Design and Development of an Educational Vocabulary Game

Rico Surya Permana [a1], I Made Sukarsa [a2], Putu Wira Buana [a3], Ni Wayan Wisswani [b4]
[a]Dept. of. Information Technology, Faculty of Engineering, Udayana University, Jimbaran, Bali, Indonesia
[b]Dept. of. Informatics Management of Bali State Polytechnic, Bali, Indonesia
e-mail: [1]rico.permana069@student.unud.ac.id, [2] sukarsa@unud.ac.id , [3] wb@unud.ac.id, [4] wisswani@pnb.ac.id

Abstrak

Bahasa merupakan elemen penting dalam budaya manusia, berfungsi sebagai alat komunikasi dan identitas bagi para penuturnya. Di era globalisasi, penguasaan berbagai bahasa memberikan keuntungan dalam aspek kognitif, budaya, akademik, dan karir. Namun, metode pembelajaran konvensional sering kurang menarik bagi para pelajar. Penelitian ini membahas perancangan dan pembangunan Bermain Kata, sebuah game edukasi interaktif yang dirancang untuk meningkatkan penguasaan kosakata dan pemahaman bahasa melalui berbagai variasi permainan, seperti mencocokkan kata dengan artinya, sinonim, antonim, dan kategori kata. Aplikasi ini dikembangkan dan kemudian dinilai menggunakan standar kualitas perangkat lunak ISO 25010 yang mencakup delapan karakteristik. Hasil pengujian menunjukkan skor keseluruhan sebesar 3,667, melebihi ambang kelayakan 2,374 (56% dari skor maksimum), dengan tujuh karakteristik dinilai Sangat Layak dan satu karakteristik Cukup Layak. Temuan ini menunjukkan bahwa aplikasi Bermain Kata layak dan efektif digunakan sebagai media pendukung pembelajaran bahasa di Indonesia.

Kata kunci: *Game Edukasi, Pembelajaran Bahasa, Multibahasa, Kosa Kata, Unity*

Abstract

Language is an essential part of human culture, serving as a tool for communication and identity. In the era of globalization, mastering multiple languages offers cognitive, cultural, academic, and career advantages. However, conventional learning methods often lack engagement for students. This study presents the design and development of Bermain Kata, an interactive educational game aimed at improving vocabulary and language comprehension through various game modes, including word-meaning matching, synonyms, antonyms, and word categories. The application was developed and evaluated based on the ISO 25010 software quality standard, which includes eight key characteristics. Testing results showed an overall score of 3.667, exceeding the eligibility threshold of 2.374 (56% of the maximum score), with seven characteristics rated as Excellent and one as Adequate. These findings indicate that Bermain Kata is a feasible and effective tool to support language learning in Indonesia.

Keywords : *Educational Games, Language Learning, Multilingualism, Vocabulary, Unity*

1. Introduction

Language is a key element in communication and the formation of a nation's identity [1]. In the digital era, the preservation and learning of national, international, and regional languages needs to be done with an approach that is in accordance with the habits of the younger generation. One effective approach is through educational games, which have been proven to increase learning motivation and memory in learning a new language. The rapid development of Android-based educational games in recent years has also shown the increasing interest and effectiveness of this media as a learning tool [2].

This research focuses on the development of Bermain Kata, an Android-based educational game that supports learning four languages at once, namely Indonesian, English, Javanese, and Balinese. This game was developed using the Unity Game Engine and adopts

various types of games that stimulate users in recognizing and understanding the meaning of words, synonyms, antonyms, and choosing several words based on categories. By utilizing a fun and competitive game approach, this game is expected to enhance a more interactive and adaptive learning experience.

Several previous studies have utilized game media in developing language learning applications, such as Balinese script preservation games [3], Japanese language education games [4], and Javanese script learning games [5]. Generally, the development methods used include the ADDIE and Waterfall approaches, as well as the implementation of the Fisher-Yates Shuffle algorithm for randomizing questions [6]. Although proven effective, most of these applications only support one language, do not provide a competitive mode, and do not optimally utilize hybrid data storage.

