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Development of Road Rules Learning Application Through Game-Based Approach

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Abstract: Road Signs Education is an application which is using the gamification approach to learn the traffic sign. To learn driving, the problem is we need an actual car and get a driving license at a proper driving school or institution by taking the course of Driver Education Curriculum (DEC). All these processes required a lot of cost and time, especially for those foreigners. Therefore, the project objectives are to design and develop a road sign learning application using a gamification approach on the Android platform and evaluate the user acceptance level of the application using the Technology Acceptance Model (TAM). Moreover, the main components that have been developed in Road Signs Education are including "Learn" mode, "Test" mode, and "Play" mode. Mobile Application Development Life Cycle is chosen as the methodology to develop the application. Furthermore, the application is developed by using Unity and C# programming language. Road Signs Education is finally developed completely, and it was tested using alpha testing and user acceptance testing. The results of the user acceptance test indicated a positive feedback rate of 88.01%. Overall, the developed application has achieved all the objectives of the project. Thus, this game-based application could act as a traffic sign learning tool for the community to have a better knowledge about the traffic sign in Malaysia.

Keywords: Road Signs, Mobile, Android

1. Introduction

A news article from The Star shows that fatal road accident has been recently increasing these years in Malaysia especially the issue of drunk driving. In 2020, 206 fatal accident cases were recorded compared to 197 incidents in 2019 according to our Deputy Inspector-General of Police Datuk Mazlan Mansor. The majority of the drivers in Malaysia are rude and treat driving like a playground even not obeying the road rules. Accordingly, people in Malaysia must learn the proper knowledge of driving to get a driver's license at the driving school. However, the road user does not only consist of Malaysian but there are also compromised foreigners from all around the world [1].

To learn driving, the problem is we need an actual car and get a driving license at a proper driving school or institution by taking the course of Driver Education Curriculum (DEC) which required a lot

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of cost and time especially for those who are foreigners. Besides that, our movement is currently restricted by our government since we are under a pandemic period. Also, to pass the theory of driving examination, also known as the Highway Code Exam, one is required to study the Malaysia Driver Guide's Book with 500 questions about the driving rules in Malaysia road [2]. This would be weary for other people to learn so much knowledge from a book. Apart from that, most people may have been forgotten the road rules after they are getting their driving license. All these problems could be troublesome for the international learner and foreigners to learn the road rules effectively. Therefore, this project attempts to design a road sign learning application using a gamification approach, develop a learning application for the Android platform, and evaluate the application by using alpha testing and perform the user acceptance testing among the international learners and foreigners who are living in Malaysia.

The first concept that applied in the application is Game-Based Learning. Game-Based Learning (GBL) refers to the learning method that integrates educational content or learning designs with gameplay [3]. The evaluation report demonstrates the educational game was useful to teach the learners about the theories of rules and regulations for driving. Hence, the implementation of the GBL concept on education application as a facilitating learning tool would increase learning efficiency [4]. Although the structure of GBL is useful for learning, due to the ability of engaging people, it may cause them obsessed with it even getting the gaming addiction [5]. In game and gamification, People can be engaged and motivated in a game mechanism. A game mechanism has the game elements, such as scores, achievements, badges, levels or leaderboard [6]. According to Dicheva et al. scores, badges, levels, progress displays, leaderboards, virtual currencies, and avatars were also classified as the key elements in the game mechanics [7].

The second concept that applied in the application is Mobile e-learning. Mobile e-learning which stated by Clark Quinn is "the intersection of mobile computing and e-learning: accessible resources wherever you are, strong search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment. E-learning independent of location in time or space." [8]. Furthermore, Ann Jones and his research team claim that the features of mobile devices contained six aspects why mobile devices may be motivating, namely: freedom, ownership, communication, fun, context, and continuity [9]. Additionally, mobile e-learning support situated learning, identity learning, and problem-solving. Whereas mobile e-learning has the strength to improve learning performance and efficiency, but there are few limitations such as the tiny screen size of mobile devices, and their short battery life [10].

This project is to develop a gamification application in learning Malaysia's road signs (Road Signs Education) and the language of the content in the application is using English. Furthermore, this project is to develop an offline Android application. Road Signs Education comprises of three main modes, which are "Learn" mode, "Test" mode, and "Play" mode. For the "Learn mode, it consists of 5 categories of road signboards and there will be a description for each signboard. While the "Test" mode is the same as the "Lesson" mode where it consists of 5 different categories of road signboards, the user can choose one of the categories to be tested. The test is using a multiple-choice question method and all the questions have 4 different options. Each category of the test has 15 questions, and the user has only 3 chances to choose the wrong option. Last is the "Play" mode, this mode is containing 3 levels, "Easy", "Medium", and "Hard", it is a top-down view car game. At each level, the user can control the car movement and collect the Star by reaching the finish line in a limited given time. Furthermore, the user is allowed to manage the profile by editing the name and view the achievement unlocked where it records the game that the user has completed. Last but not least, the user can spend the collected Star by customizing the appearance of the car.

The next section of this report is the second section where it will discuss the related work in this project. After that, the third section will demonstrate the methodology that used in this project. Then,

the fourth section will explain the result and discussion of the application. Consequently, the conclusion and the further works will be outlined in section five.

2. Related Work

This section is discussed about the related work of the project study. Also, the review of the existing application and their comparison results are explained in this section.

2.1 Driver Education Curriculum

The system overview states that it is compulsory to pass the Driver Education Curriculum (DEC) program before driving on the road in Malaysia. DEC is the program for training and licensing drivers at all driving institutes nationwide. This program is designed for the new driving learner and road user to understand the regulations of the safety road [11].

Furthermore, Road Transport Department (JPJ) has launched the Driver's Education Curriculum handbook to assist the learner with a better understanding of the road rules and regulations. The handbook mentioned that the purpose of DEC is to establish a knowledgeable, skilled, cautious, and competent, and practice good values of drivers and road users. Moreover, the handbook consists of seven chapters with a few subsections. All the chapters are included with Road User's Guide, Highway Code, Defensive Driving, Driving in Various Situations, Health and Safety Requirements for Drivers, Law and Driving Offences, Regulations and Laws Relating to Motorcyclists [2].

2.2 Current Existing Application Review

Several applications are similar in the market and most of them attempt a similar concept and implement the gamification approach in the application. Hence, the similar existing applications are selected for this study are including Road Sign Education Game, Traffic rules for children, and Drive Exam [12] [13] [14]. Table 1 shows the comparison of these existing applications with the developed application.

