

Hello Vaccines: Development of An Android Mobile Game Application on Covid-19 Vaccination Awareness

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Abstract: COVID-19 pandemic has been happening around the world since 2019. Malaysia's government has conditionally approved five COVID-19 vaccines and started to urge and encourage teenagers to receive the vaccination due to the preparation of the school reopen policy. Unfortunately, much fake news and inappropriate remarks on social media could have influenced people's faith and confidence in COVID-19 vaccinations, particularly among adolescents. Currently, many methods have been implemented for delivering the awareness related with COVID-19 vaccinations such as via social media, television news and advertisements. However, these methods are still possessing some limitations, especially in terms of the fun gaming approach. Therefore, Hello Vaccines as an android mobile game application is developed to enhance understanding and awareness about COVID-19 Vaccination among teenagers through a fun gaming approach. Game Development Life Cycles is utilized to design and implement the Hello Vaccines. Unity Game Engine, Visual Studio, and Adobe Illustrator 2020 are utilized throughout the development of this application. The overall result of the user acceptance test on the Hello Vaccines mobile game application has positive feedback with a favourable result of 89.3%. It indicates that the application reached a higher user acceptance level.

Keywords: COVID-19 vaccination, Android mobile game, Unity Game Engine

1. Introduction

COVID-19 Vaccination is used to invigorate the safe framework within the occurrence in case of presentation to SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). In Malaysia, the Covid-19 vaccination campaign was carried out to reach community immunity as the final goal. According to the National Pharmaceutical Regulatory Agency (NPRA) [1] and the Malaysian Drug Control Authority (DCA) [2] both the Pfizer-BioNTech and Sinovac COVID-19 vaccines are currently under conditional licenced for using it on teenagers aged 12 and above. The policy mentioned above is

due to Malaysia's government plans to reopen all schools to ensure students' safety [3]. Manufacturers of COVID-19 vaccinations have liability safeguards in place. While this is not proof that the vaccines are harmful [4]. Therefore, the proliferation of fake news, unfavourable and inappropriate remarks on social media, all of which have influenced people's faith and confidence in COVID-19 vaccinations, particularly among adolescents. Other than that, there are too few existing mobile game applications related to COVID-19 Vaccination. As all known, adolescents nowadays can accept information quickly via mobile games due to the content, infographics, animations, audio, and others in the mobile games can stimulate teenagers' interest and curiosity in raising awareness, particularly on COVID-19 vaccination.

The objectives of this project are to design content of "Hello Vaccines" application using dynamic 2D gamification approach. The second objective is to develop a "Hello Vaccines" application on the Android mobile platform by implementing a 2D approach. The third objective is to perform the functionality and acceptance of developed "Hello Vaccines" using Alpha and Beta Testing. For the info module, the user will have five genres of vaccine to select and understand more to introduce the basic concept of each vaccine. Every vaccine will have seven aspects to present, such as name, country, shots needed, effectiveness, type of vaccines, storage condition, and global approval date. There are 3 different level of difficulties provided for users to complete the challenge based on 3 different scenarios that indicate a low risk to high-risk environments such as street village, office town and hospital. Based on the information provide for users in the info module and throughout the gaming experience, the user needs to navigate the game character upward, downward, leftward, and rightward to answer the relevant field question given above while escape from virus assault in a limited time duration. The gamification mentioned above can enhance adolescents' awareness of how critical surroundings and crowded people could affect their safety.

Following with this introduction, the related work of this project discusses in Section 2. Section 3 outlines the Game Development Life Cycles as the methodology of this project. The testing results and discussion were described in Section 4. Lastly, the conclusion was elaborated in Section 5.

2. Related Work

A related work is a survey to assist readers in understanding the specific topic. The domain background related with COVID-19 vaccination is discussed in Section 2.1, while the approach and the software utilised related to the application is addressed in Section 2.2. Next, the studies of existing applications and the comparison table are described in Section 2.3.

2.1 COVID-19 Vaccination

With the continuous advancement of biotechnology, vaccines nowadays may have been reducing the side effects on humans and other living things and reducing the global pandemic into endemic infectious disease as soon as possible [5]. However, due to most recipients being still concerned more about the side effects, safety, and lack of information which caused them to hesitate to receive vaccines [6]. Therefore, a mobile game application that enhance the awareness and comprehension of COVID-19 Vaccination is required, especially for adolescents to expand the protection cover among the citizens in Malaysia.

Many brands of the vaccine in Malaysia are widely used within the social hierarchy, such as frontlines officers, senior citizens, adults, and adolescents. However, only 3% or 92,949 of adolescents had fully vaccinated. Plus, 1,666,131 recipients aged 12 to 17 or 53% of teenagers in the country had received at least one dose of the COVID-19 vaccine as of 2 October 2021 [7]. Hence, awareness of COVID-19 Vaccination is required to expand the protection cover among the citizens in Malaysia. Therefore, this proposed application that enhances the understanding and comprehension of adolescents about COVID-19 Vaccination is required to be developed.

2.2 Gamification Approach and Unity

Gamification is a technology that aims to restructure the game scheme and design in specific contexts, such as in raising awareness aspects. By constituting the game elements, such as the scores, badges, levels and unlocking features can influence and motivate participants' passion towards the game's content [8]. A successful gamification should address the inherent motivation of the gameplay and attract users to play the game with pure amusement and enjoyment. Unity is known as a cross-platform game engine and integrated development environment (IDE) developed by Unity Technologies, and it is used as a tool to create a game. By supporting multiple scripting platforms, such as JavaScript and C#, the developed application can be easily used from multiple platforms, such as mobile and desktop device.

2.3 Comparison of Existing Applications

In this section, the proposed application, Hello Vaccines, was compared with three current applications, Coronavirus Evolution, Can You Save The World, and Virus Wars.

