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Interactive Learning of Jawi for Children using Gamification and Artificial Intelligent

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ABSTRACT

Jawi is a traditional writing system that employs Arabic script with additional letters to transcribe the Malay language and various other languages in Southeast Asia. It is an integral part of Malay culture, which was used as the standard script for writing in the Malay language for millennia ranging from royal records to everyday life. Over time, the Romanization of the Malay language has diminished Jawi into an obscure script used only for cultural and religious purposes. The goal of this research is to create an interactive mobile application that uses gamification and artificial intelligence techniques to teach Jawi to children. This application aims to help children increase their interest and enthusiasm for learning Jawi and improve their understanding of the material presented. Although Jawi learning applications are widely available, few to none accommodate the children's actual needs and level of proficiency. The resulting application should be able to cater to 7 to 9-year-olds and aid their learning of Jawi, which is available on Android mobile devices.

Keywords: Jawi Learning, Interactive Learning, Mobile Application, Gamification, Children

INTRODUCTION

The Jawi script, adapted from the Arabic alphabet, includes 35 characters: 29 from the Arabic script and 6 additional characters tailored for the Malay language. These extra characters are essential for capturing sounds that are not present in Arabic. Written from right to left in a cursive manner, Jawi has been used historically for religious, cultural, and official texts in Malay-speaking regions [1]. Jawi script is currently the main medium used for teaching Islamic education in schools. Students who are proficient in Jawi can easily follow the lessons and thoroughly understand the content of Islamic education [2]. However, the review of the literature, along with survey and interview results, clearly shows that students experience notable difficulties in linking Jawi letters to create words [2].

Learning should be simple and fun [3], [4], [5] Emerging technology has brought about positive changes in various aspects of learning. Recently, gamification has become increasingly prevalent in online education [6], [7]. In this era of advancing technology, it should be able to utilize it to maximize the potential of young children's ability to absorb information and learn new things. Gone are the days of traditional workbooks filled with monochrome pages and minimal interactivity. Children today are very much drawn to media with saturated and bright colors, animations, and sounds. Hence, there exists a need for more tools of learning that can engage and excite children so that they may increase their enthusiasm and willingness to learn [8], [9], [10].

Gamified approaches to learning Arabic are particularly effective for beginners. These methods make the learning process fun and challenging, motivating students to commit and actively engage in classroom activities [11]. Opportunities for language learning have significantly enhanced with the introduction of portable digital devices. Their widespread availability and mobility allow learners to engage in study anytime and anywhere, without being limited to a specific location [12]. The average child aged 5-8 spends more than 81% of screen time on mobile tablets [13], [14]. Thus it is imperative to make use of the time spent by children on devices for beneficial causes such as education.

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There are several Jawi learning apps available on the market today such as in Android Studio that offer gamified apps. However, these are too streamlined in that they have a limited range of ages and do not consider the learner's proficiency. They tend to be overly simplistic, lacking the adaptability required to address an individual student's unique skill level and specific learning needs. This limitation can hinder the effectiveness of the learning experience, especially when students vary in their knowledge and proficiency levels. Hence the need to implement adaptive learning algorithms and other AI tools to facilitate this [15] Furthermore, the improvement upon the gamification methods can be executed by implementing storytelling modes that are sure to captivate young audiences [16], [17], [18], [19].

There are three main challenges faced when considering learning Jawi applications for children. The spread of the Roman script has caused the Jawi script to decline, leading to a diminished awareness and appreciation of its uniqueness among certain younger people. [20]. Second, students show significantly poor performance in both writing and reading [21]. In addition, the result of the study showed many respondents felt bored with learning Jawi based on traditional teaching [22].

RELATED WORK

Google's Play Store and Apple's Appstore offer several Jawi learning apps, including Syumul Studio's "Belajar Alif Ba Ta" on Google Play Store. This app is designed to be appealing to young learners with its colorful visuals and engaging content, but it only provides a basic introduction to Jawi. The app doesn't specify a target age group, but it seems intended for beginners, likely suitable for children aged 6 and under. It does not adapt to the learner's ability, offering only a fixed set of features.