Table 1: Comparison of the existing applications with the developed application

Application	Road Sign Education Game [12]	Traffic rules of children [13]	Drive Exam [14]	Road Signs Education
Platform	iOS 10.0 or later	Android 4.4 and up	iOS 9.0 or later	Android 4.4 and up
Category	Education, Quiz game	Education, Quiz game, Point-and-click game	Test game	Education game, Top-down view car game
Language	English	Portuguese, English, Bulgarian, Spanish, Japanese, Chinese, Indonesian, Italian, Hindi, French, Arabic, German, Greek, Korean	English	English
Strength	It has a good concept for learning road rules by using puzzle game tests.	It can support up to 14 languages and a colourful interface design.	It has an attractive background interface and user friendly.	Contain multimedia components and an attractive interface.

Table 1: (continued)

Application	Road Sign Education Game [12]	Traffic rules of children [13]	Drive Exam [14]	Road Signs Education
Limitation	• Without a scoring system. • Endless practice in puzzle game tests makes the user lose the intention.	• Lack of traffic signs' information. • The buttons of the application are not iconic.	• Does not provide the status of the current unlock level.	• It only supports 1 language (English). • Only cover 3 modes (Learn, Test and Play).
Improvement	• Can be improved by adding the scoring method in the game test.	• Can be improved by adding the lesson of the road sign. • Optimize the button design with the common symbol that is related to the button function.	• Can be improved by adding the current level and total levels of the game.	• Can be improved by adding more languages. • Can be improved by adding more levels in Play mode.
Game Elements	• Without achievements, levels, avatars, and scores	• Without achievements, avatars and scores.	• Without achievements, levels, avatars, and scores.	• It has achievements, levels, avatars (customize car) and scores.

According to the observation and the comparison review from Table 1, all the applications are having their strengths and limitations, but Road Sign Education Game [12], Traffic rules for children [13], and Drive Exam [14] are lacking the game elements compare to the developed application (Road Signs Education). Therefore, the limitations of these three related applications are lead to the development of the application (Road Signs Education).

3. Methodology

The methodology that has been chosen for this project is the Mobile Application Development Life Cycle (MADLC). The phases of MADLC are including Identification, Design, Development, Prototyping, Testing, Deployment and Maintenance [15].

3.1 Identification Phase

The first thing in this phase is to decide about the application's intent. Besides that, it is necessary to identify the scope and the target user of the application. Moreover, the proposed application must have an appropriate mobile platform such as Android-based and iOS. In this project, the proposed application will be developed for the Android application. All these aspects in this stage are probably done at the title defence and written inside the proposal. During this process, two types of requirements are done, the first is the user requirement and the second is the system development requirement.

In the user requirement, the selected audience are the students at University Tun Hussein Onn Malaysia. Moreover, the questionnaire approach has been used to collect the data among the students at University Tun Hussein Onn Malaysia. However, it is due to the pandemic duration, the questionnaire

is going through Google Forms and 60 respondents participated in the survey. In addition, there is a total of 10 questionnaire questions are prepared in this Google Forms which are categorized by personal information, understanding analysis, and application delivery analysis. All the questions in the questionnaire could be answered by "yes" or "no". Therefore, it is the closed-ended questions to gather information from the respondents. Table 2 shows the outcome of the requirement analysis in the identification phase.

Table 2: Result of the requirement analysis

Gender	Number of respondents	Total
Male	31	60
Female	29	
Questions	Yes	No
Do you have a driving license?	85%	15%
Did you go to a driving school to learn about knowledge of Road Safety?	91.7%	8.3%
Have you ever read the Rules of the Road Regulations?	90%	10%
Could you remember all the Road Signs?	13.3%	86.7%
Being a road user, do you follow the traffic laws?	53.3%	46.7%
Is it important to learn the Road Rules and Regulations?	86.7%	13.3%
Do you spend more time on your smartphone than on your computer?	91.7%	8.3%
Would you prefer to learn traffic rules through smartphones?	86.7%	13.3%
Do you recommend offline-based learning apps?	86.7%	13.3%
Would you recommend everyone to use an English learning app?	91.7%	8.3%

Moreover, the application requirement is identified by the requirement of software and hardware for using the application. Hence, the user must fulfil the minimum requirement of software and hardware when using the application. Table 3 shows the software and hardware requirement of the user.

Table 3: Software and hardware requirements for user

Requirement	Item	Description
Software	Operating System	Android 4.4 'KitKat' (API level 19) and above version.
Hardware	Smartphone device	Minimum requirements: 1 GB RAM of memory and 50 MB available space of storage.

Hence, at the end of this phase, the outcome is produced according to the task in this phase. Table 4 show the result of the task in the identification phase.

Table 4: Task and outcome of the identification phase

Task	Outcome
• Identify target user. • Select the platform of the application. • Create a project schedule. • Requirement analysis form. • Identify the scope of the project.	• Project proposal. • Gantt Chart. • Data requirement analysis from the respondents. • Software and hardware requirements.

3.2 Design Phase

The design of the application has included the layout of navigation, buttons and other visual elements. Initially, the user interface of the application was designed by using wireframes for each interface page. Before designing the storyboards, the use case diagram and flowchart are created to show the clear path of the application structure.

Figure 1 shows the structure of the use case diagram. The name of the boundary diagram is Road Signs Education Application Structure. There is only one stakeholder involved in the application which is the user. In this use case diagram, the application will be launched by the user. After the application is launched, six processes can be chosen by the user which includes "View Profile", "Select Learn module"," Select Test module", "Select Play module", "Custom car" and "View About". As an example, after the action of "View Profile", the next action will be the Edit Name" and "Display achievement". The structure of the use case diagram is presented in Figure 1.