Table 1: Comparison of existing applications

	Coronavirus Evolution [9]	Can You Save The World [10]	Virus Wars [11]	Hello Vaccines
Features				
Platform	Desktop	Web & Desktop	Mobile	Mobile
Language	English, Russian, Chinese	English	English	English
Target Users	Public	Public	Public	Adolescents aged 13 to 17
Internet Connection	Required	Required	Not Required	Not Required
Purchase	In-app purchase	Free to play	Free to play	Free to play
Exit Button	Available	Not Available	Not Available	Available
Button Design	Inconsistent in terms of sizes	Consistent in terms of sizes	Inconsistent in terms of colours	Consistent in terms of size
COVID-19 Vaccination content	Irrelevant, it discussed more	Irrelevant, it discussed more	Relevant	Relevant

	about the virus itself.	about the virus itself.		
Table 1: (continued)				
Features	Coronavirus Evolution	Can You Save The World	Virus Wars	Hello Vaccines
Weakness	<ul style="list-style-type: none"> - Characters are designed too small and indistinct - Not all game mode is free to play - Violence - Lack of valuable content involves in this application 	<ul style="list-style-type: none"> - The paused and settings buttons are hard to click - The game character quickly moves out of the camera, which cannot be view -Does not provide a mobile version 	<ul style="list-style-type: none"> - Layouts of design were poor - Does not provide any guidance before playing the game. -Play the game without purpose -Too many ads often appear in this application 	<ul style="list-style-type: none"> - Only cover three levels throughout this application
Strength	<ul style="list-style-type: none"> - Multiplayer modes allow the user to play with friends - Have many characters and weapons to choose - Provide three different languages 	<ul style="list-style-type: none"> - Related too much of the information of COVID-19 - Animated buttons and characters are provided - Provide tutorial before starting the game officially 	<ul style="list-style-type: none"> - Simple gameplay as just injecting the syringe by tapping the screen continuously - Vibration effect provided 	<ul style="list-style-type: none"> - Free to play - Consistent design with animated buttons and game characters. - Provide some sound effects and background music separately - Provide an app guide for users.

Table 1 shows a comparison between the three existing applications and the proposed application. There are only two applications support in mobile platform, while English used as medium language for the three applications except the Coronavirus Evolution does provide not only English, but the Russian and Chinese. All the applications just simply provide to public users, but the proposed application is targeted to adolescents aged 13 to 17. The first two applications were required an internet connection, while the last two applications were not required an internet connection. All the application are free to play, but the Coronavirus Evolution required in-app purchase. The Coronavirus Evolution and the proposed application are provided an exit button, while the other two applications do not. The Can You Save The World and the proposed application are serving with a consistent button design, whereas the other two applications do not. Lastly, the proposed application, Hello Vaccines is the only application that provide relevant COVID-19 Vaccination content.

3. Methodology

Game development life cycle (GDLC) [12] is a parameter used to guide game development progress. During the game development process, developers might face various challenges, which must be explicitly resolved. This application is a mobile game that using a dynamic 2D side-scrolling gamification approach. Thus, GDLC as shown in Figure 1 is the most recommended approach to apply as the project's methodology to ensure the quality and standard of the games delivered.

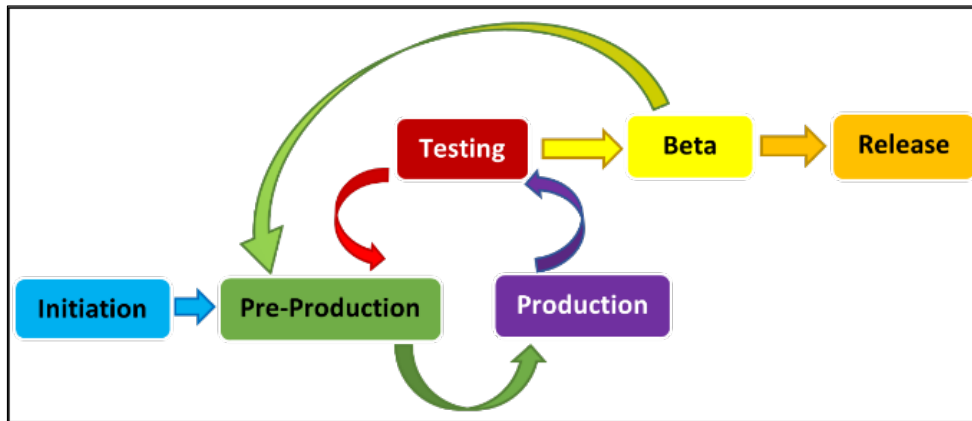


Figure 1: The game development life cycle model [12]

It has 6 phases included: the initiation phase, pre-production phase, production phase, testing phase, beta phase, and release phase.

3.1 Initiation Phase

In this subsection, the justification for designing this application is explored and tabulated. Next, the feasibility study must then be completed in this part to determine that the suggested requirements are appropriate for the application. Prior to that, it is necessary to research the needs of the target users, who are teens aged 13 to 17. A brief interview with Miss Yeong Shu Wen of University Sains Malaysia, who is now undergoing clinical trials, was used to determine the user requirements. This project’s user requirements are tabulated in Table 2.

Table 2: User requirements

Stakeholder Category	Role in Product	Design Implications	Action Required
Target Users	End-user of the application	Easy to learn	<ul style="list-style-type: none"> Effortless gameplay style can ease users while playing the game. Provide explicit instruction and guidance. The COVID-19 vaccines or other relevant metaphors were applied.
		Easy to navigate	<ul style="list-style-type: none"> It contains general icons with text such as start, paused, and settings buttons to navigate easily. The navigational structure is not too complicated.
		Implement User Level Mechanics	<ul style="list-style-type: none"> Utilize three different difficulties of levels in the game.
		Increase user’s curiosity	<ul style="list-style-type: none"> Utilize the unlock features in the game. Create more animated models and import them into the game application.

