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Introduction of Hiragana and Katakana Letters Learning Media Using Voice Command Method to Improve Japanese Language Learning Ability Based on Augmented Reality

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ABSTRACT

The purpose of this study is to apply the MDLC technique to design and develop interactive learning materials for Hiragana and Katakana letters using Augmented Reality (AR) on Android devices. This study involved eleventh-grade students and was conducted at SMA Negeri 1 Ajibarang. The application was developed by following the stages of the Multimedia Development Life Cycle (MDLC), namely conceptualization, design, material collection, assembly, testing, and distribution. The application is equipped with a Voice Command feature that allows users to navigate and interact with the application easily. Black Box Testing was used for functionality testing, and the results showed that all application features functioned as intended without issues. Furthermore, the System Usability Scale (SUS) feasibility test resulted in an average score of 82.67%, which falls into the "B" category with a feasibility level classified as "Good," indicating that the application was acceptable to users. This AR application presents interactive 3D visualizations of Japanese letters, making it easier for students to understand the material and increasing their motivation and engagement in learning. Recommendations for future development include expanding the application to cover additional learning materials, adding new features to enhance the learning experience, providing training for teachers to optimize application use, and conducting periodic evaluations based on user feedback.

KEYWORDS

Augmented Reality; Hiragana; Katakana; Learning Media; Multimedia Development Life Cycle; Voice Command.

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1. INTRODUCTION

Technological advances are currently developing very rapidly and have a significant influence on various fields of life, including education. In general, learning media are used as supporting tools to increase the effectiveness of the teaching and lenjing process [1]. These media include various forms that are able to stimulate thinking, attract attention, and develop students' skills and abilities, thereby creating more meaningful learning interactions [2].

Learning media play an important role in educational activities because they help teachers present material and facilitate students' understanding [3]. To increase the effectiveness and efficiency of the Japanese language learning process, learning media act as mediators between teachers and students [4]. Currently, LKS (student worksheet) books are still used as part of the teaching methodology. However, these worksheet books have several shortcomings, including designs that are not fully aligned with the curriculum, resulting in inconsistencies with educational programs [5].

Based on the results of interviews with Mrs. May Krisnasari, a Japanese language teacher appointed by the school as a research assistant, several problems were identified at SMA Negeri 1 Ajibarang. One of the main issues is the reliance on LKS books as the primary learning resource, as well as students' lack of understanding in speaking and recognizing Japanese Hiragana and Katakana letters. In addition, there are challenges in implementing the Merdeka Curriculum, particularly the dominance of printed materials in formal education. Students experience difficulties in understanding the curriculum due to limited exposure to technological advancements, especially Augmented Reality (AR). The limitations of both traditional and digital learning materials contribute to these issues. Therefore, the use of augmented reality as a learning medium is expected to introduce innovation into the Japanese language learning process, making it easier for students to understand Hiragana and Katakana.

In the Japanese writing system, Hiragana and Katakana are fundamental syllabic scripts. Hiragana is used for native Japanese words and grammatical particles, while Katakana is used for foreign loanwords, names, and scientific terms. Mastery of both scripts is essential for beginner learners before progressing to more complex Kanji characters [6].

Augmented Reality (AR) is a technology that integrates digital information into the user's real-world environment. This technology combines real and virtual objects, supports real-time interaction, and operates within a three-dimensional space [7]. In the field of education, AR provides a more engaging learning experience and encourages active learning behaviors, which can improve learning outcomes, particularly for visual and kinesthetic learners [8].

To develop the learning media, the Multimedia Development Life Cycle (MDLC) model is applied. This model consists of six stages: Conceptualization, Design, Material Collection, Assembly, Testing, and Distribution. The MDLC model provides a systematic and flexible approach to developing interactive applications that integrate text, animation, audio, video, and graphics [9].

In addition, the application integrates a Voice Command feature that allows students to interact with the system through speech. This feature enhances accessibility, particularly for students who have difficulty using touchscreen interfaces or who prefer more intuitive interaction methods [10].