The limitations of previous applications are seen in the lack of support for multilingual learning, the absence of online-offline synchronization features, and the absence of an achievement system or leaderboard that can motivate users continuously. In addition, most similar applications do not provide online competition features between users, either in the form of real-time games or a global ranking system. In fact, the implementation of competition features such as ranked mode and leaderboards can encourage user engagement and motivation through a more interactive and challenging learning experience.

As a solution to these limitations, this study proposes the development of an educational game, Bermain Kata, which offers key features such as (1) interactive game variations (multiple choice, fill in the blanks, select multiple words, and arrange words); (2) solo and competition mode options; (3) support for four languages, including two regional languages; (4) a hybrid data storage system using SQLite and Firebase Firestore; and (5) software quality assessment using the ISO/IEC 25010 standard.

2. Research Method

This research focuses on the development of Bermain Kata, a mobile-based educational game designed to improve vocabulary mastery and language comprehension. In the development process, the Waterfall method is used as an approach that supports a systematic and structured workflow.
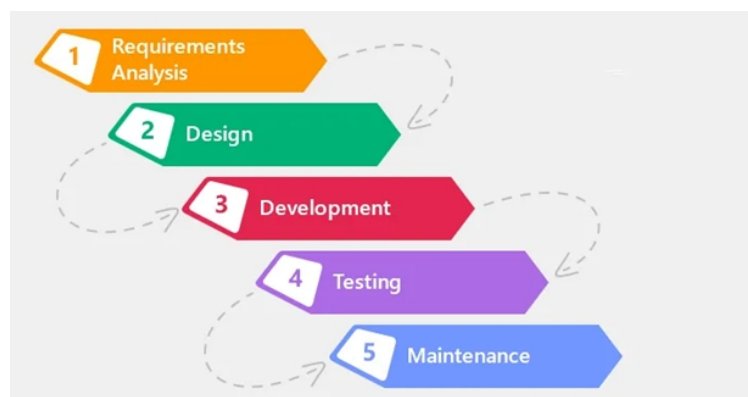

Figure 1.

Waterfall Method

The image above shows the flow of stages in the Waterfall model used in the development of this game. This study applies the Waterfall software development method because of its systematic approach and is suitable for projects with needs that have been determined from the start. Further explanation of each stage will be presented in the next section.

2.1. Requirements Analysis

This stage is carried out to understand what users need in the application to be created. Information is obtained by reading various references such as books, journals, and similar applications so that the Bermain Kata design is in accordance with learning objectives and user needs.

2.2. Design

This phase includes the development of the game architecture and the design of key mechanisms and features, such as solo and competitive modes. Each level is structured in stages to keep the user interested. The user interface is designed to be intuitive, responsive, and visually appealing to support an interactive learning experience.

2.3. Development

This stage includes the game programming process based on the system design that has been prepared. Supporting assets such as graphics, sound, and other visual elements are created to strengthen the appearance and interaction in the game. All components are then integrated into the system as a whole so that the application can function according to the goals that have been set.

2.4. Testing

The testing phase is carried out to ensure the quality and stability of the system before it is used by users. Testing begins with unit testing, which aims to verify that each module or component of the game functions properly individually. Next, integration testing is carried out to ensure that the relationship between components runs as expected. Finally, a complete system test is carried out, including testing on the competition feature, to evaluate the performance, stability, and reliability of the application as a whole.

2.5. Maintenance

After the Bermain Kata educational game is successfully built and released, the maintenance phase is carried out to fix bugs, adjust features based on user feedback, and make updates to improve stability and gaming experience. Maintenance is carried out when problems are found during real-world use or based on the results of further post-release testing.

3. Literature Study

A literature study was conducted to support the design process of the educational game Bermain Kata. The study focused on the development of mobile-based educational games, the Waterfall method, and the use of Unity, SQLite, and Firebase Firestore as supporting technologies.

3.1. Educational Games

Educational games are a type of game specifically designed for learning purposes by combining entertainment and education elements in one interactive medium. These games insert certain subject matter, such as language, mathematics, or science, into a fun game mechanism so that they can improve players' skills and knowledge more effectively [7].