Table 2: (continued)

Stakeholder Category	Role in Product	Design Implications	Action Required
Subject Matter Expert (SME)	Content reference in the relevant field	Visibility	<ul style="list-style-type: none"> The buttons and other navigational components are placed to be easy to find and utilize.
		Consistency	<ul style="list-style-type: none"> Confirm all the navigational buttons with font in a consistent size and position. Applied the same buttons to perform the same behaviour in different interfaces.

Moreover, the functional and non-functional requirements are then gathered for system development direction requirements. As shown in Table 3, the functional requirement is to provide a certain service or function to the end-user. As shown in Table 4, the non-functional requirement determines the system's quality characteristic.

Table 3: Functional requirements

Functional Requirement	Description
Autonomous System Activities	<ul style="list-style-type: none"> Once users enter each module, the animated doctor was automatically moved his head and hand. The countdown timer was automatically decreased before users starts the game. The time duration for each level was decreased automatically once the game starts. The score was increased automatically according to the remaining time for the user answers the question correctly. The score was not increased automatically once the user answers the question wrongly. The background music was played automatically once the game start. A 'click' sound effect was played automatically once the user presses any button. The application was played the 'Cheering' sound effect when the game is completed The application was played the 'Failed' sound effect when the game is failed. The application was played the 'correct audio' sound effect when users answer the question correctly. The application was played the 'wrong audio' sound effect when users incorrectly answer the question. All the titles in this application were displayed in 'LiZiJunLinJian' font type at the top.

Table 3: (continued)

Functional Requirement	Description
Autonomous System Activities	<ul style="list-style-type: none"> • The application was provided feedback for every action done by users. • The animated game logo was displayed at the top of the interface. • The application was locked at all levels except the first-time user's EASY' Level.
User Interaction	<ul style="list-style-type: none"> • The application was enabled users to interact with all elements by using the touch screen approach. • The application was provided users a 'Settings' button to navigate the Settings Panel Interface. • The application was provided users an 'App Guide' button for users to navigate to the App Guide Panel Interface. • The application was provided users a 'Start' button to navigate the Module Selection Interface. • The application was provided users an 'Exit' button to navigate the Confirmation Exit Interface. • The application was provided users a tutorial for users with an overview of the content and structure of the game application. • The application was provided users a 'Next' button for users to navigate to the next page. • The application was provided users a 'Cancel' button to quit this panel interface. • The application was provided users with a 'Home' button to navigate the main menu interface. • The application was provided users with an 'Info' button to navigate the Info Selection Interface. • The application was provided users with a 'Game' button to navigate the Game Level Selection Interface. • The application was provided users with seven buttons for users to navigate to the info's as follows: <ul style="list-style-type: none"> ❖ 'Name' tab button navigates to the name of the vaccine. ❖ 'Country' tab button navigates to the manufacturing country of the vaccine. ❖ 'Shots Needed' tab button navigates to the dosage required for the vaccine. ❖ 'Effectiveness' tab button navigates to the significance of the vaccine. ❖ 'Type of Vaccine' tab button guides the technology used for the vaccine. ❖ 'Storage Condition' tab button navigates to the circumstances of preservation for the vaccine. ❖ 'Approval Date' tab button navigates to the date of authorization for the vaccine.

Table 3: (continued)

Functional Requirement	Description
User Interaction	<ul style="list-style-type: none"> • The application was provided a ‘Voice’ button to narrate the current feature of the vaccine after being pressed. • The application was provided a ‘Back’ button to navigate to the previous interface, Info Selection Interface. • The application was provided a ‘Back’ button to navigate to the previous interface, Module Selection Interface. • The application was provided three buttons for users to navigate to the Sub-Game Level Selection Interface as follows: <ul style="list-style-type: none"> ❖ ‘EASY’ button navigates to an easy level. ❖ ‘MEDIUM’ button navigates to medium level. ❖ ‘HARD’ button navigates to hard level. • The application was provided a ‘Pause’ button to navigate the Paused Panel Interface. • The application was provided an optical D-Pad for users to control the game character’s leftward, rightward, and upward motion. • The number of the moving obstacles was increased as the level increase. • The application was provided a ‘Cancel’ button for users to quit the fact board interface and move to the win or failed panel interfaces depending on users' scores. • The application was provided a ‘Module Selection’ button to navigate the Module Selection Interface. • The application was provided an ‘Game Level Selection’ button to navigate the Game Level Selection Interface. • The application was provided a ‘Resume’ button for users to continue the game. • The application was provided a ‘Restart’ button for users to reset the game. • The application was provided a ‘Home’ button to navigate the main menu interface. • The application was provided a ‘Settings’ button to navigate the Settings Panel Interface. • The application was provided a ‘Sound’ button for users to mute or unmute the sound effect of the application. • The application was provided a ‘Music’ button for users to mute or unmute the background music of the application. • The application was provided a ‘Cancel’ button for users to quit from the settings interface. • The application was provided a ‘YES’ button for users to quit the application. • The application was provided a ‘NO’ button to cancel the Confirmation Exit Interface.

Table 4: Non-functional requirements

Non-functional Requirement	Description
Usability	<ul style="list-style-type: none"> • Users were found the application easy to use, easy to learn, and enjoyable user experience. • Users were able to access the application anytime.
Performance	<ul style="list-style-type: none"> • The response time of the mobile game must within 1 second. • The application was operated offline wholly.
Implementation	<ul style="list-style-type: none"> • The application was able to operate on any Android mobile if it is Android 5.1 and above
Security	<ul style="list-style-type: none"> • Users were able to view the content involved in the application but cannot alter the content.
Cultural	<ul style="list-style-type: none"> • The game environment of this application was focused on those vaccines conditionally approved by Malaysia's government.

