

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

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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 (makhras), 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 (makhras). 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 makhorijul letters and mastery of the rules of tajwid as the foundation for good and correct reading competence[4]

Despite this, the implementation of Quranic teaching at the elementary school level still faces a number of significant obstacles. One major problem that frequently arises is the lack of learning resources that can adapt to the technological advances that attract students today.[5] Teaching methods that still rely on print media and blackboards are considered inadequate in fostering learning motivation.[6] Furthermore, the lack of adequate visualization of the hijaiyah letters and their pronunciation poses a barrier to accurately understanding the letter patterns.[7]

The ability to read the Quran is not only influenced by internal aspects of the student, such as interest, enthusiasm, and language skills, but also by external aspects such as teaching methods and the quality of the media used.[8] Therefore, innovation in the development of learning tools is essential to create a more effective, interactive, and enjoyable learning environment for students.[9]

In line with rapid advances in science and technology, the integration of digital technology into education is now a necessity. Among the various promising technological innovations, Augmented Reality (AR) is emerging as a relevant option for implementation in learning contexts.[10] AR technology can directly combine virtual elements with the real world, providing a more immersive learning experience and increasing user participation.[11] In the Quran learning process, the use of AR provides the ability to view the hijaiyah letters in three dimensions, complete with pronunciation guides, so students can more easily understand the letters' pronunciation correctly and accurately.[12]

Regarding this issue, this study aims to create a learning tool for the hijaiyah letters and pronunciation using Augmented Reality technology using the ABATA method.[13] The resulting tool is expected to increase enthusiasm for learning and provide a more interactive, effective, and enjoyable learning experience for elementary school students. This research is expected to lead to tangible developments in sustainable innovations in digital technology-based Quran learning media.[14]

METHOD

This research employed a combined approach with research and development (R&D) methods. This method combines quantitative and qualitative techniques to gain a more comprehensive understanding of the learning media creation and evaluation process.

Quantitative techniques were used to analyze data obtained from media validation, material validation, and user responses using a Likert-scale questionnaire. Meanwhile, qualitative techniques were utilized to evaluate the results of observations, teacher interviews, and validator feedback with the aim of improving the product being developed. This approach was chosen because it aligns with the design, development, and testing steps of educational products in real-life learning contexts.

The development model used in this research is the ADDIE model, which consists of five sequential stages: Analysis, Design, Development, Implementation, and Evaluation. However, in this study, the development stage was only implemented up to the Development phase, so the Implementation and Evaluation stages were not fully implemented. The ADDIE model was chosen because it provides an organized, systematic work process that focuses on the needs of users, particularly students at SD IT Cendekia.

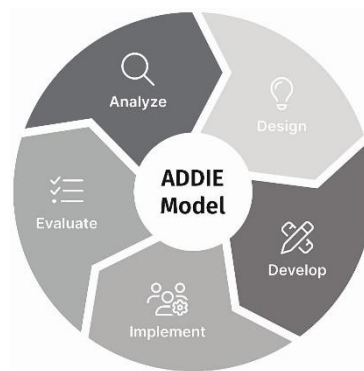


Figure 1. ADDIE Model

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, intended for fifth grade students of SD IT Cendekia Darussalam. The media created aims to improve 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 study, the development stage was only carried out up to the Development stage, without continuing to the Implementation and Evaluation stages. The stages implemented are as follows:

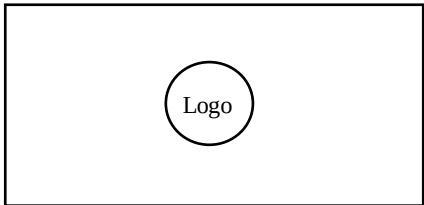
Analysis

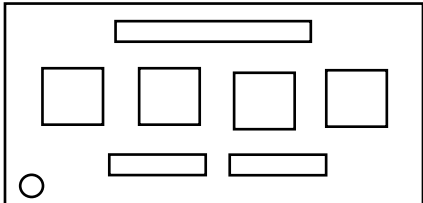
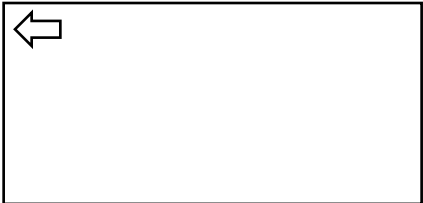
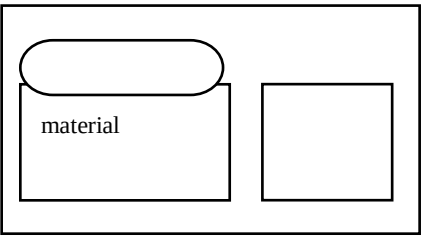
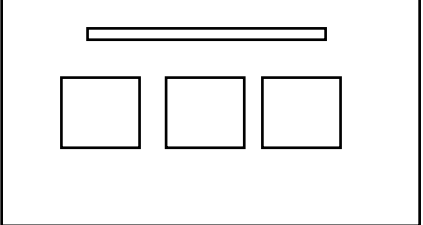
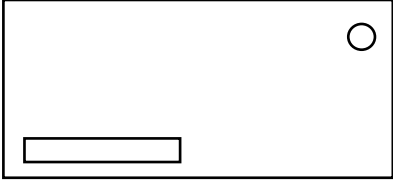
This study was conducted to map specific needs in the learning of the Hijaiyah alphabet and the Makharijul Huruf in elementary schools. This process was conducted through direct observation in grade 5 of SD IT Cendekia Darussalam, observing how learning takes place and the learning media commonly used. Furthermore, interviews with teachers were conducted to identify current teaching methods, challenges, and obstacles experienced by students.

Design

This stage focuses on developing learning content, creating storyboards, and designing an attractive and user-friendly application interface. The application flow is also defined and pages are created that can access the camera for barcode scanning 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 course 	There are several menu options: Learning Hijaiyah Letters, Learning Letter Makhraj, Practice, Scan Barcode, Hijaiyah letter recognition and pronunciation which can produce sound and Application Information.
3. Barcode Scan Feature (AR Marker) 	Students point their phone cameras at a barcode or special marker printed on a piece of paper. When the barcode is successfully detected, the Hijaiyah letters appear in 3D.
4. Introduction to Makhrijul Huruf 	Displays an explanation of material regarding makhraj along with a description of the makhraj letters.
5. Exercises 	Questions to match letters to sounds or images of makhraj. Answers given receive immediate feedback as to whether they are correct or incorrect.
8. Closing Page 	Congratulations, encouragement to continue studying the Qur'an, and a button to return to the main menu and repeat the exercise.

Development

This stage is the realization of the design into a functional Android application, utilizing Unity as the primary development platform, Meshy AI for 3D object asset creation, and Worldcast for functional Augmented Reality. The resulting product is an AR application ready to enter the testing phase.



