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Mobile Game-Based Learning Application on Science for Indigenous People

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Abstract

This study emphasizes the crucial role of gamification elements in making an application enjoyable and interactive, particularly for indigenous populations. The study identified several issues such as the scarcity of Malay-based educational games available for Indigenous People, which aligned with the Sustainable Development Goals' emphasis on Quality Education. The primary objective of this project is the design and development of the 'Saintifik' mobile application, tailored specifically for the public and formatted as a single-user program available on the Android platform with Malay as the primary language. The application's scope is extensive, covering an educational platform that aligned to the syllabus of a Standard 1 Science Curriculum textbook in Malaysia with Malay Language. Designed for individual users, the Saintifik mobile application introduces the Digital Educational Game Life Cycle (DEG) methodology to the study. The application includes several interactive features such as a (i) scoring system, (ii) timer, (iii) gamified challenges and (iv) rewards. The application's significance extends beyond its use as a learning tool for the science curriculum as it also serves as a teaching aid to supplement educational activities. For future improvements, the study recommends the inclusion of more content, additional gamification elements, bilingual support, and compatibility with multiple platforms.

Keywords: Digital Educational Game Life Cycle (DEG), Mobile Application, Gamification, Mobile Learning and Technology

Introduction

The impact of mobile technology on education has been profound, facilitating a shift towards digital learning methodologies that have increased accessibility and engagement (Crompton et al., 2017). However, this transformation has been uneven, with Indigenous People often left behind in the race towards digitalization. Language barriers, cultural differences, and a lack of relevant content have prevented indigenous populations from fully benefiting from this digital shift (Sotiriadou et al., 2013). This paper aims to address these gaps through the

development of a mobile game-based learning application, "Saintifik," designed specifically for Indigenous People and using Malay as its primary language.

Mobile game-based learning leverages the power of play and interactivity to enhance learning experiences and outcomes (Hamari et al., 2016). Gamification techniques and game mechanics, such as scores, timers, and challenges, are known to foster engagement and motivation among users. However, few game-based educational tools cater to the specific needs and cultural sensitivities of indigenous populations (González-González & Blanco-Izquierdo, 2020).

The 'Saintifik' application, designed in line with the Sustainable Development Goals on Quality Education, is developed to offer a science education tool tailored to the Malay-speaking indigenous population. The content of the application aligns with the Standard 1 Science Curriculum, thus providing a much-needed resource for this underserved community (Jara et al., 2012). Adapting the Digital Educational Game Life Cycle (DEG) methodology, the Saintifik mobile application aims to offer a comprehensive educational tool. The DEG methodology, which emphasizes iterative testing and refinement based on user feedback, ensures the application remains user-centric and effective (Kapp, 2012). The 'Saintifik' mobile application promises to bridge the education gap among Indigenous People through a Malay-based, engaging, and curriculum-aligned science educational tool. This paper details its design, development, and potential benefits, while also suggesting areas for future development.

Literature Review

Gamification, the process of integrating game-like features into traditionally non-game environments, has found widespread application across diverse fields, ranging from medicine and entertainment to education (Setiawan et al., 2020). This fusion of teaching, digital learning, and gamification has increasingly become a central discourse among educators and learners (Abdul Rahman et al., 2018). Primarily, gamification aspires to leverage the motivational potential innate to video games by incorporating game design elements into non-gaming contexts (Sailer et al., 2017). Consequently, gamification offers mutual benefits to teachers and students by fostering interactive learning styles and enhancing learner engagement with instructional materials.

A. Structural Gamification

Structural gamification is the strategy of applying game-like features to stimulate learner engagement without modifying the learning content. Examples of this strategy include incorporating game elements such as scores, levels, medals, leaderboards, and achievements into an instructional context (Elshiekh & Butgerit, 2017).

B. Content Gamification

Content Gamification, on the other hand, entails transforming learning content to emulate a game-like experience. It involves the addition of game components, mechanisms, and game thinking. Therefore, alongside game elements, content undergoes modification by infusing a storyline, challenges, mysteries, and characters to enthrall the learners (Elshiekh & Butgerit, 2017).

C. Gamification Elements

- *Score*

Points, often a summative representation of completed tasks, have been found to foster motivation and engagement due to their ability to offer instant feedback and acknowledgment of task completion (Barghani, 2020). In mobile applications, users receive their scores, and in some instances, highest scores per category upon task completion, thus pushing users to achieve maximum points for each sub-topic.