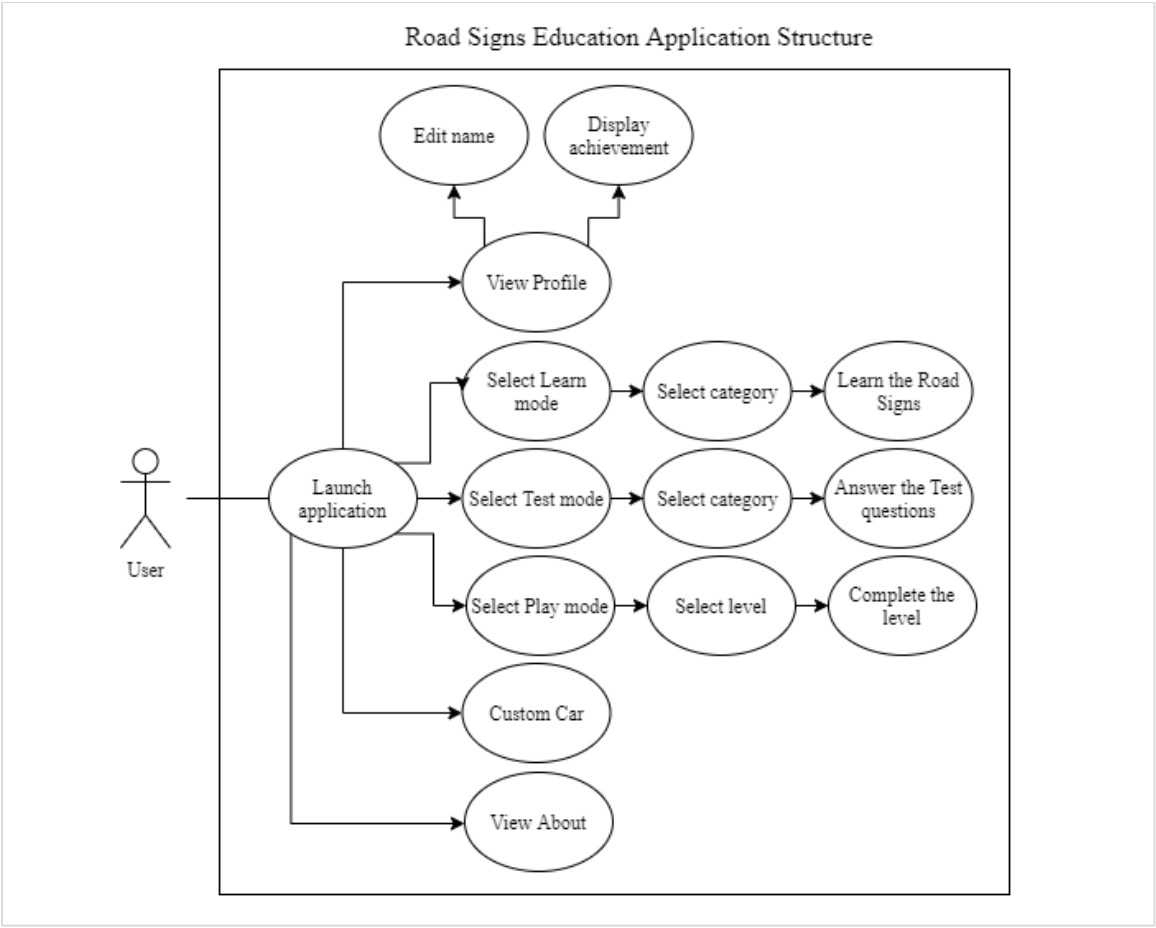


Figure 1: Structure of use case diagram

The use of the flowchart is to better comprehend the process of the overall application architecture. According to the flowchart shown in Figure 2, Road Signs Education has the main menu interface. There are consisting of three modes: "Learn", "Test", and "Play". In the "Play" mode, it consists of three levels: "Easy", "Medium", and "Hard". Besides that, every single mode and level has its process. As an example, when the user chooses the "Test" mode, the next process will be to determine whether the user win or not, and if the user won, it would show the success message. After that, the application will ask the user whether want to try again, if the user chooses not, it will go back to the Main Menu. The flowchart of the application is shown in Figure 2.

