the use of visual media. One of the main challenges found is the long-term use of print media, which makes students feel bored and reduces their interest in learning due to the lack of interesting visual stimulation.

As support for the results of these observations, flexible in-depth interviews without rigid measuring instruments were also conducted with the teacher who taught the class. The questions in this interview focus on the dynamics of the learning atmosphere in the classroom and the concrete challenges faced by teachers when teaching makhorijul letters to students. The interview results support data from observations where teachers admit that the lack of new learning media is the main reason students quickly feel bored. Repetitive learning without technological updates makes students less able to explore their visual depiction abilities of letter shapes and pronunciation accuracy. By synchronizing information from observations and interviews, it was concluded that there was an urgent need for alternative learning media in this class. Therefore, this research focuses on the development and introduction of the latest interactive media based on Augmented Reality (AR) to explore new learning experiences, increase active student participation, and facilitate concrete understanding of hijaiyah letters and makhorijul letters for fifth grade students at SD IT Scholar Darussalam.

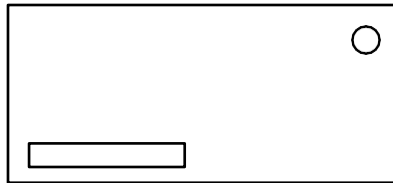
Design

At this stage the focus is on preparing learning content, creating storyboards, and designing an attractive and user-friendly application interface. At this stage, the application flow is also determined, and the creation of a page that can access the camera for scanning barcodes as a medium for displaying Augmented Reality objects.

Table 1. AR Learning Media Storyboard

No.	Object	information
1.	Opening Page	Displays the logo of the application.
		
2.	Main menu	There are several menu options: Study Hijaiyah Letters, Study Makhraj Letters, Pracite, Scan barcodes, recognizer Hijaiyah letter and their pronuncitation which can make sound and aplication Information
		
3.	Barcode Scan Feature (AR Marker)	Student direct their cellphone cameras to a barcode or special marker printed on the paper.When the barcode is successssfully detected, the hijaiyah letters will appear in 3D format.
		
4.	Introduction to the hijaiyah letters	Display an explanation of material regarding Makhraj along with a description of the makhraj letters.
		
5.	Exercises	Questions to match letters with sounds or makhraj images. The answers given immediately get feedback whether they are right or wrong.
		

8. Cover page



Congratulations, encouragement to continue studying the Koran, and a button to return to the main menu and repeat the exercise.

Development

This stage is the phase of realizing the design into a functional Android application by utilizing Unity as the main development platform, Meshy AI for creating 3D object assets, and Worldcast for creating functional Augmented Reality. The resulting product is an AR application that is ready to enter the testing stage.



Figure 2. Creating an Android-based application in Unity

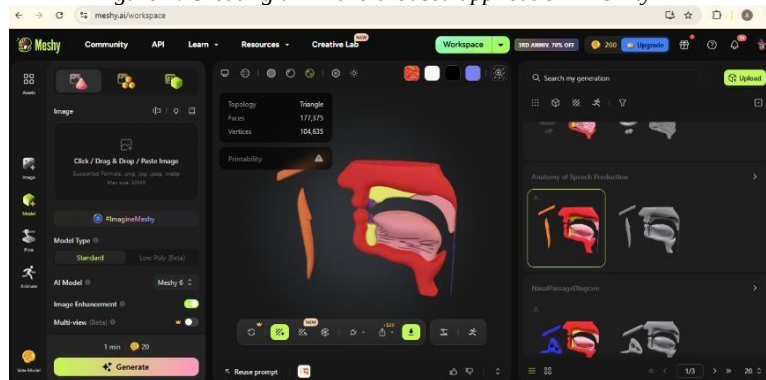


Figure 3. 3D rendering using Meshy AI



Figure 4. Process of creating markers and QR codes in Worldcast

The interface of the developed application is presented in several pictures. The main page, learning menu, and AR-based hijaiyah letter object visualization are shown in Figures 5 to 13.