- *Timer*

Incorporating a timer or any time-regulated element introduces suspense into the user experience. By imposing time limits on user interaction with the application, users are steered towards a focused problem-solving approach, resulting in diverse decision-making outcomes (Schonbohm & Zhang, 2021).

- *Challenges*

Challenges motivate users to activate expected behaviours, finish tasks, and advance their cooperation, interaction, and learning processes. Legaki et al (2019) contend that challenges stimulate learners to apply knowledge gained from course content effectively and devise strategies to maximize points on each game level.

- *Reward*

Rewards are a pivotal component of gamification, acting as key motivators that enhance user engagement and promote learning (Huang & Soman, 2013). They come in various forms, such as points, badges, and leaderboards, serving as a tangible manifestation of the user's achievement and progress (Seaborn & Fels, 2015). The ability of rewards to provide immediate feedback fosters a sense of accomplishment, triggering positive emotions and reinforcing desired behaviors (Nicholson, 2015). Importantly, the element of reward can be customized according to the user's preferences, making it more relevant and effective (Thiebes et al., 2014). The dynamic nature of rewards in gamified learning environments contributes significantly to an enhanced learning experience, ensuring users remain motivated and engaged with the content (Kapp, 2012).

D. Advantage of Gamification Elements

According to Alexander (2021), gamification can increase user engagement compared to traditional tasks. Gamified learning modules encourage engagement by presenting students with challenges and tracking progress. Commendation upon mastering content and progressing to higher difficulty levels is a common feature. The use of stories and narratives is another gamification technique that guides students through the learning process, fostering a connection with the learning tools and enhancing focus on the topics. Furthermore, gamified learning helps consolidate learner memory of the content taught. Swacha & Ittermann (2017) argue that gamification can boost knowledge retention, which attests to its efficacy as a potent strategy for long-term content recall post-learning sessions.

Methodology

The methodology serves as the backbone of a research project, providing a systematic, theoretical examination of the methods employed in a specific field of study (Igwenagu, 2016). Particularly in the realm of mobile application development, the chosen methodology

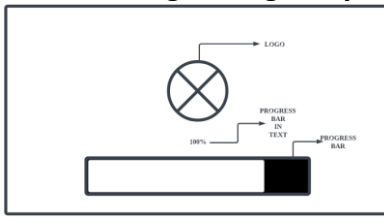
shapes the direction, execution, and outcome of the project. An effective methodology facilitates the design process by offering a structured roadmap, detailing the step-by-step procedures, activities, tools, and prerequisites associated with application development (Olivera et al., 2021). This section elaborates on the research methodology implemented in this project and its subsequent application. The selected strategy for this project is the Digital Educational Game Life Cycle (DEGLC).

The DEGLC is a methodological framework tailor-made for educational game development. The DEGLC comprises several stages: conceptualization, design, prototyping, development, testing, and maintenance, each having its distinct significance and contribution towards the successful realization of a digital educational game (González-González et al., 2019). The iterative nature of DEGLC ensures continuous refinement and optimization of the game application, enhancing its effectiveness as an educational tool.

Throughout this project, the DEGLC methodology is adhered to, ensuring that the mobile application meets the pedagogical and engagement objectives. Furthermore, consistent with the DEGLC's iterative approach, the application will undergo continuous evaluation and modification during its development, promoting its efficacy and usability.

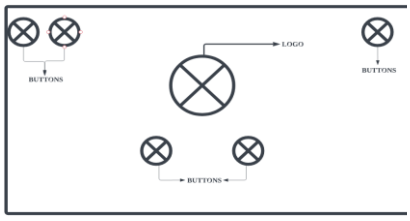
Results and Discussions

A. Game Design Using Storyboard



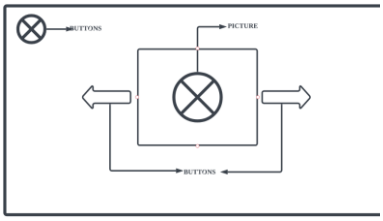
Splash Screen and Loading Page

This is the initial page that users will encounter while using the Saintifik mobile application.