3.2 Pre-production Phase

Content structure, navigational structure, and flowchart on how to use this mobile game application are designed and illustrated in this phase. Therefore, this task can well-defined the module's function of the application and its game flow. The mobile game application design also needs to be completed in this phase, consisting of game object design, button design, and interface design. For reference, the flowchart diagram of the application is displayed in Appendix A. The interface design of the Hello Vaccines mobile game application is illustrated using a storyboard, also shown in Appendix A. It will consist of characters and background design. All of the scene's design are accomplished with Adobe Illustrator 2020 such as modelling the doctor and player by using pen and tools to draw out the concept arts and applied the colour on the characters mentioned above. Based on the user requirements analysis in Sub-Section 3.1 above, the interface design of the application must be visible and consistent in terms of size of buttons. Hence, users can easily navigate and learn how to utilize this mobile game application. Most of the interfaces are select high luminance with medical metaphor as the background of the interface to related with the theme of the application, COVID-19 Vaccination.

3.3 Production Phase

In the main menu interface, the background with medical metaphors hexagon of Hello Vaccines mobile game is utilized for first page of the application. The logo of the mobile game (HELLO VACCINES) is designed by using Adobe Illustrator 2020 and it will appear at the main menu of the application. Besides that, this logo will show before entering the application to notify user. This interface is created in a simple and tidy method to comfort the user experience while playing this application. Some buttons were chosen both icon and text-based, such as start button, back button, etc. For info module, the most important feature is the navigational must be navigating between different types of vaccine. Thus, it is important to ensure that the script snippet is implemented correctly to provide user-friendly module for users when they want to navigate between different vaccines. The script is also implemented on the voice button that allows users to play the information of vaccine via narration. For the game module, the C# script will be concentrated on the functionality and performance required in 2D gamification approach, such as player character, obstacles, question, the options, the score, timer, and other remaining objects for the game. Since the level do require unlocked features, thus some of the code script snippet in Hello Vaccines that contributes to the scene navigation of the prototype is attached in Appendix A. Besides that, the scripts are also implemented to ensure that users enable to open those pop-out panel or to navigate out from the 2D platform game.

3.4 Testing Phase

The testing phase of the GDLC approach is the crucial step. This phase will consist of two types of testing: alpha and beta testing. The alpha testing is going to be conducted by the application developer throughout the development process of the application until the project is completed whereas beta testing in terms of system usability scale (SUS) is carried out by distributing the mobile game application alongside with questionnaire to adolescents aged between 13 to 17 years old through online method. The questionnaire is presented in Google Form to collect the target users' feedbacks regarding of their satisfaction towards the developed mobile game application. After the data is collected in the form of target users' feedback, they are evaluated and taken into consideration as future improvement. Any flaws with the application that are identified will be noticed and fixed as soon as possible. Table 5 below shows the results of alpha testing in this example.

Table 5: Results of alpha testing for Hello Vaccines

Test	Expected Result	Actual Result	Improvement required
Home Buttons	Navigate to the home scene.	Works well as expected.	Not required.
Start Button	Navigate to the module selection scene.	Works well as expected.	Not required.
App Guide Button	Navigate to the tutorial video scene.	Works well as expected.	Not required.
Close Buttons	Close the panel.	Works well as expected.	Not required
Settings Buttons	Show setting panel.	Works well as expected.	Not required.
Exit Button	Shows confirmation panel.	Works well as expected.	Not required.
Mute Buttons for Sound Effects	Mute all the sound effects.	Works well as expected.	Not required.
Unmute Buttons for Sound Effects	Unmute all the sound effects.	Works well as expected.	Not required.
Mute Buttons for Background Music	Mute the background music.	Works well as expected.	Not required.
Unmute Buttons for Background Music	Unmute the background music.	Works well as expected.	Not required.
Yes Button in Exit Panel	Quits game.	Works well as expected.	Not required.
No Button in Exit Panel	Close the confirmation panel.	Works well as expected.	Not required.
Info Button	Navigate to the info selection module scene.	Works well as expected.	Not required.
Game Button	Navigate to the game level selection scene.	Works well as expected.	Not required.
Pfizer Button	Navigate to the Pfizer info scene.	Works well as expected.	Not required.

Table 5: (continued)

Test	Expected Result	Actual Result	Improvement required
Sinovac Button	Navigate to the Sinovac info scene.	Works well as expected.	Not required.
AstraZeneca Button	Navigate to the AstraZeneca info scene.	Works well as expected.	Not required.
Sputnik V Button	Navigate to the Sputnik V info scene.	Works well as expected.	Not required.
Back Button in Info Selection Module	Navigate to the module selection scene.	Works well as expected.	Not required.
Back Buttons in each Info Panel	Navigate back to the info selection scene	Works well as expected.	Not required.
Name Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Country Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Shots Needed Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Effectiveness Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Type of Vaccine Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Storage Condition Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Approval Date Button in respective Info Panel	Shows respective information	Works well as expected.	Not required.
Voice Buttons in Pfizer Info Panel	Play the narration for respective information	Unable to play the narration clip.	Checks all the audio sources to ensure all the audio is completely link to the buttons.
Back Button in Game Level Selection Panel	Navigate to the home scene	Works well as expected.	Not required.
“EASY” Level Button	Navigate to the “EASY” Level game scene	Works well as expected.	Not required.