Unlike popular language learning apps like Duolingo, which include gamification, artificial intelligence, and minimal storytelling, no app currently offers courses in Jawi or Malay [23], [24], and [25]. The project proposes to develop a unique Jawi learning app that not only captures children's interest with interactive visuals but also adapts to the user's skill level and proficiency. This method is designed to enrich the learning experience and avoid boredom by matching the content to the user's cognitive abilities.

REQUIREMENT OF A NEW SYSTEM

The first stage in planning is to find reasons why a system should be built as well as understand its requirements through various means. Firstly, an interview was conducted with Ustazah Nur Syahadah Binti Sazali, a teacher at Sekolah Agama Rakyat Murad Addiniyah. Ustazah Syahadah teaches elementary students in Jawi and other subjects at the school. She has stated that teachers use an Android app called ejawi2u which can transcribe Malay text written with Latin alphabets into Jawi text. It also provides exercises to practice Jawi such as transcribing a Malay text into Jawi. As for the students themselves, they do not use any mobile application. As mentioned in the background and related works section, by researching the available applications on the Google Play store, there are very few Jawi learning applications that are interactive and fun to use. And none utilizes algorithms that can match the user's proficiency. Not to say that this is necessarily a bad thing, it simply provides room for improvement.

METHODS AND METHODOLOGY

Google Play is used as the main market for Android apps while doing research on current mobile applications for learning Jawi. The Apple App Store is used for the same purpose for iOS mobile devices. However, some Android apps are not available for download on Google Play as they are incompatible with newer versions of Android. To bypass this, an apk of the app is installed through other app markets such as Aptoide. Unfortunately, this can cause some minor UI misalignment due to incompatibility of Android versions. Information and data were gathered while performing research as well as interviewing an educator teaching Jawi to children. Besides that, KAFA workbooks and textbooks for years 1, 2, and 3 are used as references for developing the app in content creation to ensure a standardized curriculum.

Agile development, encapsulated in the Agile Manifesto's guiding principles, offers a holistic approach to software development that aligns seamlessly with the multifaceted goals of the Jawi learning app project. At its core, Agile emphasizes collaboration, responsiveness to change, and the delivery of working software— values that resonate deeply with the cultural and educational aspirations of the Jawi learning app.

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One of the key strengths of Agile development lies in its iterative and incremental nature. The Jawi learning app, designed to preserve and promote the rich heritage of the Jawi script, benefits from the iterative approach by allowing for continuous refinement based on user feedback. In each short iteration, features are developed, tested, and refined, ensuring that the application grows organically with valuable input from the users.

The Jawi learning app project, with its cultural and educational significance, may encounter evolving requirements and user expectations. Agile's flexibility in adapting to changing circumstances ensures that the development process remains responsive. The ability to embrace changing requirements, even late in the development cycle, is a cornerstone of Agile development, ensuring that the Jawi learning app evolves in harmony with the dynamic needs of its users.

In the context of the Jawi learning app, where user engagement is paramount, Agile's emphasis on continuous collaboration and user involvement is particularly valuable. Regular feedback sessions, integrated into each sprint, enable the development team to stay closely aligned with user expectations, ensuring that the app is not only technologically sound but also resonates with the cultural and educational aspirations of its audience.

In conclusion, the adoption of Agile development for the Jawi learning app project is a strategic decision rooted in the principles of collaboration, adaptability, and user-centricity. Agile's iterative approach, responsiveness to change, and emphasis on working software align seamlessly with the project's goals. By embracing Agile development, the Jawi learning app is poised to not only meet but exceed the expectations of its users, contributing meaningfully to the preservation and promotion of the Jawi script within the contemporary digital landscape.

SYSTEM DESIGN AND IMPLEMENTATION

In system design and implementation, the part covered the system architecture, system implementation, speech recognition implementation, user interface design, and system interface design.