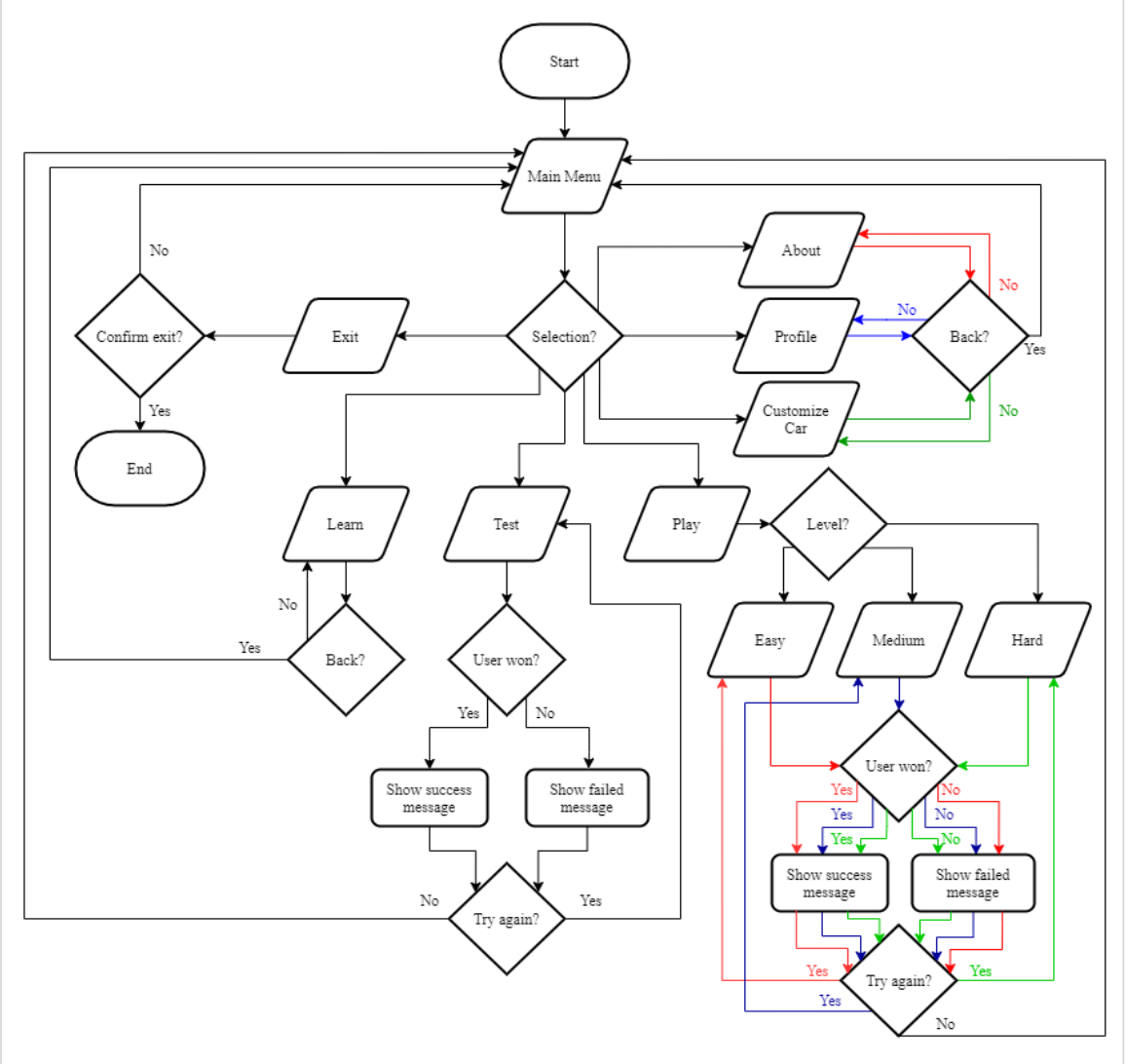


Figure 2: Flowchart of the application

Furthermore, the storyboard is used to describe the application in detail to show the sequence of the graphics interface representation. Figure 3 shows the example storyboard of the application.

Figure 3: Storyboard of the application

Therefore, the outcome is produced according to the task at this current phase. Table 5 shows the task and outcome of the design phase.

Table 5: Task and outcome of the design phase

Task	Outcome
• Propose the overall structure of the application. • Design the storyboard.	• Use-case diagram, flowchart, and storyboard.

3.3 Development Phase

In this phase, Unity and the C# programming languages used in developing the application. Some of the features will be explained in detail such as collect Star, countdown timer, achievement unlocked, audio components, test game, and top-down view car game. Figure 4, Figure 5, and Figure 6 show the process of collecting stars.

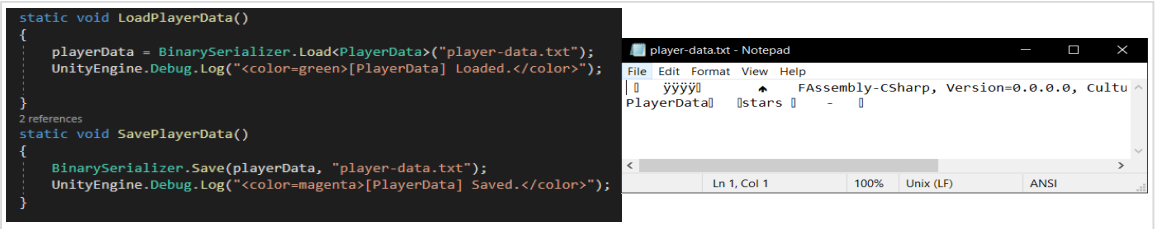


Figure 4: Load and Save Script snippet and player-data text file

Figure 4 shows the Load and Save method by using BinarySerializer, the data (collected star amount) will be saved into the file of player-data.txt. To avoid users changing the data, the user data will be saved in binary format.

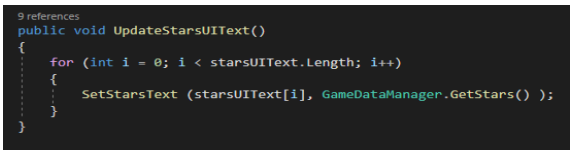


Figure 5: Update star amount script snippet

In Figure 5, the collected Star amount is set to display in the UI text form. The collected Star amount will be updated by getting the collected star amount from the GameDataManager.GetStars().

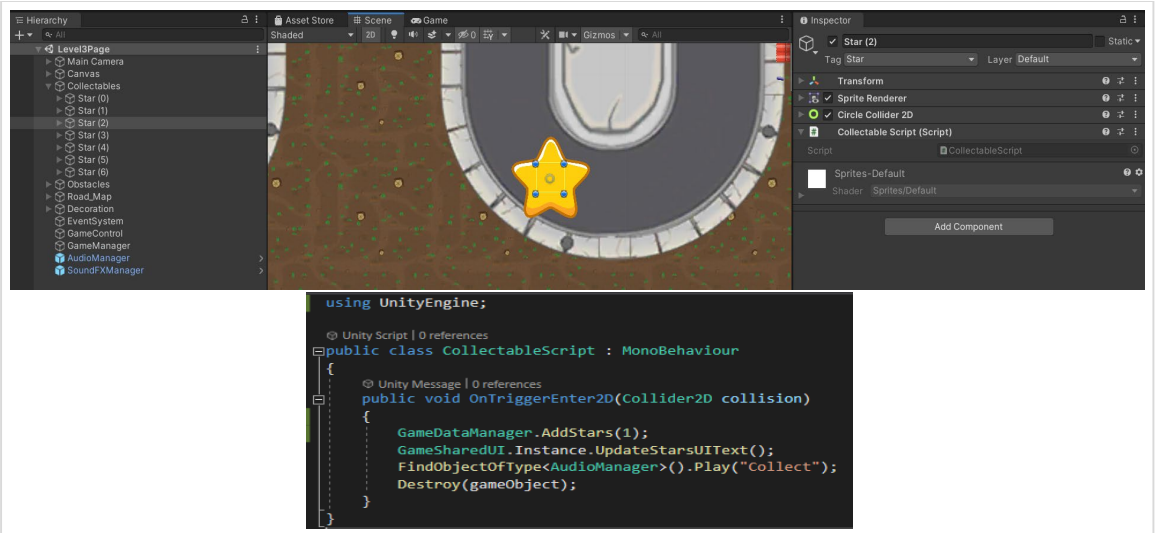


Figure 6: Star game object and collet star script snippet

In Figure 6, the Star game object is set to a collider where the car collides with the star, the collected star amount will be updated. Besides that, the star has added a script where it uses GameDataManager.AddStars(1) and UpdateStarsUIText() to update the collected stars amount.

A countdown timer is used in the Road Signs Education. The countdown timer is implemented into the "Test" mode and "Play" mode. Figure 7 shows how the countdown timer works.

```
private void Update()
{
    if (gameStatus == GameStatus.Playing)
    {
        currentTime -= Time.deltaTime;
        SetTimer(currentTime);
    }
}

1 reference
private void SetTimer(float value)
{
    TimeSpan time = TimeSpan.FromSeconds(value);
    quizUI.TimerText.text = "Time = " + time.ToString("mm':'ss");

    if(currentTime <= 0)
    {
        gameStatus = GameStatus.Next;
        StartCoroutine(WaitAndDelayLosePanel());

    }
}
```

Figure 7: Countdown Timer Script Snippet

Based on the countdown timer script snippet shown in Figure 7, the function of SetTime(float value) is to set the time in the format of minute and second. Also, there is an if statement where the currentTime is less than or equal to 0, the game will be lost. There is an Update () that will update the currentTime by deducting per second.