Several previous studies support the use of AR in Japanese language learning. The first study [11] examined the use of augmented reality technology to improve learning outcomes related to Japanese compound words using a quasi-experimental method with pre-test and post-test designs. The second study [12] focused on improving students' ability to recognize and write Hiragana and Katakana letters, with testing conducted using a t-test to compare pre-test and post-test results. The findings showed a significant improvement of 55% after the use of an AR application. The third study [13] investigated the application of AR technology to enhance Japanese language learning using a pretest–posttest method with a t-test, which demonstrated a significant increase in Hiragana and Katakana test scores. The fourth study [14] developed an AR-based learning system for Japanese compound verbs by applying multimedia learning theory principles and using learning analytics to analyze student interactions. The results indicated that the integration of AR and learning analytics improved learning effectiveness, although specific percentages were not reported. The fifth study [15] evaluated the effectiveness of AR technology in Japanese language learning through a survey using a Likert scale questionnaire completed by 10 respondents. The results showed a satisfaction level of 94.80%, indicating that the AR application was well received.

Based on these considerations, this research aims to design and develop an interactive learning medium based on Augmented Reality to introduce Hiragana and Katakana letters. The integration of the Voice Command feature is expected to facilitate ease of use and interaction. This research is expected to produce learning media that are not only valid and functional but also capable of increasing students' understanding and motivation in learning the fundamentals ok The Japanese language.

2. METHODS

This research adopts the Multimedia Development Life Cycle (MDLC) method as the basis for developing interactive learning media that integrates Augmented Reality (AR) and Voice Command functions. The MDLC approach was chosen due to its structured and iterative nature, allowing multimedia components such as audio, video, graphics, and animation to be organized into a cohesive and effective learning product. The MDLC framework consists of six sequential phases: Conceptualization, Design, Materials Gathering, Assembly, Testing, and Distribution. Figure 1 show the MDLC process.

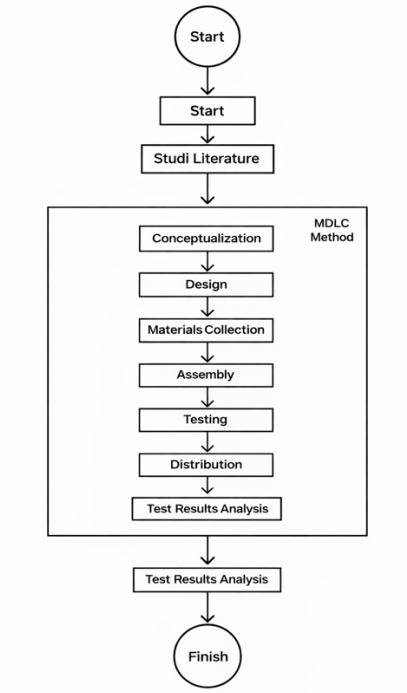

Figure 1 Research Flow Chart

This study was conducted at SMA Negeri 1 Ajibarang in the odd semester of the 2024/2025 academic year. A total of 30 students from class XI enrolled in Japanese language classes were selected as research subjects. The purpose of this study was to evaluate the effectiveness and usability of an AR-based mobile application that teaches Hiragana and Katakana, the two basic syllables of Japanese.

The development procedure begins with the conceptualization stage through literature studies and interviews with Japanese language teachers to identify the needs and objectives of the application. The design stage includes creating system workflows, use case diagrams, and user interface designs using Figma.

Figure 2 explains that the app is designed with a simple interface and logical navigation flow. Users can easily access the materials, try out the AR and voice command features, take quizzes, and find out information about the app. This structure shows that the app is interactive and educational, in line with the goal of learning Japanese in a fun and accessible way.

Figure 3 describes the user flow in running the Japanese hiragana and katakana learning media. Users have five actions that they can perform. The first action is to read the material in the application. After that, users can see 3D objects of hiragana and katakana letters through scan action. Then the user can answer a quiz to measure comprehension. Next the user can see about the application. Finally, the user can exit the application.

Furthermore, in the material collection stage, the necessary digital assets are collected, such as 3D models of Hiragana and Katakana letters made using Blender, as well as supporting audio and video assets. The assembly stage is the process of implementing the design and assets into a functional Android application using Unity 3D software with the Vuforia SDK library to implement Augmented Reality technology.

Data collection techniques were conducted through interviews, observations, and questionnaires. The System Usability Scale (SUS) questionnaire consisting of 10 statement items was used to measure the usability level of the application from the user's perspective. The collected data was then analyzed using two techniques. First, functionality analysis was conducted using the Black Box Testing method to ensure each application feature, such as navigation,

AR scanning, and quizzes, can run according to the usage scenario. Second, usability analysis was conducted by processing data from the SUS questionnaire. The score of each respondent is calculated to obtain an average final score which is then interpreted using an acceptance scale to determine the feasibility level of the application as a learning media.