Figure 2. Creating an Android-based application in Unity

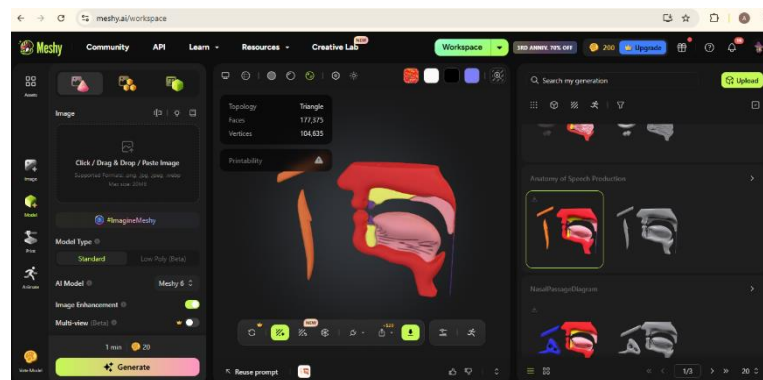


Figure 3. 3D rendering using Meshy AI

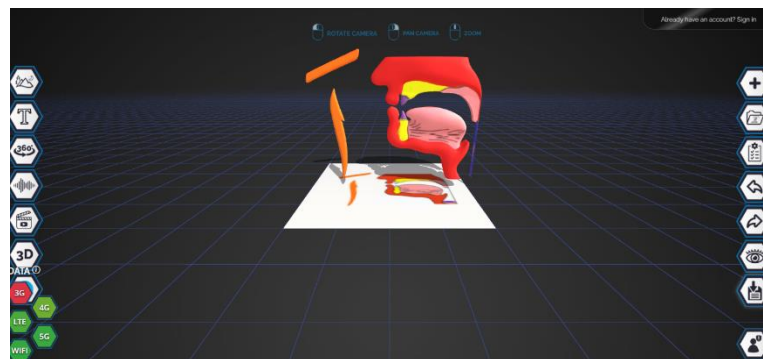


Figure 4. Process of creating markers and QR codes in Worldcast

The interface of the developed application is presented through several images. The main page, learning menu, and AR-based visualization of the Hijaiyah letter objects are shown in images 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 of Hijaiyah Letters



Figure 13. Barcode Scan Page

Implementation

The implementation phase was not fully implemented in this study. The product was only piloted on a limited basis with a few students to provide a diverse learning experience, without being fully implemented in routine classroom activities.

Evaluation

The evaluation phase was conducted on a limited basis to assess the suitability and user reactions to the media, not to evaluate the overall effectiveness of the learning. This assessment was based on validation results from media and content experts, as well as student input through a questionnaire using a star-shaped scale. This star-shaped scale is a variation of

the Likert scale created by Rensis Likert, where the star-shaped scale serves as a visual representation of the level of assessment given by respondents to facilitate understanding, especially for elementary 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 the following eligibility categories:

Persentase (%)	Category
81–100%	Very Good
61–80%	Good
41–60%	Fair
21–40%	Not Good
0–20%	Not Good

Once the instructional media is developed, the next step is to test its suitability through evaluation by subject matter and media experts. This evaluation aims to assess the quality of the content, design, and performance of the media.

Media Expert Validation results

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

Table 2. Results of media expert validation test

No	Assessment Aspects	score
1	The learning media display is attractive	5
2	The AR visual quality is clear	5
3	The buttons and menus function properly	5
4	The Augmented Reality feature functions properly	5
5	The media is suitable for use as an educational tool	5
Total Score		25
Maximum Score		25
Average		5,00
Percentage		100%
Category		Very good

Based on Table 2, the total score obtained was 25 out of a maximum of 25, with an average score of 5.00. The feasibility percentage received was 100%, which is included in the excellent category. This indicates that the developed learning media meets all feasibility aspects in terms of appearance, visual quality, button and menu functions, and Augmented Reality feature performance.

An attractive interface design and easy navigation are crucial elements for user comfort. Furthermore, the smooth functioning of the AR features demonstrates that this medium is technically ready for use as a technology-based learning tool.

Material expert validation results

Validation by experts was carried out to evaluate the extent to which the material was in accordance with the curriculum, the accuracy of the makhorijul huruf concept, and how easily students understood the material.

Table 3. Results of the material expert validation test

No	Assessment Aspects	Score
1	Suitability of the material to the curriculum	5
2	Correctness of the makhorijul huruf concept	5
3	Ease of understanding the material	5
4	Supports students' learning experiences	5
5	Suitability for use in learning	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 was 25 out of a maximum score of 25, with an average of 5.00. The feasibility level reached 100% and falls into the very good category. This indicates that the material presented through the learning media aligns with the curriculum, has sound concepts, and is easily understood by students.

Furthermore, the material provided was deemed capable of supporting learning objectives and providing a better learning experience. This demonstrates that the integration of content and AR technology has been well-designed to meet the learning needs of elementary school students.