5. 1. System Architecture

The Jawi Learning App is designed with a modular architecture to facilitate ease of development, testing, and maintenance. The system consists of several core modules show in Figure 1, each responsible for specific functionalities:

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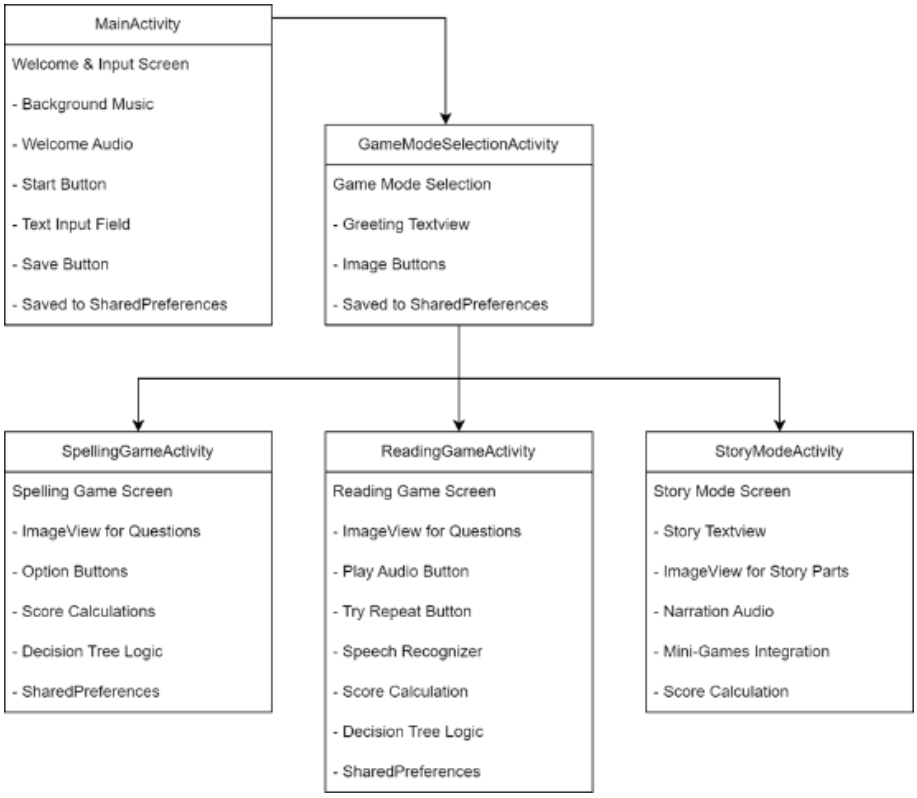

Figure 1: System Architecture Diagram

Module 1: Game mode selection – This module showcases the game modes that can be chosen. Background music is added to attract children's attention along with a visually appealing UI. The user may choose between three options, the spelling game, the reading game, and the story mode. The module's page greets the user with their username to create a personalized and welcoming experience.

Module 2: Spelling Game – This module features spelling gameplay. The user is given a picture and three spelling options to choose from. The questions are divided into three levels of mastery which are beginner, novice, and master. The questions chronology is based on the user's performance, the better they score, the more difficult the word they must spell. At the end of the round, after answering 5 questions, the user will be given a final score that determines the difficulty of the first question of the next round. The proficiency level is based on the number of syllables of a word.

Module 3: Reading Game – This module consists of the reading gameplay. The purpose of this game is so that the user is able to read and pronounce the words accurately. This module utilizes Google Cloud Speech Recognition Services configured to recognize Malay speech. The user is given an image relating to the phrase they must read as well as an audio example to engage and guide the user. Similar to the Spelling Game module, the questions will change their difficulty based on the user's performance. The better they answer, the more the number of words they have to read in a question. At the end of each round, the final score is displayed along with the option to start a new round or return to the main menu.

Module 4: Story Mode – The module allows the user to read a story accompanied by the story's audio. The story is divided into five parts. After the first four parts, the user will be prompted with alternating mini-games of spelling and reading. However, in this mode, the user can retry as many attempts as they want to get the answer right and then proceed with the story. The story finishes with a lesson and the score they got from the mini-games. Before playing any of the modules, the user must first input their username in the welcome screen.