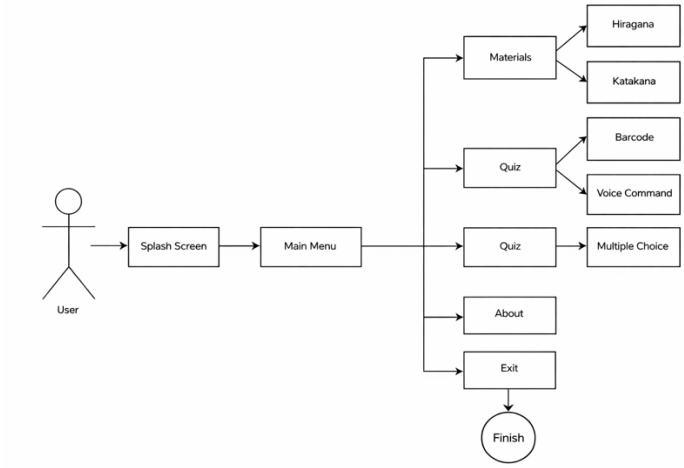

Figure 2 Program Structure.

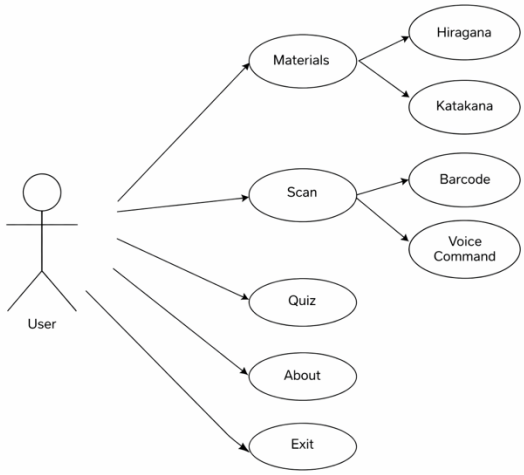

Figure 3 Application Use Case Diagram.

3. RESULT

A. Test Experiment Result

Based on the distance and angle between the camera and the marker, tests were conducted to assess the detection capability of the system. This distance test measures the camera's ability to detect markers at the closest and farthest distances using a meter. Finding the range of distance between the camera and the marker is the goal of this test. To determine the ideal angle at which the camera scans the marker, tests were conducted using a protractor up to 180 degrees. The camera was pointed at an angle of 0 degrees from the marker point to start the test. The results of the distance and angle tests are shown in Table 1.

Table 1 distance and angle test experiment.

No	Testing Parameters	X	Y	Z
1	Distance between marker and camera resolution (cm)	11-150 cm	10-150 cm	5-200 cm
2	Angle between camera and marker (degrees)	20-160 degrees	20-160 degrees	20-160 degrees

B. Experimen Result 1 Material Collection

The worksheet book is the main source used by teachers to create Hiragana and Katakana materials. To aid the learning process, content was then selected and produced in various formats, including 2D, 3D, audio and video objects. These resources are selected based on their capacity to enhance student learning and their suitability to the curriculum. Some of the learning media components are shown in Table 2.

Table 2. Material Collection.

Assets	Functions	Descriptions
Application design assets	As visualization of the application interface	Created using Figma: https://www.figma.com/design/nA5AACBLPjAJgQnSXj0DLF/TA?node-id=0-1&p=f&t=LKCN5Y4zYJz9a7MX-0
Three-dimensional letter objects	As three-dimensional visualization of hiragana and katakana letter material	Dowload via: https://sketchfab.com/21102283 Books: Parastuti Japanese Conversational Vocabulary and Rachma Mutia Japanese Pocket Dictionary
Learning video assets	As video visualization contained in the material	Dowload via Hiragana: https://youtube.com/shorts/ii5Z_OMcoXU Katakana: https://youtube.com/shorts/tMjK21yPpe4
Learning material sound assets	As video visualization contained in the material	Created though: https://ttsfree.com/text-to-speech

C. Experiment 2 Assembly Results

The creation of use cases, activity diagrams, sequence diagrams, and collection of material assets are the first steps in completing the design of the program structure, according to the assembly results. The materials are integrated by incorporating Augmented Reality interactivity, and a friendly interface to unify the learning media elements. The aim of this research is to create usable learning materials using the suggested design concepts. The main menu, which has several buttons with the following functions:

- To access the learning materials page, click the Materials button.
- Augmented reality technology is used to access the scanning and learning page by using the Scan button.
- To take the quiz, click the Quiz icon.
- Information related to the application is displayed through the About button.
- Users can use the Voice Command button to issue clear voice instructions to access the main menu content.
- The exit option page can be accessed by pressing the exit button.