3.2. Language

Language is a system composed of sound symbols whose meaning is not inherently inherent but rather formed through agreement between speakers [8]. As a means of communication, language plays an important role in conveying ideas, feelings, and information in society.

3.3. Local language

Regional languages are languages that are generally used in a particular region and function as a symbol of regional identity. In addition to being a means of communication, regional languages also play an important role in supporting and preserving local culture. Therefore, preserving regional languages by each tribe for the next generation is very important [14].

3.4. Android

Android is an open-source platform that allows developers to freely create and develop applications on smartphones [9]. The ease of use and flexibility of this system make Android one of the most popular operating systems for mobile application development.

3.5. Unity

Unity is a multiplatform game development platform that is widely used because of its ease and complete features. This application supports the creation of 2D and 3D games, is available for free, and is equipped with an asset store and various features that make it easy for developers to build and manage game projects [10].

3.6. SQLite

SQLite is a lightweight database engine that is embedded directly in the application and does not require a separate server. Data stored through SQLite resides locally in the device's memory, making it suitable for mobile applications such as Android. SQLite supports basic relational database features, such as tables, indexes, triggers, and complex queries. In addition, its file format is cross-platform, so it can be used and moved across multiple operating systems easily [11].

3.7. Firebase

Firebase is a Backend as a Service (BaaS) developed by Google [12]. This platform provides various services, such as real-time data storage, user authentication, application hosting, and analytics. Firebase makes it easy for developers to build applications without having to handle the backend infrastructure directly.

3.8. Waterfall Method

The waterfall method is a software development approach that is carried out sequentially, where each stage is completed before proceeding to the next stage. This process includes the planning, design, implementation, and testing phases that flow like a waterfall [13].

4. Result and Discussion

This section explains the results of the implementation and testing of the Bermain Kata application as a game-based learning medium. The explanation begins with the appearance of the application interface and the main features that have been developed according to user needs. Furthermore, the results of the application quality testing based on the eight characteristics of ISO/IEC 25010 are presented.

4.1. System Overview

The overview of the design of the Android-based Bermain Kata educational game aims to explain the system model and workflow of the Bermain Kata game. This explanation can be seen in the image below.
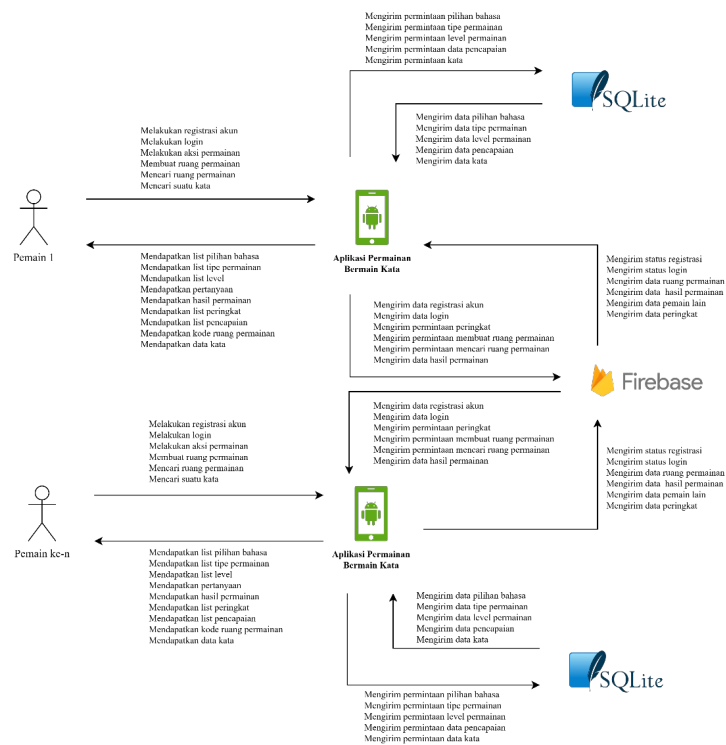
Figure 2. System Overview

Android-based Bermain Kata educational game is designed to improve users' language skills through competition (online) and solo (offline) modes. This system uses Firebase to store player data in online mode and SQLite for question data and achievements in offline mode. Data such as progress and scores are stored on the server, while game logic is executed on the client side without direct server involvement.