5.2. System Implementation

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The decision tree logic is implemented in both spelling and reading games, where every time the user gets a question correct, the difficulty of the next question increases until the highest difficulty level. But if they get a question wrong, the next question given will be that of the previous question's difficulty. The final score tallies all the points gained in a round to determine the first question of the next round.

5.3. Speech Recognition Implementation

The speech recognition functionality in the Jawi Learning App is implemented using Android's built-in SpeechRecognizer class. This allows the app to convert spoken words into text, which is then used to validate the user's pronunciation against the expected phrases. This functionality is primarily utilized in the ReadingGameActivity and parts of the StoryModeActivity. Speech recognition is the process of converting spoken language into text. It involves several steps and components [14], including:

Audio Signal Acquisition: The system captures the audio signal using a microphone. In the case of the Jawi Learning App, this is done through the user's device microphone.

Preprocessing: The captured audio signal is preprocessed to remove noise and enhance the quality. This step may include filtering, normalization, and other signal-processing techniques.

Feature Extraction: The preprocessed audio signal is analyzed to extract relevant features that can be used to identify the spoken words.

Acoustic Modeling: Extracted features mapped to phonetic units (like phonemes) using acoustic models. These models are trained on large datasets of audio recordings and their corresponding transcriptions.

Language Modeling: The sequence of phonetic units is further processed using language models to predict the most likely sequence of words. Language models take into account the grammar and context of the language being recognized.

Decoding: The system decodes the sequence of phonetic units into text. This step involves matching the phonetic units to words in the vocabulary and constructing the final recognized text.

Post-processing: The recognized text can be refined through additional processing to correct errors and increase accuracy, including tasks like spell-checking and grammar correction.

NLP is a branch of artificial intelligence that facilitates natural language communication between computers and people. The recognition of speech, analysis of texts, sentiment assessment, and machine translation are among its many functions. Speech recognition is essential to NLP because it converts spoken words into text that NLP algorithms process. Within the Jawi Learning application, this software converts spoken words into text and compares them to predicted phrases to assess accuracy.

5.4 User Interface Design

The Jawi Learning App is designed with a user-friendly and visually appealing interface to engage children aged 7 to 9 in learning Jawi. The design focuses on clarity, simplicity, and functionality, ensuring that young users can navigate and interact with the app easily. In addition, beautiful and cute elements and background images as well as background music are added to further engage the young target users.

Main Activity- The main activity serves as the title screen where users are greeted with the app's logo and an audio introduction. The interface includes a text field for users to input their names, which is stored and used to personalize their experience throughout the app. The background music plays softly to create a welcoming atmosphere. The layout is centered, with elements arranged in a vertically aligned linear layout, ensuring all components are easily accessible and visible on various screen sizes.

Game Mode Selection Activity- In the game mode selection screen, users are greeted with a personalized message that includes their name, making the experience more engaging. The interface features four custom image buttons for selecting different game modes: Spelling, Reading, and Story. These buttons are arranged in a 2x1 grid layout, and a single image button under the layout ensures a clean and organized appearance. Each button uses transparent

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background images to maintain a consistent look and feel. The buttons also have shadow effects to create a sense of depth, making them more visually appealing and interactive.

Spelling Game Activity- SpellingGameActivity is designed to present spelling questions to the user. The interface includes an image view at the top to display a picture related to the question. Below the image, three buttons display the spelling options, from which the user can select the correct one. A "Semak" button at the bottom allows the user to check their answer, with the selected option changing color to indicate whether it is correct (green) or incorrect (red). The layout utilizes a constraint layout to guarantee that all elements are properly aligned and adapt to different screen sizes.

In the ReadingGameActivity, the user is prompted with a picture and corresponding text in Jawi. Below the text, a "Main Audio" button allows the user to hear the correct pronunciation, and a "Baca" button enables them to attempt repeating the phrase. A progress bar indicates the system is processing the user's speech input. After the speech is recognized, a feedback message is displayed to show whether the user's pronunciation is correct. The layout is designed with a constraint layout to ensure elements are centered and well-organized, providing a clear and intuitive user experience.