Figure 4 illustrates the scanning page interface of the application. On this page, users can view three-dimensional (3D) letter objects generated through the scanning process. Additionally, the application provides a voice command feature that enables users to interact with the 3D objects, including performing zoom-in, zoom-out, and rotation actions. This functionality enhances user interaction and supports a more intuitive learning experience.

Figure 4 Agumented Reality of Hiragana Letter.

D. Experiment Analysis 1 Testing

1) Functionality Testing (Black Box Testing)

Functionality testing was conducted using the Black Box Testing method by the author and three expert lecturers to validate each application feature. The test results show that most of the main functions, including menu navigation, material display, AR scanning, and quiz system, run well and according to the expected scenario. However, inconsistencies were found in the Voice Command feature, where it failed to respond in two out of four testing sessions. This indicates that the voice command functionality is sensitive to external conditions such as noise and user accent. A summary of the test results is presented in Table 3.

Table 3 Functionality Testing Results (Black Box).

No	Tested Features	Expected Results	Test Result
1	Navigation Menu	Users can move between pages	Success
2	Material & Video Display	Text, image, and video materials appear correctly	Success
3	Scan AR	The application is able to detect markers and display 3D object	Success
4	3D Object Interaction	3D object can be rotated and resized	Success
5	Quiz & Score System	Quizzes run and scores are displayed accurately	Success
6	Voice Command	The application responds to voice command for navigations	Failed

2) AR Marker Detection Test

Tests were conducted to determine the system's ability to detect markers based on distance and camera tilt angle. The results show that the application can optimally display 3D objects at a certain range of distances and angles, which proves the reliability of AR's core features. The detection test results are summarized in Table 4.

Table 4 Marker Detection Test Results Based on Distance and Angle.

Testing Parameters	Optimal Range	Result
Camera to Marker Distance	5 cm – 200 cm	Smooth
Camera to Marker Angle	20° – 160°	Smooth

3) Usability Testing (System Usability Scale)

Usability testing was conducted on 30 students using the SUS questionnaire to measure the usability of the application. From the data collected, an average SUS score of 82.67 was obtained. Based on the interpretation scale, this score falls into the “B” category with a rating of ‘Good’ and an acceptance level of “Acceptable”. These results indicate that students as end users can accept the application very well, find it easy to use, and not confusing. The SUS test result data is presented in Table 5.

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4) Trial Analysis 2 Distribution

At the distribution stage, the learning media is shared through Google Drive for teachers and students to access easily. This method makes it easier to spread the material and ensures that the content can be updated. In the MDLC method stage, distribution is the last step.

The final step of the MDLC is to distribute the learning materials to classrooms in SMA Negeri 1 Ajibarang. These learning resources can be accessed using Google Drive as the distribution and usage phase is covered in the curriculum.

4. DISCUSSION

Experimental Results Tests regarding marker detection show the application's strong ability to recognize AR markers within the specified range of distance and angle. Optimal operation within a distance of 5-200 cm and an angle of 20°-160° guarantees practical usability in various learning environments, providing a reliable foundation for the AR experience. This highlights the technical feasibility and stability of the AR core functionality.

The Material Collection and Assembly results demonstrate a methodical approach to content creation and application structure. A variety of assets, including 3D models, video, and audio, along with a well-defined application flow, demonstrate a comprehensive design strategy aimed at engaging the learner. The integration of Voice Command features on the Home Page and AR scanning pages, albeit with noted inconsistencies, reflects an attempt to improve user interaction and accessibility, in line with modern interactive learning paradigms. The breakdown of the application interface further emphasizes the user-centered design approach.

Functionality Testing (Black Box Testing) confirmed that most features of the app work as intended, validating its core functionality. However, inconsistencies observed in the Voice Command feature indicate the need for further refinement. These issues may stem from variations in user accent, environmental noise, or the sensitivity of the voice recognition algorithm, indicating areas for future improvements to enhance user experience and reliability.

AR Marker Detection testing further reinforced the technical stability of the AR components, proving consistent performance within acceptable parameters. This reliability is critical for AR-based educational tools, as it directly affects the seamless integration of virtual content into the real world.