Table 5: (continued)

Test	Expected Result	Actual Result	Improvement required
“HARD” Level Button	Navigate to the “HARD” Level game scene	Works well as expected.	Not required.
Pause Buttons	Show paused panel	Works well as expected.	Not required.
Resume Buttons	Close paused panel	Works well as expected.	Not required.
Restart Buttons	Show restart confirmation panel	Works well as expected.	Not required.
Yes Buttons in Restart Confirmation Panel	Restart the game	Works well as expected.	Not required.
No Buttons in Restart Confirmation Panel	Close the restart confirmation panel	Works well as expected.	Not required.
Yes Buttons in Back to Main Menu Confirmation Panel	Navigate to the home scene	Works well as expected.	Not required.
No Buttons in Back to Main Menu Confirmation Panel	Close the back to main menu confirmation panel	Works well as expected.	Not required.
Game Level Selection Buttons in Failed and Win Panels	Navigate to the game level selection panel	Works well as expected.	Not required.

4. Results and Discussion

The results of beta testing for the developed mobile game application, Hello Vaccines, were discussed in this section. In this case, a set of questionnaires were presented on Google Form and distributed to the testing subjects alongside the APK file of the application. A group of 30 students selected randomly from SMK Kepong, Kuala Lumpur, were used as respondents. The distribution of the materials for beta testing to students was successful via online method. At the end of beta testing, a total of 30 students had participated by filling out this questionnaire. The beta testing results are displayed in Appendix A. The system usability scale (SUS) method of questions in Google Form that focus on the application's features are mainly divided into two sections: user acceptance level, as well as application functionality and performance. Regarding to the Figures 2 and 3, the gender and the range of age of the respondents have been illustrated below.

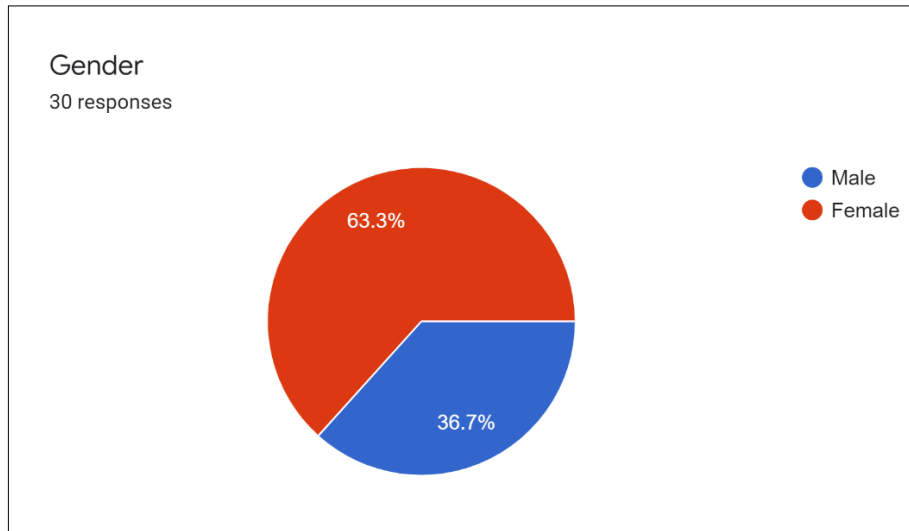


Figure 2: Gender of respondents

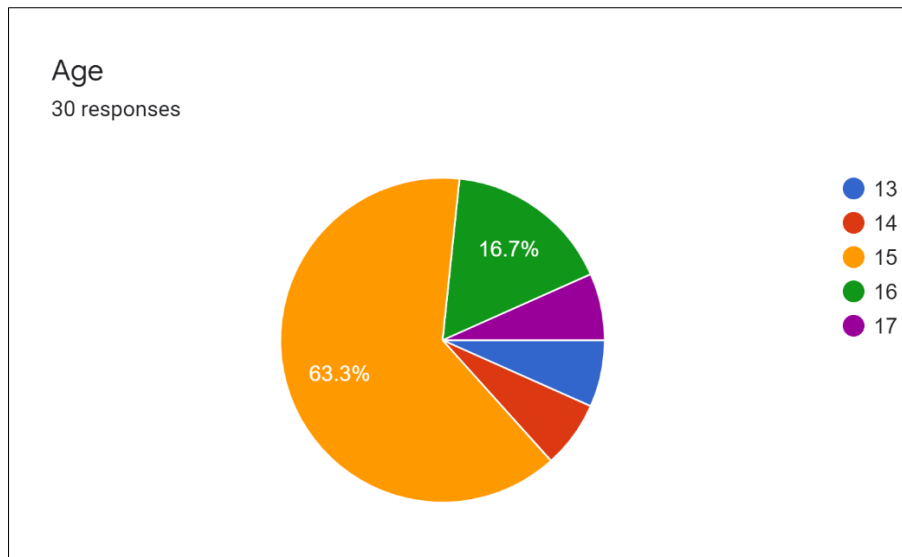


Figure 3: Age of respondents

In this section of beta testing, there were a total of 30 teenagers who took part. The 30 respondents are 11 male teenagers (36.70%) and 19 female teenagers (63.30%) as shown in Figure 2. Based on Figure 3, three (6.7%) respondents are 13 years old, 14 years old and 17 years old respectively, 5 (16.70%) respondents are 16 years old, and the rest 19 (63.30%) respondents are all 15 years old.

From the result of Google Form, there are six questions in Section B, which is user acceptance level, as shown in Figure 12, Appendix A. All the question under this segment were answered with positive feedback from the chart shown. Nevertheless, there are still a few respondents given negative or ambivalent answers to various questions.

Firstly, the 1st question is whether the application is easy to use or not. Most of the users have a high acceptance of the game which there are 9 out of 30 respondents (30%) agreed that the application is easy to use followed by 17 out of 30 respondents (56.7%) strongly agreed that the application is easy

to use, while only 2 users (10%) claimed moderate understandable level and disagreed with the statement.

Furthermore, the analysis of the 2nd question in this part, which ask the user to scale whether the interface design in Hello Vaccines is their favourable or not. Only 1 user (3.3%) disagree with the interface design of the application, while 11 out of 30 users (36.7%) agreed with the interface design of the application, however there are 18 users (60%) strongly agreed with the interface design of the application.