Story Mode Activity- The StoryModeActivity takes the user through a narrative with five parts, each followed by a mini-game. The interface for each part includes an image and Jawi text, with an audio button to play the narration. After reading each part, the user must complete a mini-game (either spelling or reading) to proceed. The layout ensures that each story part is clearly presented, with navigation buttons for progressing through the story. The mini-games are seamlessly integrated, maintaining a consistent design with the standalone game activities.

5.5 System Interface Design

The system interface design of the Jawi Learning App ensures smooth interaction between the user and the app's functionalities. The design follows a modular approach, where each activity is responsible for specific tasks, enhancing maintainability and scalability.

The main activity interface captures the user's name and stores it using SharedPreferences. This name is retrieved and used in subsequent activities to personalize the user experience. The interface includes methods for playing background music and handling user input efficiently.

The game mode selection interface in Figure 2, handles navigation to different game activities based on user selection. Each image button has an OnClickListener that triggers an intent to start the corresponding activity. This modular design allows easy addition or modification of game modes without affecting the overall structure.

Figure 2: Mode Selection Interface

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The SpellingGameActivity interface manages the presentation of spelling questions, user input validation, and score tracking. The interface includes methods for displaying the next question, checking answers, updating scores, and storing progress using SharedPreferences. This ensures that the user's progress is saved and can be retrieved in future sessions.

The ReadingGameActivity interface incorporates speech recognition using Android's SpeechRecognizer class. The interface includes methods for initializing the speech recognizer, handling speech input, and providing feedback to the user. The recognized text is compared with the expected answer, and the result is displayed to the user, ensuring an interactive and responsive experience.

The StoryModeActivity interface combines storytelling with interactive mini-games. The interface includes methods for displaying story parts, playing narration audio, and transitioning between story parts and mini-games. The mini-games are integrated seamlessly, with interfaces similar to the standalone game activities. The user's progress and scores are tracked and stored, allowing for a coherent and engaging narrative experience.

RESULT AND DISCUSSION

System testing was split into two phases: developer testing and user testing. The project was evaluated to ensure it adhered to the system requirements defined in the early stages. Details of these two phases are provided below:

a. Developer Testing

This is to ensure it correctly handles user interactions and requests. This included verifying that username registration functionalities worked seamlessly, with user details accurately stored and retrieved. The testing also examined syntax, functionality, and logical errors in the app. The developer ensured that questions and answers in the spelling and reading games were displayed correctly, and that scores were updated and stored as expected. No major issues were found during this testing phase that is shown in Table 1 below.

b. User Testing

User testing was conducted with 10 students aged 7 to 9, The system was nearly complete at the time of testing. Each user tested all functionalities of the app, including the spelling game, reading game, and story mode. After testing, users were interviewed to fill up a survey feedback form to provide insights into their experience with the app. Since the users testing are children, they did not personally fill out the form themselves but instead asked for their feedback. The survey sought to gather opinions on the app's perceived value, user-friendliness, and ease of learning.

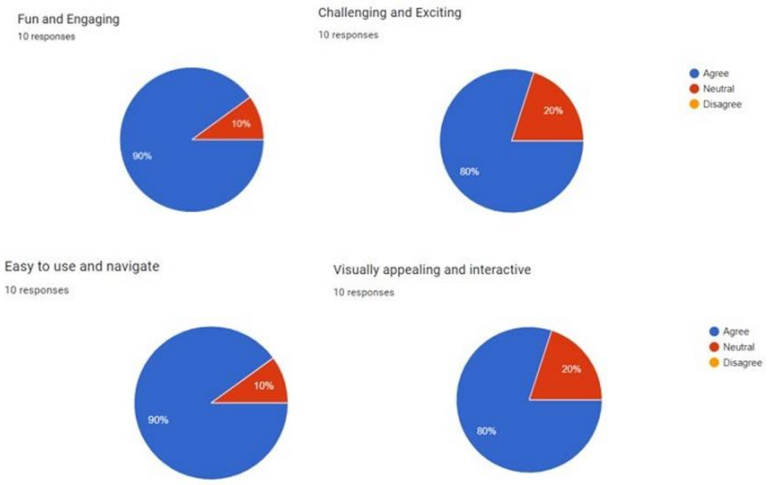

Figure 3: Pie Charts of User Feedback

The feedback was overwhelmingly positive. The pies chart Figure 3 illustrate the results of the user testing, with percentages of Agree to Disagree, where yellow signifies disagreement, red signifies neutral and blue signifies agreement. Most users found the modules engaging and helpful for learning Jawi. Most users agreed that the