When the users completed the game level, there will be an achievement unlocked for them. It is important to save the completed level progress because it helps the user to identify which level is not completed. Figure 8, Figure 9 and Figure 10 show the process of implementing the Achievement Unlocked Panel.

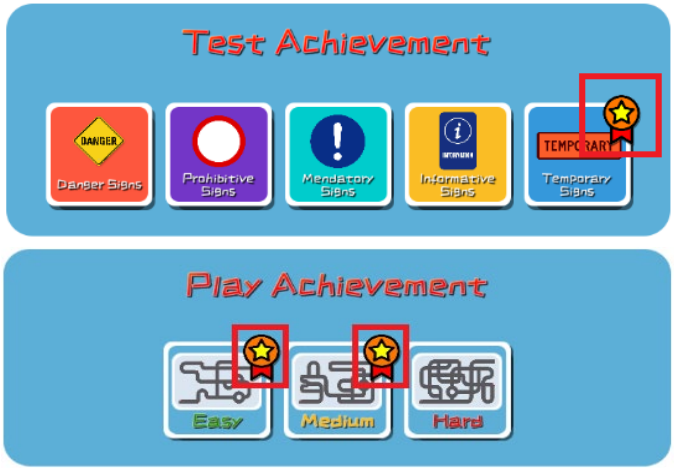
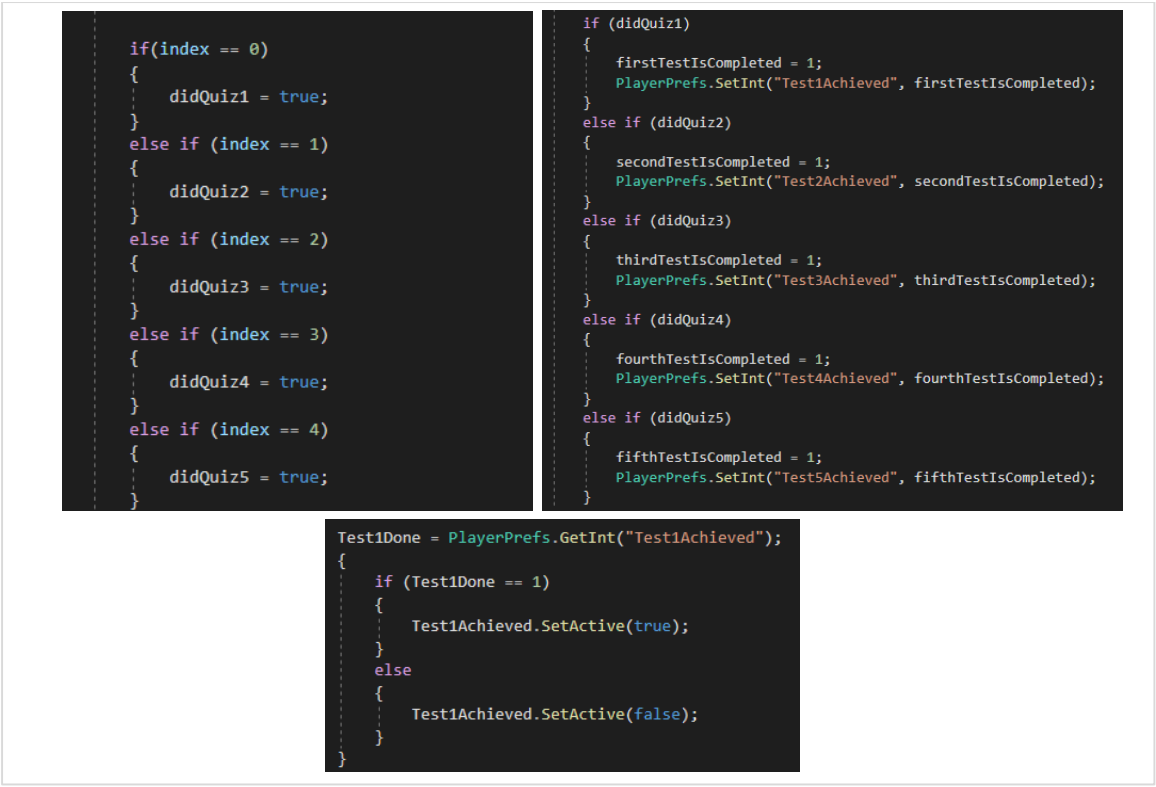


Figure 8: Achievement Unlocked Interface

In Figure 8, an achievement image icon is awarded to the user at the user profile when the user completed the test and the gameplay level.



```
if(index == 0)
{
    didQuiz1 = true;
}
else if (index == 1)
{
    didQuiz2 = true;
}
else if (index == 2)
{
    didQuiz3 = true;
}
else if (index == 3)
{
    didQuiz4 = true;
}
else if (index == 4)
{
    didQuiz5 = true;
}
```

```
if (didQuiz1)
{
    firstTestIsCompleted = 1;
    PlayerPrefs.SetInt("Test1Achieved", firstTestIsCompleted);
}
else if (didQuiz2)
{
    secondTestIsCompleted = 1;
    PlayerPrefs.SetInt("Test2Achieved", secondTestIsCompleted);
}
else if (didQuiz3)
{
    thirdTestIsCompleted = 1;
    PlayerPrefs.SetInt("Test3Achieved", thirdTestIsCompleted);
}
else if (didQuiz4)
{
    fourthTestIsCompleted = 1;
    PlayerPrefs.SetInt("Test4Achieved", fourthTestIsCompleted);
}
else if (didQuiz5)
{
    fifthTestIsCompleted = 1;
    PlayerPrefs.SetInt("Test5Achieved", fifthTestIsCompleted);
}
```

```
Test1Done = PlayerPrefs.GetInt("Test1Achieved");
{
    if (Test1Done == 1)
    {
        Test1Achieved.SetActive(true);
    }
    else
    {
        Test1Achieved.SetActive(false);
    }
}
```

Figure 9: Test Achievement Script Snippet

Figure 9 shows a part of coding from the achievement script, and the process is using an if-else statement. In the first snip picture, the index represents the test category. When the user finished the test category (Temporary Test) which is representing the (index == 4), it will get a Boolean value where the didQuiz5 is equal to true. To save the status of the completed category test, it will be stored in PlayerPrefs and the visibility of the achievement image icon game object will be determined by the value from PlayerPrefs.