4.1. Use Case

The use case diagram of the design of the Bermain Kata game aims to determine the relationship between users and a system so as to determine the functionality and actors who can interact with the system. The use case diagram of the design of the Bermain Kata game can be seen in the image below.
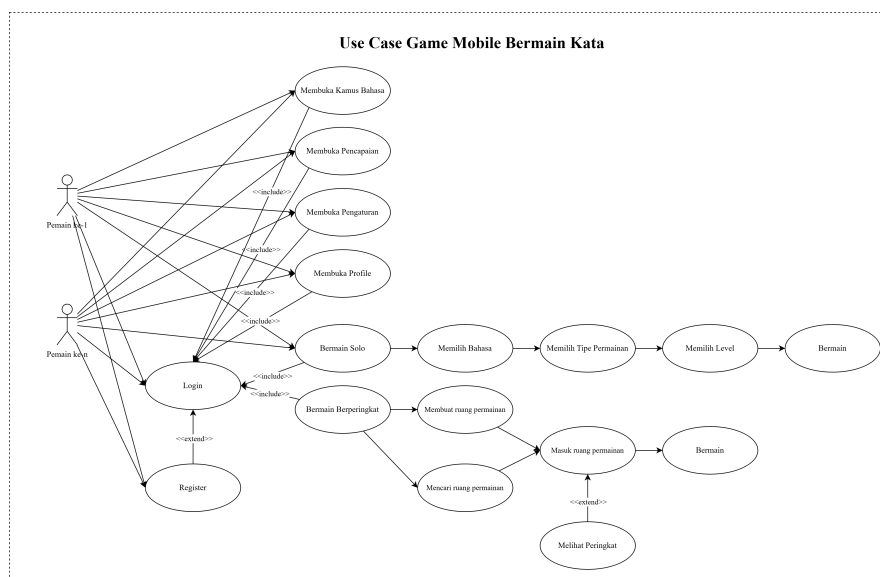

Figure 3. Use Case Diagram

The image above is a use case diagram of the Bermain Kata game. The use case diagram in the Bermain Kata game has two actors interacting with the system. Player 1 and Player n both have the same role in the game. The players can play in solo mode (offline) or play in competition mode (online). Each actor is also required to authenticate the user in order to access competition mode (online).

4.1. Application Interface Implementation

The interface in the Bermain Kata game is designed with comfort and ease of use in mind. The layout is simple and functional so that users can quickly understand the gameplay and available features. Visual elements such as color, icons, and typography are chosen to support readability and ease of navigation. With this design, it is expected that users can run the game interactively without experiencing difficulties in operating the application.
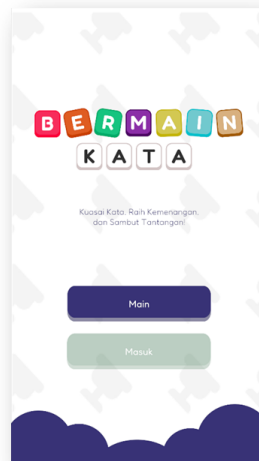

Figure 4. On Boarding Scene View

The image above shows the onboarding scene in the Bermain Kata game. This scene appears first when the player opens the application. If the player chooses to play without logging in, they will be directed to the solo mode main menu scene. Conversely, if they choose to log in, the player will be directed to the login scene.
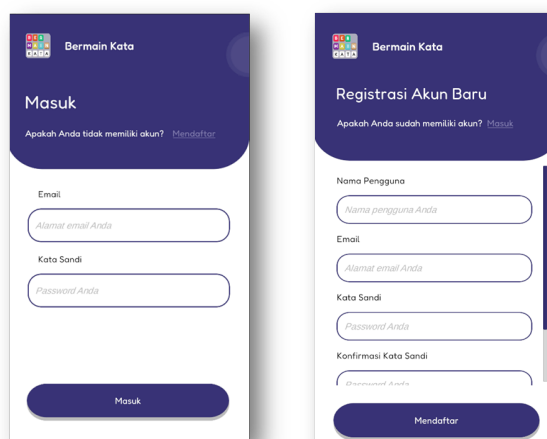

Figure 5. Login and Register Scene View

In the sign-up scene, there are five form components that must be filled in by players to create an account. After successfully creating an account, players can access all game features, including the competition mode, which is only available to registered users.