Figure 5. Application Logo Display



Figure 6. Main menu page



Figure 7. Page for Learning Makhraj Letters



Figure 8. Makhraj Letter Material Page



Figure 9. Practice Question Page



Figure 10. Question Page 1



Figure 11. Hijaiyah Letter Learning Page



Figure 12. Audio page for Hijaiyah letters



Figure 13. Barcode Scan Page



Figure 14. Media trial with fifth grade students of SD IT Cendikia

Implementation

The implementation phase was not carried out in its entirety in this study. The product was only tested on a limited basis with several students to provide a different learning experience, without being fully implemented in routine classroom learning activities.

Evaluation

The assessment stage is carried out on a limited basis to assess the extent of user suitability and reactions to the media, not to evaluate the effectiveness of learning as a whole. This assessment is based on validation results from media experts and material experts, as well as input from students via a questionnaire using a star symbol scale. This star symbol scale is a variation of the Likert scale created by Rensis Likert, where the star symbol functions as a visual representation of the level of assessment given by respondents to facilitate understanding, especially for elementary level students.

Data Analysis Techniques

Information analysis in this study was conducted using two methods: qualitative and quantitative. Qualitative methods were applied to describe the results of observations, interviews, and responses and input from validators to refine the learning media created.

Quantitative analysis was conducted on data derived from validation questionnaires conducted by media experts, subject matter experts, and user responses. The data was analyzed by calculating the scores obtained and converting them into percentages using the following formula.

$$P = \frac{f}{n} \times 100\%$$

Description:

P = Percentage of eligibility

f = Total score obtained

n = Maximum score

The percentage results are then classified into eligibility categories as follows:

Table 2. Results of media expert validation test

Percentage(%)	Category
81–100%	Excellent
61–80%	good
41–60%	Fair
21–40%	Poor
0–20%	Not good

After the preparation of the teaching media is complete, the next step is to test the suitability of the media through evaluation by material experts and media experts. This evaluation aims to evaluate the quality of the content, design and performance of the media that has been created.

Media Expert Validation results

Validation by media experts is carried out to evaluate interface display elements, visual quality, navigation methods, and the performance of Augmented Reality features in the learning media created.

Table 2. Results of media expert validation test

No	assessment aspects	Score
1	Visual Appearance (Attractiveness)	5
2	AR visual quality	5
3	Function Buttons and Menu (Navigation)	5
4	Performance of Augmented Reality Feature	5
5	Feasibility of Educational Media	5
Total Score		25
Maximum Score		25
Average		5,00
Percentage		100%
Category		Very good

Based on Table 2, the total score obtained is 25 out of a maximum of 25 with an average value of 5.00. The eligibility percentage received is 100%, which is included in the very good category. This shows that the learning media that has been developed meets all aspects of feasibility in terms of appearance, visual quality, button and menu functions, as well as the performance of the Augmented Reality feature. Attractive interface design and ease of navigation are important elements that support user comfort. Apart from that, the functioning of the AR feature that runs smoothly shows that this media is technically ready to be used as a technology-based learning media.

Material expert validation results

Validation by experts is carried out to evaluate the extent to which the material is in accordance with the curriculum, the accuracy of the concept of mahorijul letters, and how easy it is for students to understand the material.

Table 3. Results of the material expert validation test

No	Assesment aspects	Score
1	Curriculum suitability	5
2	Accuracy of Makhorijul Letter Concept	5
3	Clarity/Ease of Understanding the Material	5
4	Student Learning Experience (Learning Experience)	5
5	Instructional/Learning Feasibility	5
Total Score		25
Maximum Score		25
Average		5,00
Percentage		100%
Category		Very good

Based on information from Table 3, the total score obtained is 25 out of the highest score of 25 with an average of 5.00. The feasibility level reaches 100% and is in the very good category. This shows that the material delivered through learning media is in accordance with the curriculum, has the correct concepts, and is easy for students to understand. Furthermore, the material provided is considered capable of supporting learning objectives and providing a better learning experience. This shows that the combination of material content and AR technology has been made well according to the learning needs of students at the elementary school level.

User response results

The trial was carried out on 22 fifth grade students at SD IT Scholar Darussalam to assess user responses to the Augmented Reality-based hijaiyah and makhorijul letter learning media that had been developed. The tool used is a questionnaire with a Likert scale of 1–5 using a star symbol, where a value of 1 means strongly disagree and a value of 5 means strongly agree.