In Figure 10, the finish line game object is added with a collider where the car triggers with the colliders, the value of Level1Completed with be stored in the PlayerPrefs, and the visibility of the achievement image icon game object will be determined by the value from PlayerPrefs.

The audio in Road Signs Education is including the music background and the sound effects. Figure 11 shows the audio components applied to the Road Signs Education in Unity.

In Figure 11, an AudioManager script is added to the game instance and there are 6 different sounds that including the theme music, victory sound, lose sound, collect star sound, answer correct sound and answer incorrect sound.

A multiple-choice test game is implemented in the “Test” mode. In the multiple-choice test game, there is a set of list questions to be prepared as well. Figure 12 shows the script snippet of the “Test” mode.

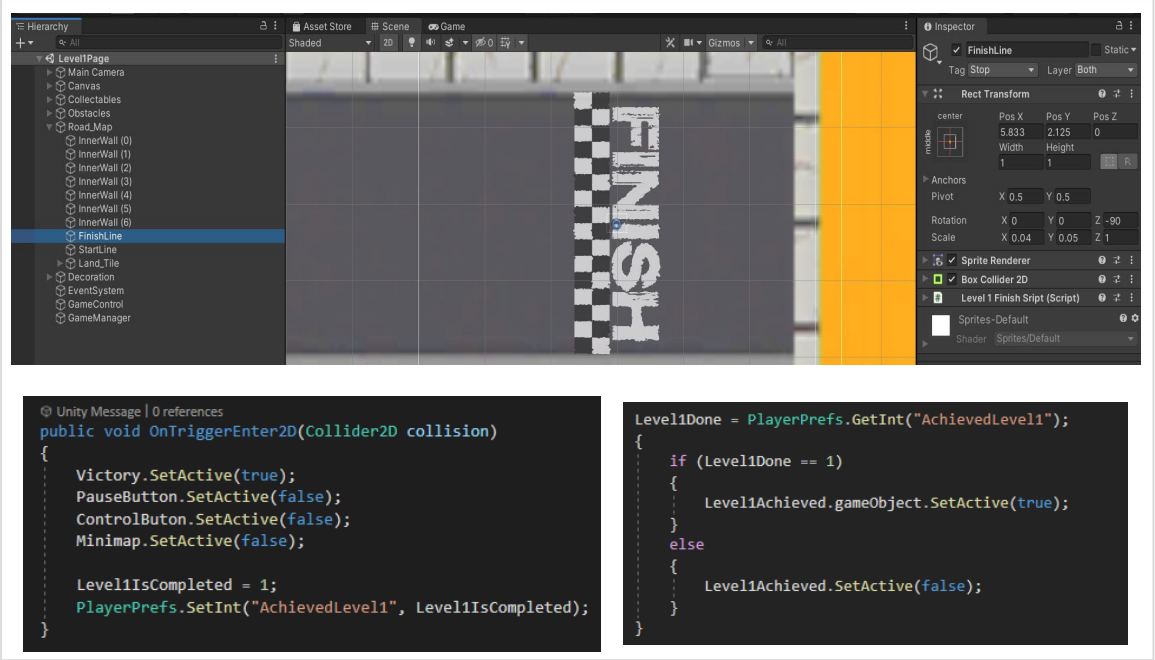


Figure 10: Finish line game object and gameplay level script snippet

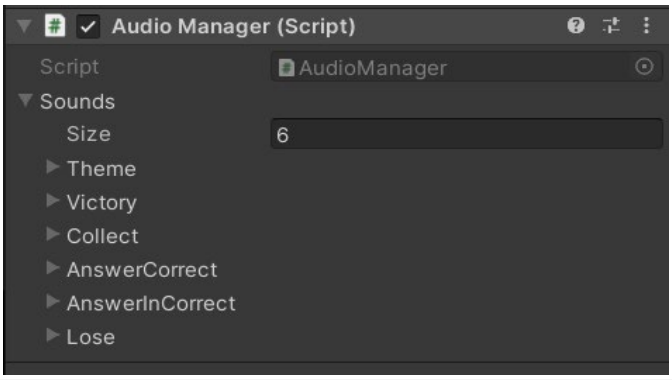


Figure 11: Game instance with an audiomanager script

Figure 12: Script snippet of life count mechanism in "Test" mode

Figure 12 shows the script snippet of the life count mechanism in the "Test" mode. By using the if-else statement, when the user selected the wrong answer, the life image colour will turn into the wrong colour (red). ReduceLife(int index) is the function where it turns the correct colour into the wrong colour (green to red).

The "Play" mode is using a Top-Down View Car game mechanism. In the game, to make the car move physically, a script is added to the car game object. Figure 13 and Figure 14 show how the user controls the car movement.

```
void ApplyEngineForce()
{
    //Apply drag if there is no accelerationInput so the car stops when the player lets go of the accelerator
    if (accelerationInput == 0)
        carRigidbody2D.drag = Mathf.Lerp(carRigidbody2D.drag, 3.0f, Time.fixedDeltaTime * 3);
    else carRigidbody2D.drag = 0;

    //Caculate how much "forward" we are going in terms of the direction of our velocity
    velocityVsUp = Vector2.Dot(transform.up, carRigidbody2D.velocity);

    //Limit so we cannot go faster than the max speed in the "forward" direction
    if (velocityVsUp > maxSpeed && accelerationInput > 0)
        return;

    //Limit so we cannot go faster than the 50% of max speed in the "reverse" direction
    if (velocityVsUp < -maxSpeed * 0.5f && accelerationInput < 0)
        return;

    //Limit so we cannot go faster in any direction while accelerating
    if (carRigidbody2D.velocity.sqrMagnitude > maxSpeed * maxSpeed && accelerationInput > 0)
        return;

    //Create a force for the engine
    Vector2 engineForceVector = transform.up * accelerationInput * accelerationFactor;

    //Apply force and pushes the car forward
    carRigidbody2D.AddForce(engineForceVector, ForceMode2D.Force);
}
```

```
void ApplySteering()
{
    //Limit the cars ability to turn when moving slowly
    float minSpeedBeforeAllowTurningFactor = (carRigidbody2D.velocity.magnitude / 2);
    minSpeedBeforeAllowTurningFactor = Mathf.Clamp01(minSpeedBeforeAllowTurningFactor);

    //Update the rotation angle based on input
    rotationAngle -= steeringInput * turnFactor * minSpeedBeforeAllowTurningFactor;

    //Apply steering by rotating the car object
    carRigidbody2D.MoveRotation(rotationAngle);
}

1 reference
void KillOrthogonalVelocity()
{
    //Get forward and right velocity of the car
    Vector2 forwardVelocity = transform.up * Vector2.Dot(carRigidbody2D.velocity, transform.up);
    Vector2 rightVelocity = transform.right * Vector2.Dot(carRigidbody2D.velocity, transform.right);

    //Kill the orthogonal velocity (side velocity) based on how much the car should drift.
    carRigidbody2D.velocity = forwardVelocity + rightVelocity * driftFactor;
}
```