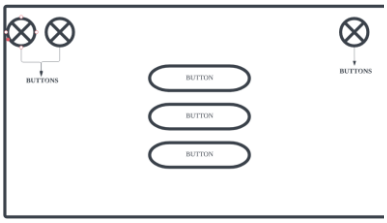
Homepage

On the homepage, there are five buttons, including a "learn" button for a lesson on the science curriculum and a "main" button that leads the player to the games. Next, on the upper left is a button that displays information about the app and a button to toggle the app's music on/off. Finally, the exit button is in the top right corner, allowing the user to leave the application in response to a prompt.



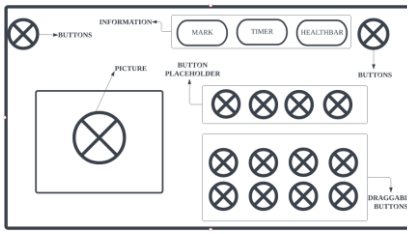
Tutorial Page

On the tutorial page, there are three buttons. On the upper left is the back/homepage button, which allows the user to return to the homepage. The arrow button is used to advance the science slide and alter the image accordingly.



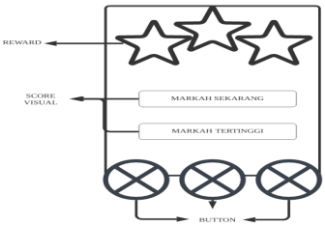
Category Play/Learn Page

The choose category lets users pick a topic to play or learn about. The three major buttons represent the game's three chapters. The upper left buttons return users to the homepage and turn music on/off. The app's exit buttons are in the upper right.



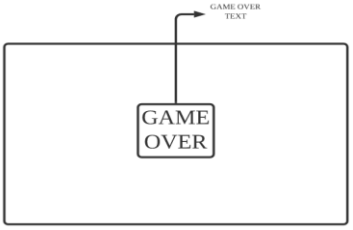
Game Page

After the user choose the topic, they wish to play, the game's puzzles will correlate to the user's selection. This page contains the gamification elements of timer, scoring (point), and challenge (health bar). If the player does not empty the health bar, they will be awarded stars on the reward/bonus page based on the health bar. There is also a voiceover for each letter, images, and indications of whether the user entered the correct or inaccurate information.



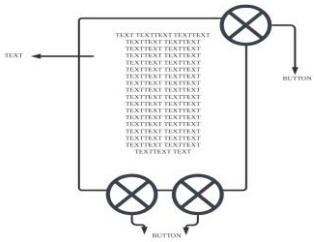
Reward Page

After finishing each stage, the user will receive a reward (star) dependent on the level of the health bar. Additionally, the user will receive their score and top score for the category in which they participate.



Game Over Page

This page will appear when the user's health bar or remaining time reaches zero. The user will then wait five seconds before returning to the homepage.



Exit Page

This page will be accessible when clicking the exit button. The exit page will request confirmation from the user before closing the programme. The user will then select "yes" or "no" based on their preferences.

Fig. 1 Storyboard

Fig. 1 depicts the storyboard for the mobile game-based learning application.

B. Flowchart

The flowchart operates as an intuitive roadmap for the functional flow of a system or software, granting users a comprehensive understanding of the correct system usage. Fig. 2 illustrates the flowchart for the 'Saintifik' mobile application framework. Upon initiating the application, users are directed to the main screen where they are presented with the choice to delve into study materials or directly engage in the game.

If users opt for the 'view tutorial' option, they are guided to choose from several study topics, starting with 'Animals', proceeding to 'Humans', and culminating with 'Living and Non-Living Objects'. Users retain the flexibility to navigate back to the homepage at any point. Conversely, if users decide to immerse themselves in the gameplay, they are ushered into the topic selection layout. Here, they can curate their gameplay by selecting the preferred game type. The game incorporates dynamic gamification elements like a timer, scoring mechanism (points), and challenges (represented by a health bar).

Upon completion of the game, users are presented with their final score alongside details of the highest score achieved. The highest score data is prominently displayed on the homepage. Importantly, successfully responding to the game's challenges earns the users' stars, serving as tangible rewards for flawless task execution. Finally, users have the option to exit the game via a dedicated 'exit' button.