In addition, the 3rd question in this part is asking the user whether the navigation of the application is clear or not. There are 18 users (60%) strongly agreed that the navigation in Hello Vaccines is clear, while still 8 users (26.7%) agreed that the navigation in Hello Vaccines is clear also. There are same number, 2 of the respondents (6.7%) who disagreed and claimed moderate for the navigation of the application is clear.

Besides, the 4th question in this part is asking the user whether they know where to access the information of each vaccine that they want in the application. 18 of the respondents (60%) who strongly agreed that they know where to access the information of each vaccine that they want in this application, while there are still 9 users (30%) agreed that they know where to access the information of each vaccine that I want in Hello Vaccines. On the other hand, there are only 2 users (6.7%) and 1 user (3.3%) claimed the understandable level of the application is disagreed and moderate, respectively.

Next, the 5th question in this part is whether the game is interesting or not. There are 43.30% of respondents, 13 out of 30 respondents, strongly agreed that the intention to complete all levels in this application. Plus, 12 out of 30 respondents (40%) agreed the intention to complete all levels in this application. In contrast, there are 4 users (13.3%) disagreed that they are interested on completing all levels in Hello Vaccines, as the game progresses to higher levels, it will be more challenging to complete causes 1 user (3.30%) claimed that the interesting level of the game is moderate.

Lastly, the last question in this part is whether the game is challenging to be played or not. There are (70%) of respondents, 21 out of 30 respondents, strongly agreed that the game is challenging to be played. Moreover, 8 out of 30 respondents (26.7%) agreed the game is challenging to be played. However, 1 user (3.3%) finds that the game is not challenging enough. As a result, the user acceptability level overall results show good and positive feedback from the respondents.

For the analysis of Section C, which is asks for users' opinion on the functionality and performance of the application, as shown in Figure 13, Appendix A.

The 1st question is whether the user can click and interact with those buttons or not. All respondents agreed with the statement, while 20 out of 30 of them (66.7%) even strongly agreed that they can function the buttons well, while 10 users (33.3%) agreed that those buttons are well functioned.

Besides, the 2nd question in this part asks the user whether the tab buttons can be click and view the information of each vaccine in the info module of the application. Almost all respondents agreed with the statement, which 22 out of 30 of them (73.3%) even strongly agreed that tabs buttons can be click and view the information of each vaccine in the info module of the application, while 6 users (20%) can click the tab buttons and view the information of each vaccine in info module. However, there are same number, 1 user (3.3%) disagreed and claimed moderate for this statement.

In addition, the 3rd question in this part is whether the voice buttons can be click and listen the narration of the feature for each vaccine in the info module of the application. 15 out of 30 respondents (50%) strongly agreed to this statement, while 11 of them (36.7%) agreed with the statement. However,

as the voice progress, 3 users (10%) disagreed with this statement, and only one user (3.30%) claimed the statement with moderate.

Furthermore, the 4th question in this part is whether the button in the selection menu can be click and play the respective level of game. Almost all the respondents agreed with the statement, where 20 users (66.7%) strongly agreed, and 8 users (26.7%) agreed on it, however, as the game continue played by users, the difficulty of each level was increased, thus there are 2 users (6.7%) disagreed with this statement.

Additionally, the 5th question in this part is whether the player character can be controlled to move to the option that they want and answer the questions or not. All the respondents agreed with the statements. 21 out of 30 users (70%) strongly agreed the player character can be controlled well to move to the option and answer the questions, while 9 of them also agreed with the statement. As a result, all five questions were answer positively, meaning that the purpose of the game to create awareness and enhance information was met.

Lastly, the last question in this section is whether the respondents would recommend this application to their friends or not, as reveals below in Figure 4. All the respondents agreed to share this application with their friends. The percentage that represents the result of this question is 100%.

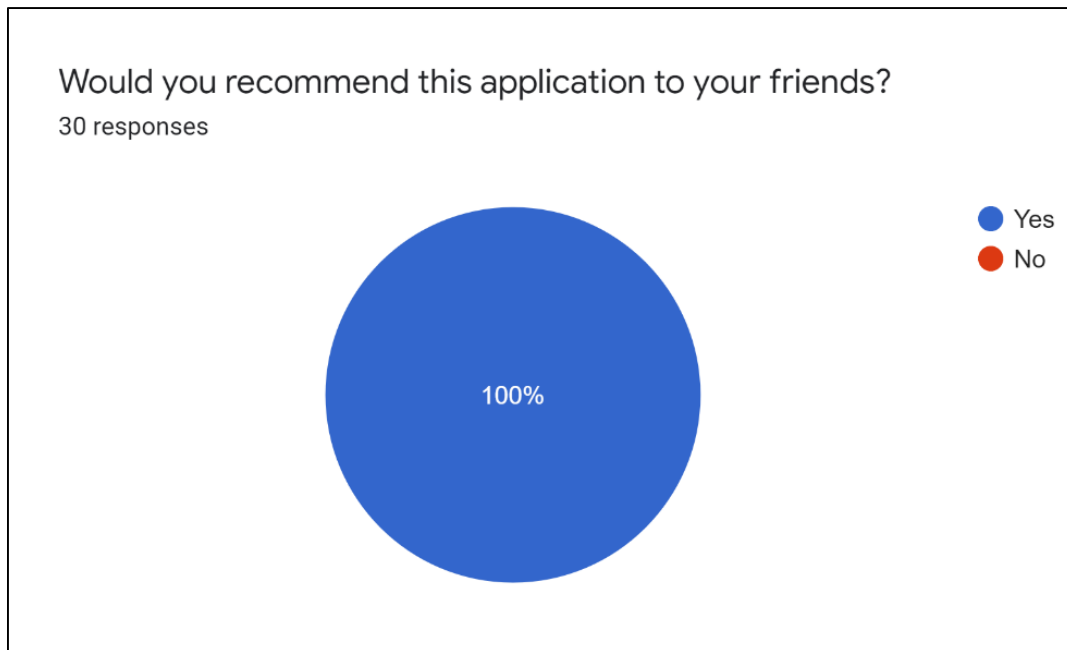


Figure 4: Last question in the Level of Functionality and Performance Test

To recap, Hello Vaccines overall percentage of beta testing in terms of system usability scale (SUS) resulted in a positive outcome, with a percentage gained of 89.3%. The result shows that the overall outcome is satisfactory since most criteria for 30 users' expectation and satisfaction have been reached. Therefore, it has concluded that this application consists of several advantages as following:

- i. Hello Vaccines has a good user approval rating, indicating that teenagers love playing the game.
- ii. Hello Vaccines is a highly functional programme. This is because all the buttons, panels, and scenarios are displayed correctly. Furthermore, dependent on the situation, all background music and sound effects are played correctly.
- iii. Hello Vaccines includes textual information, graphical icons, animation, video, background music, and sound effects, among other things.

- iv. Countdown features increase the expectation of competition experience; they will always get ready and well prepared before the game started.
- v. Unlock features increase teenager's interest and ability; they will no longer see awareness game as boring games but rather challenges to overcome the game with rising difficulty.
- vi. Users can play Hello Vaccine without having to be connected to the internet. It benefits the target audience, particularly those with inadequate internet access.

Nevertheless, Hello Vaccines had showed its advantages, but at the same time it also has its own weaknesses which is found after analysing the results of user testing. The limitation of this application is listed as following:

- i. There are only 1 character designed in the game application. Therefore, the users can only use 1 character throughout these 3 game levels.
- ii. There is no booster in the game.
- iii. The character in the application has only applied 3 types of animation which less lifelike to represent the character.

In this condition, some improvements that can be implemented in the future of Hello Vaccines to solve its current limitations are also suggested in the end of the project. The suggested future works are shows as following:

- i. Create more different characters for users to purchase in application, while develop various strengths for each character to demonstrate their speciality.
- ii. Provide some boosters in the game, such as a power that can temporary immune from viruses' attack and power that can double the score for certain questions to obtain higher score.
- iii. The character's movement can be more specific by add-on more unique actions such as bow during escaping from viruses' attack and landing when the character is not flying.

5. Conclusion

In conclusion, Hello Vaccines is a successful game developed using a well-planned Game Development Life Cycle methodology by using software such as Unity Game Engine, Visual Studio, and Adobe Illustrator. The design content of Hello Vaccines using dynamic 2D gamification approach to emphasise the COVID-19 vaccination facts and awareness. Hello Vaccines is developed on the Android mobile platform by installed Android SDK and JDK plugins in Unity, then publish the completed APK file from Unity to Google Drive to enable users from download and install the app on Android mobile. During the testing phase, a range of target users aged from 13 to 17 were performed the usability, functionality, and acceptance towards Hello Vaccines. Thus, all three goals of project have been encountered, the advantages and limitations of the application were also identified after analysing the results of the user acceptance test during beta testing. Besides that, those recommendation and significant enhancements can be able to enhance Hello Vaccines in no longer future.

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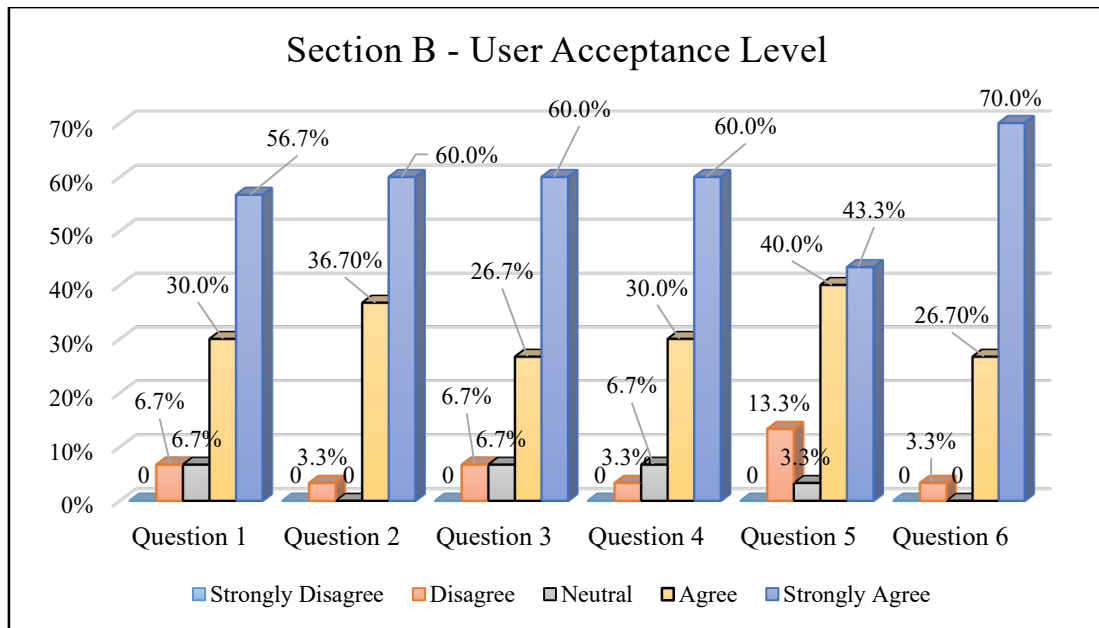