Figure 13: Top-Down View Car's Physical Script Snippet

Figure 13 shows the part of codes of the top-down view car's movement. The car movement is using 3 functions: ApplyEngineForce(), ApplySteering(), and KillOrthogonalVelocity().The function, ApplyEngineForce() is to move forward the car and the function, ApplySteering() is to turn the direction of the car (left or right). Without the function of KillOrthogonalVelocity(), the car will not turn its direction like a drifting car, and the car will not move physically.

```
void Update()
{
    Vector2 inputVector = Vector2.zero;

    //Get input for Phone
    inputVector.x = CrossPlatformInputManager.GetAxis("Horizontal");
    inputVector.y = CrossPlatformInputManager.GetAxis("Vertical");

    //Send the input to the car controller.
    topDownCarController.SetInputVector(inputVector);
}
```

Figure 14: Script Snippet for the Input of Top-Down View Car

Figure 14 shows the part of the script of input for controlling the car movement. By using the CrossPlatformInputManager, the inputVector.x is to move the car on a horizontal axis, while the inputVector.y is to move the car on a vertical axis.

Thence, at the end of this phase, the outcome is produced according to the task. Table 6 show the task and outcome of the development phase.

Table 6: Task and Outcome of the Development Phase

Task	Outcome
• Develop the application by using the Unity game engine.	• Complete the built of the application.

3.4 Prototyping Phase

The application has been developed successfully and it is prototyped in the Android-based device. Table 7 shows the screenshot of the prototyping of the Road Signs Education in an Android smartphone.

Table 7: Prototype of the Developed Module Interface

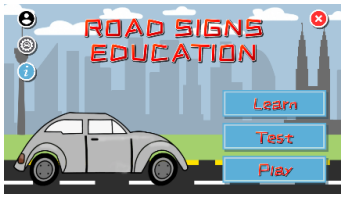
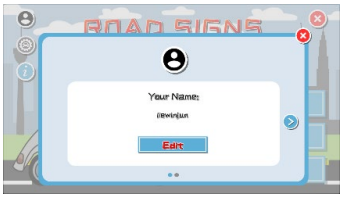
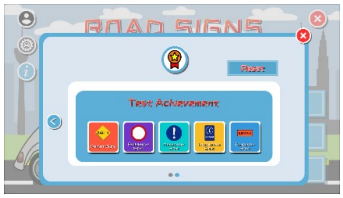
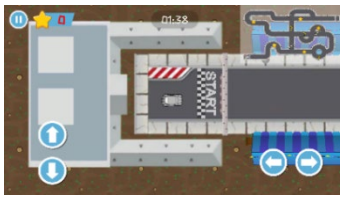
Module	Application Interface
Main Menu	
Profile and Achievement	 
"Learn" mode	  
"Test" mode	 
"Play" mode	 

Table 7: (continued)

Module	Application Interface

Customize car	

Therefore, the developed application can run in the Android-based device and the developed application is being prototyped in the Android-based device as Table 7 shows the screenshot of the prototyping of the Road Signs Education. The final product of the development project is the APK file. The user can install the APK file into the Android-based device. Figure 15 shows Road Signs Education supported on different Android smartphones.

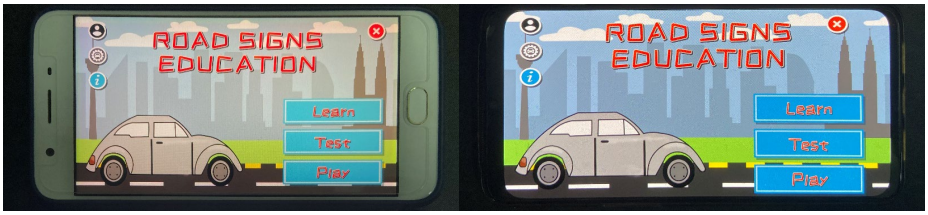


Figure 15: Road Signs Education supported on different Android smartphones

Hence, Road Signs Education has been successfully installed on Android smartphones and it is capable on all different Android smartphones. At the end of this phase, the outcome is produced according to the task in this phase. Table 8 show the task and outcome of the prototyping phase.

Table 8: Task and Outcome of the Prototyping Phase

Task	Outcome
• Install in the Android-based device.	• Able to run on an Android-based device.

3.5 Testing Phase

The alpha testing was carried out by the developer during the development process until the end of the project and it is performed based on the button functionality. Some errors have happened such as the Pause Button is clicked, the user still can control the car movement and the Purchase Car Button clicked more than once, it will continue to deduct the collected star amount. Therefore, the Purchase Car Button is removed after the car is purchased. Table 9 shows the result of the alpha testing.

Table 9: Result of alpha testing

Buttons	Expected Result	Actual Result	Action
Learn mode Button	Navigates to Learn mode.	Functions well as expected.	No action is needed.

Test mode Button	Navigates to Test mode.	Functions well as expected.	No action is needed.
Play mode Button	Navigates to Play mode.	Functions well as expected.	No action is needed.
Exit Button	Shows confirmation exit once clicked.	Functions well as expected.	No action is needed.
Pause Button	Pause the timer countdown.	The Car still can control to move when it is paused.	Remove the Car Control Button in the scene when pausing.
Restart Button	Restart the status of the current scene.	Functions well as expected.	No action is needed.
Home Button	Navigates to the Home menu scene.	Functions well as expected.	No action is needed.
About Button	Navigates to the About scene	Functions well as expected.	No action is needed.
Customize Car Button	Navigates to the Car Customization scene	Functions well as expected.	No action is needed.
Purchase Car Button	Allow the user to purchase when collects enough stars amount and unlock the selection of the car.	The amount of collected stars continues to deduct when clicked more than once.	Remove the Purchase Car Button after purchased.