Table 4. Distribution of User Response Scores Per Person

No	Respondent Code	Questio n 1	Questio n 2	Questio n 3	Total Score Obtained	Maximum Score
1	Hanifa Inaya	5	5	5	15	15
2	Abdillah	5	5	5	15	15
3	Felisha Bikrum Sakhi	5	4	5	14	15
4	Danish Ahmad Sudirman	5	5	5	15	15
5	Adly Fairuz	5	5	5	15	15
6	Qurratu	4	5	5	14	15
7	M. Farid Atalla Surbakti	5	5	5	15	15
8	Dzukran Arifin Pasaribu	5	5	5	15	15
9	Syakira Nabila	5	5	5	15	15
10	Hilwa Humaira Amroe	5	5	5	15	15
11	Achmad Kurbatin Tanfi	4	5	5	14	15
12	Rafa	5	5	5	15	15
13	M.Azzam Sharkan Ghazali	5	5	5	15	15
14	Syakira Nabila	5	5	5	15	15
15	Muhammad Adam Naufal	5	5	5	15	15
16	Anindita Keysha Azzahra	5	4	5	14	15
17	Annisa Luthfia	5	5	5	15	15
18	Muhammad Raziq Alfata	5	5	5	15	15
19	Naura Izzati	5	5	5	15	15
20	Zabid	5	5	5	15	15
21	Nur Akifah	5	5	5	15	15
22	Muhammad Abizar	5	5	5	15	15
Total	TOTAL NUMBER	108	108	110	321	330

Table 5. Summary of User Respondent Test Results

No.	Statement	Max Score	Acquisition Score	Percentage	Category
1.	Augmented Reality based learning media easy to use by students	110	108	98,18%	Very good
2.	Media helps students understand hijaiyah letters and makhorijul letters	110	108	98,18%	Very good
3.	Learning uses Augmented Reality media feels more exciting and interesting	110	110	100%	Very good
Total		330	326	98,78%	Very good

Lembar penilaian
 Nama: Syakira Nabila
 Petunjuk:
 Lingkari atau warnai bintang sesuai perasaan kamu ya

1. Apakah media ini mudah digunakan?
 ★ ★ ★ ★ ★

2. apakah pembelajarannya mudah dipahami?
 ★ ★ ★ ★ ★

3. Apakah seru belajar menggunakan media ini
 ★ ★ ★ ★ ★

Figure 14. Questionnaire sheet with star symbol

The results of the response test show that for the first statement a score of 108 out of a maximum of 110 was obtained with a percentage of 98.18%, the second statement received a score of 108 out of 110 with a percentage of 98.18%, and the third statement achieved a perfect score of 110 out of 110 with a percentage of 100%. Overall, the total score obtained was 326 out of a maximum score of 330 with a percentage of 98.78%, so that the learning media developed can be categorized as very good and received very positive responses from students.

CONCLUSION

Based on the studies that have been carried out, it can be concluded that the development of learning media using Augmented Reality (AR) for teaching hijaiyah letters and makhoriul letters based on Android has been successful using the ADDIE model. The resulting media is able to present hijaiyah letters in a three-dimensional (3D) visual format which is equipped with audio pronunciations and animated makhoriul letters, thus creating a more interactive and interesting learning experience for students.

The results of the assessment by media and material experts show that the media created has a very good feasibility level with a percentage of 100%. This shows that this media meets the standards for display quality, functionality, and conformity with the curriculum and concept of makhoriul letters. Apart from that, the results of the user response test involving 22 students also showed the very good category, which shows that this media is easy to use, helps understand the material, and provides an enjoyable learning experience.

Thus, the Augmented Reality-based learning media that has been developed can be used as an innovative alternative to support the process of learning hijaiyah letters and makhoriul letters at the elementary school level, especially in improving students' learning experiences.

ACKNOWLEDGMENT

The author would like to express his deep gratitude to all parties who have supported the implementation of this research. Special gratitude goes to SD IT Scholar Darussalam for providing permission and the opportunity to conduct research.

The author also appreciates the role of fifth grade teachers and students who have contributed as research subjects, so that the data collection process can be carried out well.

In addition, the author would like to express his gratitude to the supervisor who has provided guidance, suggestions and direction during the research process and preparation of this article.

Hopefully the findings of this research can make a positive contribution to the development of technology-based learning media, especially in teaching hijaiyah letters and makharijul letters.

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