User response results

A trial was conducted on 22 fifth-grade students at SD IT Cendekia Darussalam to assess user responses to the augmented reality-based learning media for the hijaiyah and makhorijul huruf. The tool used was a questionnaire with a Likert scale of 1–5, where a score of 1 means strongly disagree and a score of 5 means strongly agree.

Table 4. Results of the user respondent test of 22 students

No.	Statement	Max Score	Earned Score	Percentage	Category
1.	Augmented Reality-based learning media is easy for students to use.	110	104	94,55%	Very good
2.	The media helps students understand the hijaiyah and makhorijul letters.	110	107	97,27%	Very good
3.	Learning using Augmented Reality media feels more exciting and engaging.	110	110	100%	Very good
Total		330	321	97,27%	Very good

The results of the response test show that for the first statement, a score of 104 was obtained from a maximum of 110 with a percentage of 94.55%, the second statement obtained a score of 107 from 110 with a percentage of 97.27%, and the third statement achieved a perfect score of 110 from 110 with a percentage of 100%. Overall, the total score obtained was 321 from a maximum score of 330 with a percentage of 97.27%, so that the developed learning media can be categorized as very good and received very positive responses from students.

DISCUSSION

Based on the results of the study, the designed Augmented Reality-based learning media demonstrated excellent feasibility in terms of both media and content. Validation by media experts and material experts, which achieved a 100% score, confirmed that this media met the quality standards required for the teaching and learning process.

In terms of media, an attractive interface design, easy navigation, and functional Augmented Reality features were key factors contributing to the success of this media. This demonstrates that interactive media design can enhance user experience during the learning process.

In terms of content, alignment with the curriculum and the accuracy of the makhorijul huruf concept were key factors supporting the quality of learning. The material provided was not only conceptually correct but also easy for elementary school students to understand. This demonstrates that the developed media has successfully combined technology with learning content effectively.

The results of user feedback tests also showed that this learning media received very positive reactions from students. High student approval for ease of use, understanding of the material, and enjoyment of learning indicate that the use of Augmented Reality technology can increase student engagement in the learning process.

These findings align with multimedia learning theory, which suggests that the combination of visuals and audio can improve students' comprehension and retention. The use of three-dimensional (3D) objects and audio pronunciations in this media has been shown to help students better understand the Hijaiyah letters and the Makhoriul Huruf.

However, this study has several limitations. The media developed can only be used on Android-based devices and is limited to basic Hijaiyah letter material. Furthermore, the number of respondents involved in this study is also limited, making it unrepresentative of the broader population.

Therefore, future research is recommended to develop more interactive features such as quizzes or Augmented Reality-based learning evaluations, as well as expand the material to include more in-depth Tajweed learning. Furthermore, testing needs to be conducted with a larger number of respondents to obtain more generalizable results.

The findings of this study were obtained through the integration of quantitative and qualitative data, which demonstrate that the developed learning media not only meets the numerical feasibility but is also relevant based on user experience.

CONCLUSION

Based on the study, it can be concluded that the development of learning media using Augmented Reality (AR) for teaching the Hijaiyah alphabet and the alphabetic alphabet based on Android has been successful using the ADDIE model. The resulting media presents the Hijaiyah alphabet in a three-dimensional (3D) visual format, complemented by audio pronunciation and alphabetic alphabet animations, creating a more interactive and engaging learning experience for students.

The assessment by media and materials experts showed that the developed media had a very good feasibility rating, with a score of 100%. This demonstrates that the media meets the standards for quality in appearance, functionality, and alignment with the curriculum and alphabetic alphabet concepts. Furthermore, the results of the user response test involving 22 students also showed a very good rating, indicating that the media is easy to use, facilitates understanding of the material, and provides a pleasant learning experience.

Therefore, the developed Augmented Reality-based learning media can be used as an innovative alternative to support the learning process of the Hijaiyah alphabet and alphabetic alphabet at the elementary school level, particularly in enhancing students' learning experiences.

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Hopefully, the findings of this study can make a positive contribution to the development of technology-based learning media, particularly in teaching the hijaiyah alphabet and makharijul huruf.

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