Meanwhile, in the login scene, players simply enter the email and password that have been registered previously.

Figure 6. Game Mode Scene View

The image above shows the game mode scene in the Bermain Kata game. The competition game mode can only be accessed when the player uses a created account and is connected to the internet. Meanwhile, solo mode can be played without having to create an account or connect to the internet.
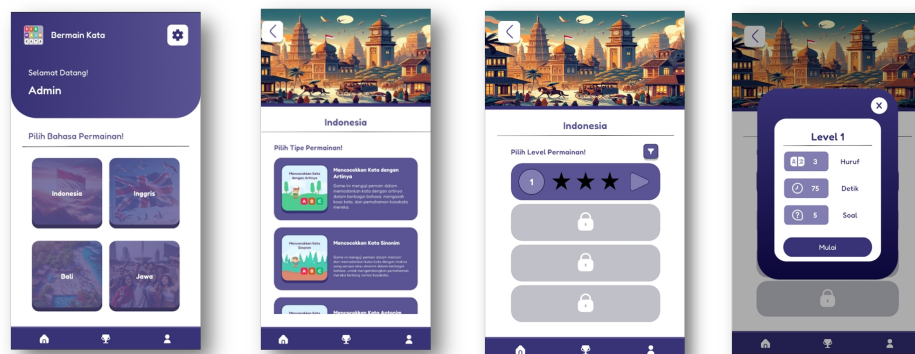

Figure 7. Solo Game Mode Scene View

The image above shows a series of solo mode scenes in the Bermain Kata, starting from a scene that displays four language options, namely Indonesian, English, Balinese, and Javanese. After selecting a language, players are directed to the game type scene, where several game variations are available, such as matching words with their meanings, synonyms, antonyms, and by category. Selecting the game type will take players to the level selection scene, which displays a list of available levels. Players can only play levels that have been unlocked and are free to repeat any level that is already available.
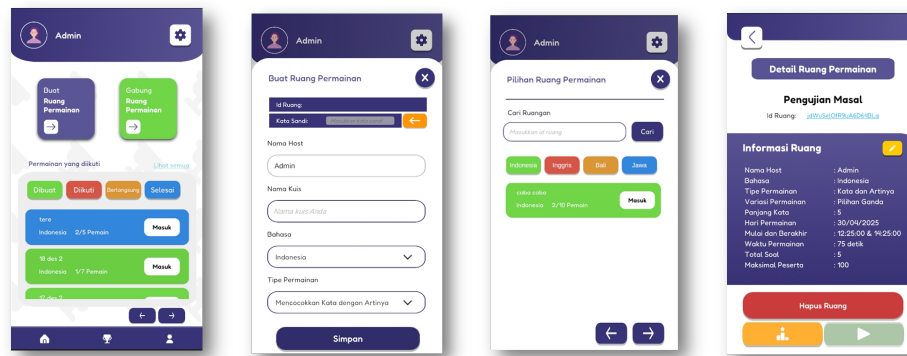
Figure 8. Competition Game Mode Scene View

The image above shows a series of competition scenes in the Bermain Kata game. In the main competition scene, players can choose to create a new game room or join an existing room. In addition, there is a list of game rooms that players have participated in. In the create game room interface, players can adjust game parameters such as start time, end time, word length, and number of questions through the form provided. In the join game room interface, players are presented with a list of available rooms and can join them. For certain rooms, players can use the search feature by entering the game room ID. Furthermore, in the game room detail scene, players can review complete information about the selected room, such as the room name, time limit, and player status. Players can choose to join or cancel their participation. There is also a button to view the leaderboard and start the game when the time is right. Especially for room creators, there is an additional feature to edit the game room before it starts.
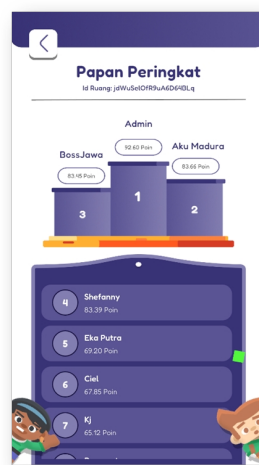