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functionalities provided in the app were effective and expressed a desire to continue using the app in the future as a supplementary learning tool. Users also appreciated the educational value and user-friendliness of the app, noting that it made learning Jawi enjoyable and accessible.

The development of the Jawi Learning App could be further enhanced by incorporating additional features and improvements. Future enhancements could include more interactive modules and advanced speech recognition capabilities. Additional research on interactive learning tools and educational content could help make the app even more effective and engaging for young learners.

6.1 Requirements Traceability Matrix

Table 1: Requirements Traceability Matrix

Requirement ID	Requirement Description	Implemented Feature	Verification Method
R1	Users can register and log in	Main Activity with username input	Tested in developer testing
R2	Users can select different game modes	Game Mode Selection Activity	Tested in user testing
R3	Users can play spelling game	SpellingGameActivity	Tested in user testing
R4	Users can play reading game	ReadingGameActivity	Tested in user testing
R5	Users can hear audio narration in story mode	StoryModeActivity with audio playback	Tested in developer testing
R6	Scores are saved and retrieved correctly	SharedPreferences for score storage	Tested in user testing
R7	The App provides feedback for correct/incorrect answers	Highlighting and scoring logic in-game activities	Tested in user testing

6.2 Functional Testing Results

a. Spelling Game Functionality:

Test Case: Verify correct answer highlights in green and incorrect in red that showed in Figure 4.

Result: Pass - Correct answers are highlighted in green and incorrect answers in red as expected.

Figure 4: The wrong option selected in Spelling Mode

b. Reading Game Functionality:

Test Case: Verify speech recognition correctly identifies spoken words that showed in Figure 5.

Result: Pass - Speech recognition accurately matches spoken words to the expected text.

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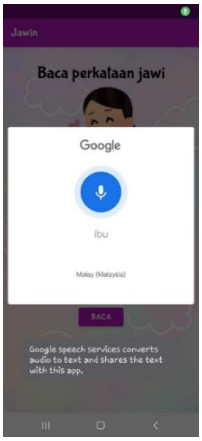

Figure 5: Reading Game Speech Recognition

c. Story Mode Functionality:

Test Case: Verify audio playback for each part of the story. Result: Pass - Audio plays correctly for each story segment in Figure 6.

Figure 6: A Part in Story Mode

CONCLUSIONS

The Jawi Learning App for Children was developed with the primary aim of creating an engaging and effective tool for young learners to acquire Jawi language skills. Through the integration of gamification, adaptive learning, and speech recognition, the app provides a comprehensive learning experience tailored to the needs of children aged 7 to 9. The positive feedback received from user testing highlights the app's potential to enhance Jawi language education significantly. The app's interactive features, such as adaptive spelling and reading games, ensure that children remain motivated and challenged according to their proficiency levels. The incorporation of a story mode adds a narrative element that keeps users engaged and reinforces their learning through context-based exercises. Furthermore, the offline functionality makes the app accessible to a wider audience, addressing a common limitation in many educational tools. The decision tree algorithm tailors the difficulty of questions to the user's performance, offering a personalized learning experience. Speech recognition technology allows for pronunciation practice, promoting active learning and improving speaking skills. Despite some limitations in the accuracy of speech recognition and the hardcoded nature of the questions, the app has demonstrated stability and reliability during testing. In summary, the Jawi Learning App successfully meets its objectives by offering an interactive, engaging, and accessible platform for young learners to improve their Jawi language skills. The project has shown promising results, indicating its potential as a valuable educational resource.

Data Availability: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflict of interest: The authors declare that there is no conflict of interest.

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