Most importantly, Usability Testing, quantified by the System Usability Scale (SUS), resulted in a high average score of 82.67. This "Good" rating, which falls into the "Acceptable" category, strongly suggests that the application is well received by its target users (students). The high SUS score, supported by positive feedback from the school, indicates that the media is intuitive, easy to navigate and effectively increases students' engagement and enthusiasm in learning. This high usability is a key factor in the potential wide adoption and success of such a learning tool. While there are limitations to Voice Command, the overall positive user perceptions underscore the strength of the app's design and core functionality.

Finally, the Distribution Analysis, which utilizes Google Drive, highlights a practical and scalable approach to disseminating learning media. This method ensures wide accessibility for teachers and students, facilitating easy updates and maintenance, which is essential for dynamic educational resources.

In conclusion, this research successfully developed a functional and highly useful AR-based learning media for Hiragana and Katakana. Although slight improvements are needed for the Voice Command feature, this application shows significant potential in enhancing Japanese language learning through innovative and interactive design.

Table 5 System Usabilty Scale (SUS) Testing Results.

R	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total	SUS Point (*2,5)
R1	4	2	4	2	4	2	4	2	4	2	30	75
R2	5	1	4	1	4	2	4	2	4	2	33	82.5
R3	5	1	4	1	4	2	4	2	4	2	40	100
R4	4	1	5	1	5	1	5	1	5	1	30	75
R5	5	2	4	2	4	2	4	2	4	2	34	85
R6	5	1	4	2	3	1	4	2	5	1	37	92.5
R7	4	1	5	1	5	3	4	1	5	1	30	75
R8	4	2	4	2	4	2	4	2	4	2	30	75
R9	4	2	4	2	4	2	4	2	4	2	32	80
R10	4	1	5	2	4	2	5	2	3	2	34	85
R11	4	2	5	2	4	1	5	1	4	2	30	75
R12	5	2	4	2	4	2	4	2	4	2	39	97.5
R13	4	2	5	1	5	1	5	1	5	1	30	75
R14	5	2	4	2	4	2	4	2	4	2	32	80
R15	5	2	5	2	4	2	4	2	4	2	40	100
R16	4	1	5	1	5	1	5	1	5	1	30	75
R17	5	2	4	2	4	2	4	2	4	2	36	90
R18	4	1	5	1	5	1	4	1	4	3	32	80
R19	5	1	5	2	4	2	4	2	4	2	37	92.5
R20	4	1	4	1	4	1	5	1	5	2	32	80
R21	4	1	4	1	4	2	4	2	4	2	30	75
R22	5	2	4	2	4	2	4	2	4	2	39	97.5
R23	4	2	5	1	5	1	5	1	5	1	30	75
R24	5	2	4	2	4	2	4	2	4	2	33	82.5
R25	4	2	4	2	4	2	5	1	4	2	28	70
R26	5	2	4	2	4	3	4	2	4	3	35	87.5
R27	4	1	5	1	4	1	5	2	4	2	35	87.5
R28	4	2	4	2	4	2	4	2	4	2	30	75
R29	5	2	4	2	3	2	4	1	3	2	30	75
R30	4	1	5	1	4	2	4	1	4	2	34	85
Rata – rata SUS Point												82.67%

5. CONCLUSION

This research has successfully developed an interactive learning media to introduce the letters Hiragana and Katakana using Augmented Reality (AR) technology supported by the Multimedia Development Life Cycle (MDLC) approach. This application is built through six stages, namely conceptualization, design, material collection, assembly, testing, and distribution. Each stage is carried out systematically to ensure the application meets functional, educational, and usability standards. Based on the results, the app demonstrated high functionality across its main features, such as menu navigation, AR scanning, 3D object interaction, and quiz scoring. Although the Voice Command feature showed some inconsistencies during testing, it still adds a modern and accessible element to the learning experience. Usability testing through the System Usability Scale (SUS) resulted in a high average score of 82.67, indicating that the application is "Good" and "Acceptable" according to user perception. This positive response indicates that this learning media is easy to use, interesting, and supports learning effectiveness. In conclusion, the AR-based learning media is not only feasible to implement, but also has strong potential to improve students' motivation and understanding of Japanese characters. Future improvements could focus on improving the reliability of voice commands and expanding the content to cover broader aspects of language learning.

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