Figure 9. Scene Leaderboard View

The image above shows the leaderboard scene in the Bermain Kata game. In this scene, players can see a list of all players along with the points they have earned in the selected game room. The information on the leaderboard is arranged sequentially, starting from the player with the highest to the lowest points.
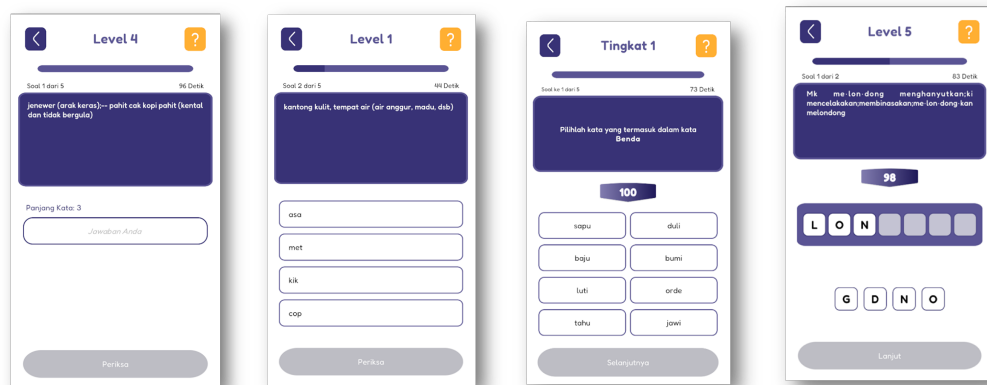
Figure 10. Game Variation Scene View

The image above shows various gameplay scenes from variations of the game in the Bermain Kata. In the multiple-choice gameplay, players are presented with a number of questions that display the meaning of words and are asked to choose the most appropriate answer from several options. In the fill-in-the-word gameplay, players must type a word that matches the meaning shown in the question. Next, in the gameplay of choosing several appropriate words, players must choose three words that match the category given in each question. Players will get points deducted if they choose the wrong answer. Finally, in the word-arranging gameplay, players are asked to arrange letters in sequence to form the correct word. Mistakes in arranging will deduct points, and the question will change after the word is successfully arranged.
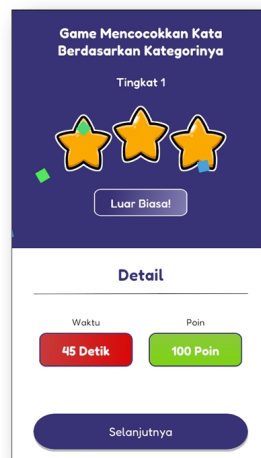

Figure 11. Game Result Scene View

The image above shows the game result scene in the Bermain Kata game. This scene displays information from the results of the process of answering questions in the gameplay scene. The interface presents information related to the level played by the player, the stars obtained, the predicate obtained, the time remaining, and the percentage or final points of the player.
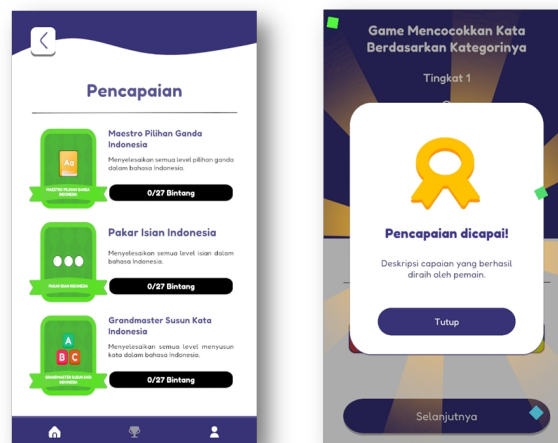
Figure 12. Achievement Scene View

The image above shows the achievement scene and achievement capital in the Bermain Kata game designed to increase player motivation and engagement in the learning process. In the achievement scene, players can see a list of achievements that have been achieved and those that have not been achieved, complete with a brief explanation of each achievement. Meanwhile, the achievement capital provides detailed information about the achievements that have been successfully achieved. This feature aims to provide appreciation for player progress while encouraging them to continue to expand their vocabulary mastery through the available challenges.