Figure 12: Result of Section B for Hello Vaccines

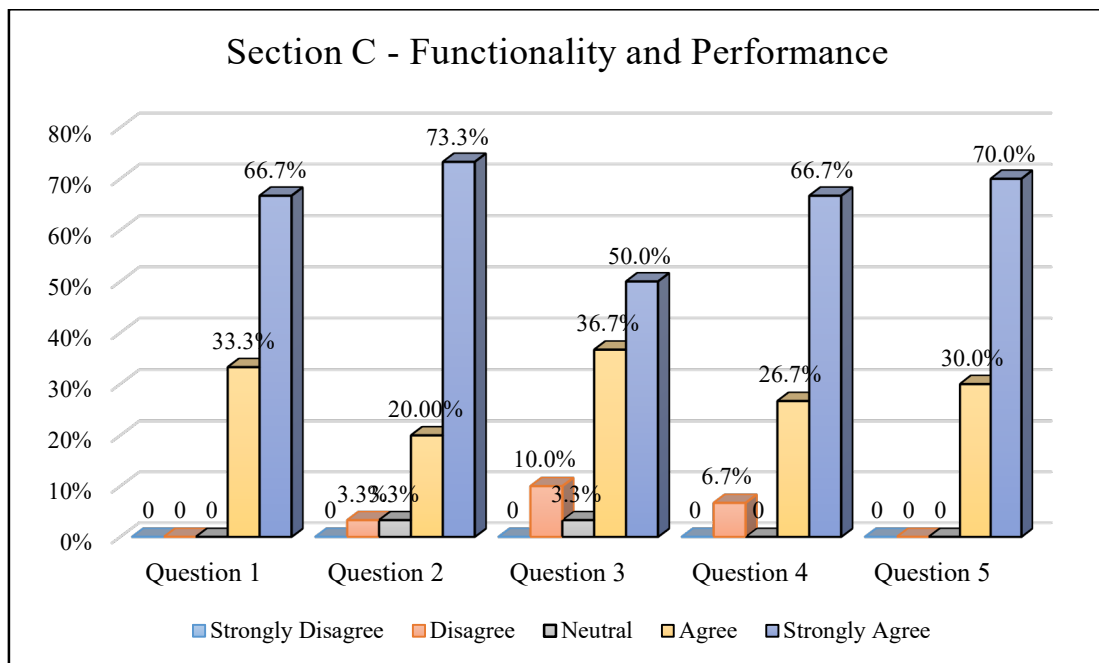


Figure 13: Result of Section C for Hello Vaccines

References

- [1] J. Kaos JR & R. Rahim, *Covid-19: Health Ministry in discussion to procure vaccines for children aged below 12, says KJ*, The Star, 24 Sept 2021. [Online]. Available: <https://www.thestar.com.my/news/nation/2021/09/24/covid-19-health-ministry-procuring-vaccines-for-children-aged-below-12-says-kj> [Accessed on Oct. 1, 2021]
- [2] CodeBlue, *Klang Valley to Give Teens Covid-19 Jabs After Sarawak, Labuan*. CodeBlue, 7 Sept 2021. [Online]. Available: <https://codeblue.galencentre.org/2021/09/07/klang-valley-to-give-teens-covid-19-jabs-after-sarawak-labuan/> [Accessed on Oct. 1, 2021]

- [3] Justin Ng, *All you must learn about Malaysia vaccinating teens under 18 against Covid-19*. 1 Oct 2021. [Online]. Available: <https://www.lifestyleasia.com/kl/living/wellness/all-you-must-know-about-malaysia-vaccinating-teens-under-18-against-covid-19/> [Accessed on Oct. 1, 2021]
- [4] Dorit R. Reiss, *The COVID-19 Vaccine Dilemma*, 6 Admin. L. Rev. Accord 49, 2020. [Online]. Available: https://repository.uchastings.edu/faculty_scholarship/1798 [Accessed on Oct. 1, 2021]
- [5] Kremer, Michael; Snyder, Christopher M, *Strengthening incentives for vaccine development*, NBER Reporter, ISSN 0276-119X, National Bureau of Economic Research (NBER), Cambridge, MA, Iss. 4, pp. 7-11, 4 December 2020. [Online]. Available: <http://hdl.handle.net/10419/234015> [Accessed on Oct 30, 2021]
- [6] Syed Alwi, S.A.R., Rafidah, E., Zurraini, A. et al, *A survey on COVID-19 vaccine acceptance and concern among Malaysians*. BMC Public Health 21, 1129, 12 June 2021. [Online]. Available: <https://doi.org/10.1186/s12889-021-11071-6> [Accessed on Oct 30, 2021]
- [7] Sharma, S. K., & Mohan, A, *Tuberculosis: From an incurable scourge to a curable disease - journey over a millennium*. The Indian journal of medical research, 137(3), 455–493, 2013. [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3705655/> [Accessed on Oct 30, 2021]
- [8] Xu, F., Buhalis, D., & Weber, J, *Serious games and the gamification of tourism*. Tourism Management, 60, 244-256, 18 December 2016. [Online]. Available: <https://doi.org/10.1016/j.tourman.2016.11.020> [Accessed on Oct 30, 2021]
- [9] (2020), *Coronavirus Evolution* [Desktop app]. Retrieved from STEAM store. https://store.steampowered.com/app/1264770/Coronavirus_Evolution/
- [10] (2020), *Can You Save The World?* [Desktop & Web app]. Retrieved from ITCH IO: <https://martin-jacob.itch.io/can-you-save-the-world>
- [11] (2021), *Virus Wars* (Version 1.8.6) [Mobile app]. Retrieved from Google Play Store. https://play.google.com/store/apps/details?id=com.calamosgames.viruswars&hl=en_US&gl=US
- [12] Ramadan, R., & Widyani, Y, *Game development life cycle guidelines*. Tidbits, 2013. [Online]. Available: <https://mmotidbits.com/2009/06/15/project-management-for-gamedevelopment/> [Accessed on Oct 30, 2021]