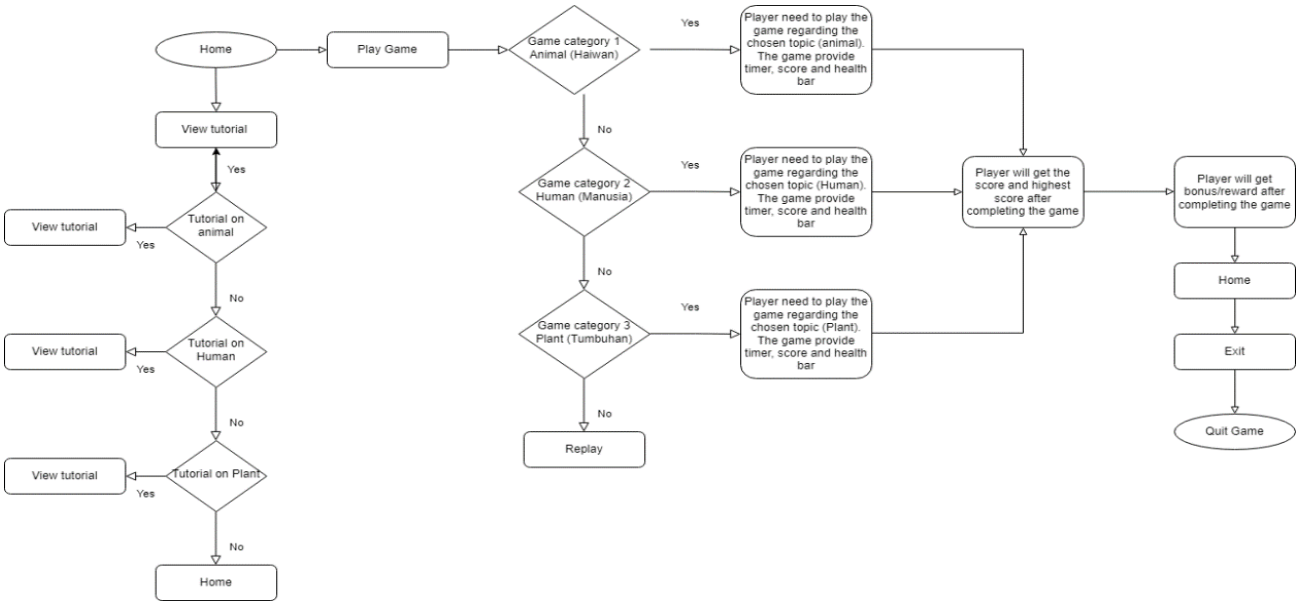


Fig. 2 Application flowchart

C. Use Case Diagram

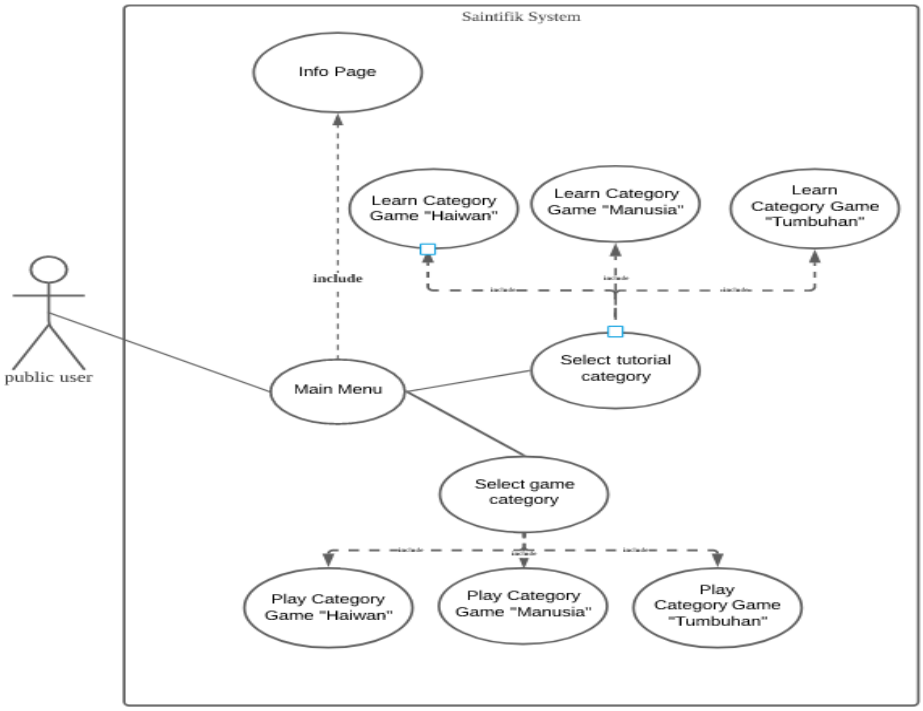


Fig. 3 Use case diagram for the application

Fig. 3 depicts the interaction between the user and the process using a case diagram.