4.2. Application Quality Test Results

Testing is an important part of the game development process to ensure that Bermain Kata works according to its function and meets software quality standards. Testing is carried out based on the ISO/IEC 25010 approach, which includes eight main characteristics, such as functional suitability, performance efficiency, compatibility, and usability [15]. To support this process, data was collected through distributing questionnaires to users, with 30 respondents filling out a general questionnaire and 26 respondents filling out a technical questionnaire. The general questionnaire was used to assess the overall user experience, while the technical questionnaire focused on the functional and technical aspects of the application.

Table 1. Eligibility Percentage Based on Likert

Eligibility Percentage	Qualification
76% - 100%	Very Eligible
56% - 75%	Quite Eligible
40% - 55%	Less Eligible
0% - 39%	Not Eligible

The figure above shows the level of application feasibility based on the ISO/IEC 25010 standard, using the percentage of Likert scale results as an evaluation reference. Feasibility is classified into four categories: very feasible (76-100%), quite feasible (56-75%), less feasible (40-55%), and not feasible (0-39%).

Table 2. Writing Each Matrix In Each Assessment Section

No	Characteristics ISO 25010	Score	Eligibility Standards 56%	Testing Status
1	Functional Suitability	377	252	Very Eligible
2	Performance Efficiency	390	252	Very Eligible
3	Compatibility	208	168	Quite Eligible
4	Usability	670	420	Very Eligible
5	Reliability	508	336	Very Eligible
6	Security	580	364	Very Eligible
7	Maintainability	583	364	Very Eligible
8	Portability	351	218	Very Eligible
	Overall	3667	2374	Very Eligible

Based on the test results of the eight characteristics of ISO 25010, a total score of 3,667 was obtained with an eligibility standard of 2,374 (56% of the maximum score). Each characteristic is evaluated based on a Likert scale and categorized into a certain eligibility status. The results show that seven of the eight characteristics obtained a "Very Eligible" status, namely functional suitability, performance efficiency, usability, reliability, security, maintainability, and portability. Meanwhile, the compatibility characteristic obtained a "Quite Eligible" status. Overall, the application is considered to be in the "Very Eligible" category, which indicates that the application has met most of the technical aspects required according to the ISO 25010 standard so that it can be relied on for further use.

5. Conclusion

Based on the research results, it can be concluded that the Android-based educational game Bermain Kata was successfully developed using Unity as the game engine and the C# programming language and supported by a local database (SQLite) and server (Firebase). The integration of the two types of databases allows the implementation of two game modes, namely solo mode (offline) and competition mode (online). The development of this application follows the waterfall method in a structured manner, starting from the needs analysis stage to implementation and testing. Based on the test results referring to the ISO/IEC 25010 standard, the Bermain Kata game obtained an average score of 3.667 from a feasibility limit of 2.374 (56% of the maximum score). Seven of the eight characteristics received the status of "very eligible," while one characteristic received the status of "quite eligible." Overall, this application has met most aspects of software quality and is considered very feasible to be used as an interactive and educational language learning medium.

References

[1] N. Maghfiroh, "BAHASA INDONESIA SEBAGAI ALAT KOMUNIKASI MASYARAKAT DALAM KEHIDUPAN SEHARI-HARI," *Komunikologi : Jurnal Ilmiah Ilmu Komunikasi,* pp. 103-104, 2022.

[2] I. G. A. Apriliawan, M. G. R. Kristiantari and N. Arnawa, "Pengembangan Game Edukasi Cari Kata Baku Berbasis Android Untuk Siswa Sekolah Dasar," *Jurnal Ilmiah Pendidikan Citra Bakti,* vol. 9, no. 2, pp. 262-273, 2022.

[3] I. G. N. A. C. Putra, I. K. A. A. Putra, I. B. G. Dwidasmara, I. M. Widiartha, N. A. S. ER and I. P. G. H. Suputra, "Implementasi Metode Convolutional Neural Network Pada Pengenalan Aksara Bali Berbasis Game Edukasi," *Science and Information Technology,* pp. 1-15, 2023.

[4] E. W. Ramadhona, T. Prasetya, A. I. Purnamasari, A. R. Dikananda and O. Nurdiawan, "Game Edukasi "Nihongo Kurabu" Belajar Bahasa Menggunakan Unity 2D Berbasis Android," *Information Management For Educators And Professionals,* vol. 6, no. 1, pp. 71-80, 2021.

[5] K. Mustofa, N. Suarna and A. R. Dikananda, "Game Edukasi Pengenalan Aksara Jawa Untuk Menambah Pengetahuan Dengan Menggunakan Metode ADDIE," *JATI (Jurnal Mahasiswa Teknik Informatika),* vol. 6, no. 2, pp. 811-816, 2022.

[6] W. A. Rohmah, Asriyanik and W. Apriyandari, "Implementation of the Algorithm Fisher Yates Shuffle on Game Quiz Environment," *JITE (Journal of Informatics and Telecommunication Engineering),* vol. 4, no. 1, pp. 162-172, 2020.

[7]   M. R. H, A. Bukhari, Mursalim, Butsiarah and Tamsir, "Pengembangan Game Edukasi Pengenalan Aksara Lontara Menggunakan Metode Game Development Life Cycle," *Jurnal Minfo Polgan,* vol. 12, no. 2, pp. 411-422, 2023.

[8]   S. A. Putri and I. Nurulpaik, "Penggunaan Bahasa Slang dalam Interaksi Verbal Siswa Sekolah Dasar (Kajian Sosiolinguistik)," *JIIP (Jurnal Ilmiah Ilmu Pendidikan),* vol. 8, no. 6, pp. 6234-6240, 2025.

[9]   I. K. K. M. Putra, P. W. Buana, I. M. Sukarsa and N. W. Wisswani, "Rancang Bangun Sistem Informasi Outsourcing Berbasis Mobile Menggunakan Framework Flutter," *Jurnal Teknologi Informasi,* vol. 10, no. 1, pp. 1-8, 2024.

[10] D. Rudini, A. Bastian and D. Zaliluddin, "Perancangan Game Kasada Aksara Dan Bahasa Sunda Sebagai Media Edukasi Menggunakan Unity Berbasis Android," *J-ENSISTEC (Journal of Engineering and Sustainable Technology),* vol. 9, no. 2, pp. 825-834, 2023.

[11] I. K. A. M. Antara, I. M. Sukarsa and P. W. Buana, "Rancang Bangun Aplikasi Kalender Bali Menggunakan Framework Flutter," *JITTER- Jurnal Ilmiah Teknologi dan Komputer,* vol. 3, no. 1, 2022.

[12] J. Panjaitan and A. F. Pakpahan, "Perancangan Sistem E-reporting Menggunakan ReactJS dan Firebase," *Jurnal Teknik Informatika dan Sistem Informasi ,* vol. 7, no. 1, pp. 20-34, 2021.

[13] R. J. Pratama and E. Setiawan, "Rancangan Bangun Aplikasi Web Tactical Floor Game Berbasis Google Maps API (Studi Kasus: Ditlantas Polda Jawa Timur)," *JATI (Jurnal Mahasiswa Teknik Informatika),* vol. 8, no. 2, pp. 1783-1790, 2024.

[14] V. Paputi, S. R. U. A. Sompie and B. A. Sugiarso, "Sangihe Language Recognition Educational Game," *Jurnal Teknik Elektro dan Komputer,* vol. 12, no. 2, pp. 113-120, 2023.

[15] I. O. f. Standardization, "ISO/IEC 25010," 5 4 2025. [Online]. Available: https://iso25000.com/index.php/en/iso-25000-standards/iso-25010.