D. High-fidelity Prototype for Saintifik Application

Fig. 4 Splash screen and loading page

Fig. 4 shows the initial page that users will encounter while using the 'Saintifik' mobile application. Saintifik logo is displayed at the center of the screen and the progress bar will load before proceeding to home page.

Fig. 5 Homepage

Fig. 5 shows the home page for "Saintifik" application. This jungle theme representing nature since all the topic in this applicaion are related to nature. On the homepage, there are five

buttons, including a "learn" button for a lesson on the science curriculum and a "main" button that leads the player to the games. Next, on the upper left is a button that displays information about the app and a button to toggle the app's music on/off. Finally, the exit button is in the top right corner, allowing the user to leave the application in response to a prompt.

Fig. 6 Category play or learn page

Fig. 6 shows the category play or learn page, the user may choose the topic they wish to play or learn about. The three buttons in the middle represent the three possible chapters in the game. The game is designed using gamification elements. The buttons in the upper left corner allow users to return to the homepage and toggle the music on or off. The application's exit buttons are in the upper right-hand corner. 'Saintifik' application uses the same theme throughout the app for consistency. They are also picture representing the topic with animation to increase engagement. The user can choose between three topics which are (i) *"Haiwan"* (Animal), (ii) *"Manusia"* (Human) *and* (iii) *"Tumbuhan"* (Plants).

Fig. 7 Tutorial page

Fig. 7 shows the tutorial page with three buttons. On the upper left is the back or homepage button, which allows the user to return to the homepage. The arrow button is used to move the topic's slide and alter the image accordingly. Also intergrated on the slideshow is voice-over of the subject that is being discussed. User can also tap the picture to prompt a voice-over.

Fig. 8 Game page

After the user choose the topic's, they wish to play, the game's puzzles will correlate to the user's selection. Fig. 8 shows the page contains the gamification elements of timer, scoring (point), and challenge (health bar). If the player does not empty the health bar, they will be awarded stars on the reward/bonus page based on the health bar. There is also a voiceover for each letter, images, and indications of whether the user entered the correct or inaccurate information.

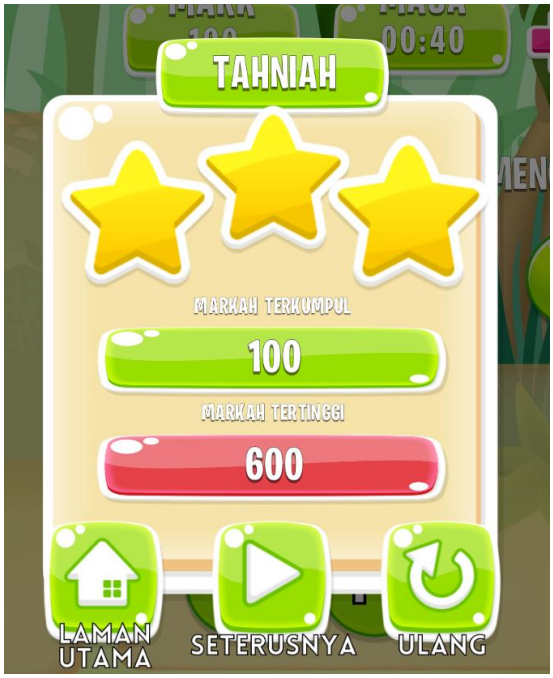


Fig. 9 Reward page

After finishing each stage, the user will receive a reward (star) dependent on the level of the health bar as shown in Fig. 9. Additionally, the user will receive their score and top score for the category in which they participate.

Conclusion

The development of the "Saintifik" mobile application for indigenous people signifies a vital step in the pursuit of quality education through the integration of gamification in learning, specifically in the field of science. The application's utilization of the Malay language coupled with engaging gamification elements like score, timer, and challenges contribute to an

enriching and interactive learning experience. While the current development shows promising potential, future research could explore adding more content, expanding gamification elements, providing dual language support, and ensuring compatibility across various platforms. Further investigations could delve into the effectiveness of the app in diverse cultural contexts, aiming for a more inclusive, equitable, and universal educational tool that transcends linguistic and geographical boundaries.

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