The user acceptance testing was done by the target user after the end of the application development, and the result of the user acceptance testing is explained in detail in the section of Result and Discussion. Table 10 shows the task and outcome of the testing phase.

Table 10: Task and outcome of the testing phase

Task	Outcome
• Conduct alpha testing. • Carry out user acceptance testing using Technology Acceptance Model.	• Result of the alpha testing. • Result of the user interface evaluation, perceived usefulness, and perceived ease of use.

3.6 Deployment Phase

After the testing phase, the application is ready to deploy in the public and Road Signs Education is uploaded into Google Drive to allow others to download. Table 11 shows the task and outcome of the deployment phase.

Table 11: Task and outcome of the deployment phase

Task	Outcome
• Upload the APK file to Google Drive.	• Allow others to download in Google Drive.

3.7 Maintenance Phase

The final phase is the maintenance phase where the developer is required to make changes according to the feedback and comments from the user. Besides that, the strengths and limitations of the application are determined by the collected feedback and comments from the user. Table 12 shows the task and outcome of the maintenance phase.

Table 12: Task and Outcome of the Maintenance Phase

Task	Outcome

• Collect feedback and comments from the users.	• Made changes in the form of bugs fixes and enhancements based on the limitations.

4. Result and Discussion

This section is discussed the outcome of the user acceptance test on Road Signs Education and the discussions about the positive and negative aspects of the Road Signs Education.

4.1 User Acceptance Testing

The user acceptance testing is conducted to get the evaluation from the target user. The Technology Acceptance Model (TAM) is used to evaluate user acceptance. This evaluation model is separated into 3 parts which are User Interface Evaluation, Perceived Usefulness (PU), and Perceives Ease of Use (PEOU) [16]. A Google Form is used to collect the result of the user acceptance test. Figure 14, Figure 15, and Figure 16 show the bar chart of the user acceptance test result.

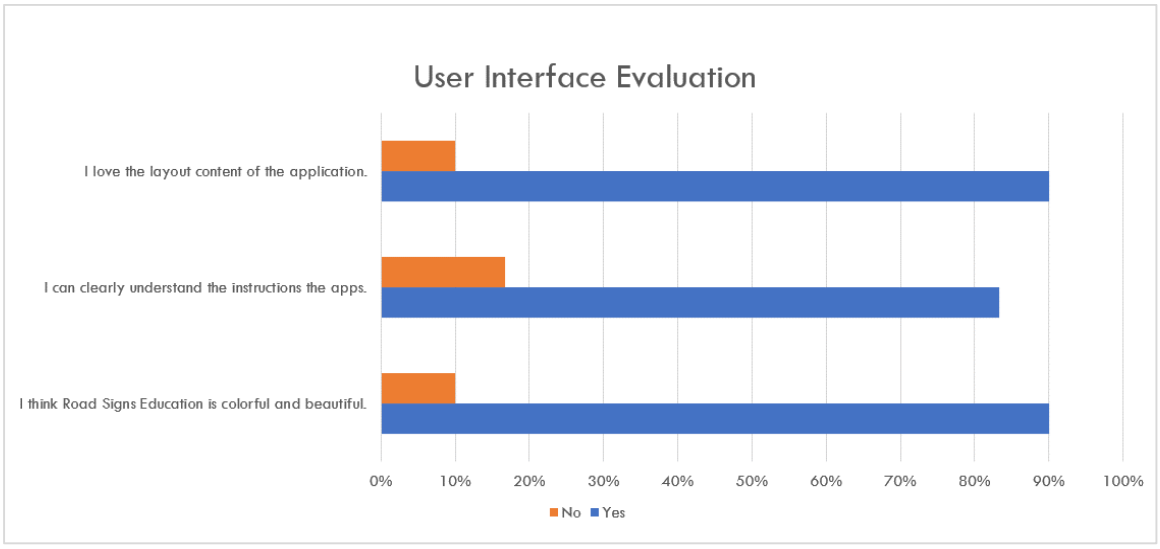


Figure 14: User Interface Evaluation

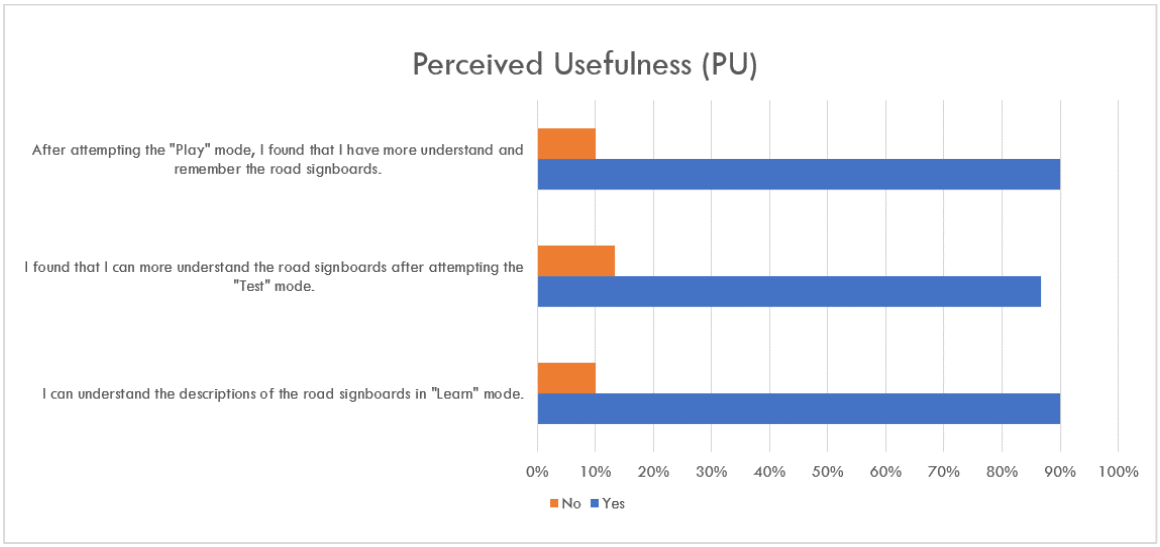


Figure 15: Perceived Usefulness (PU)

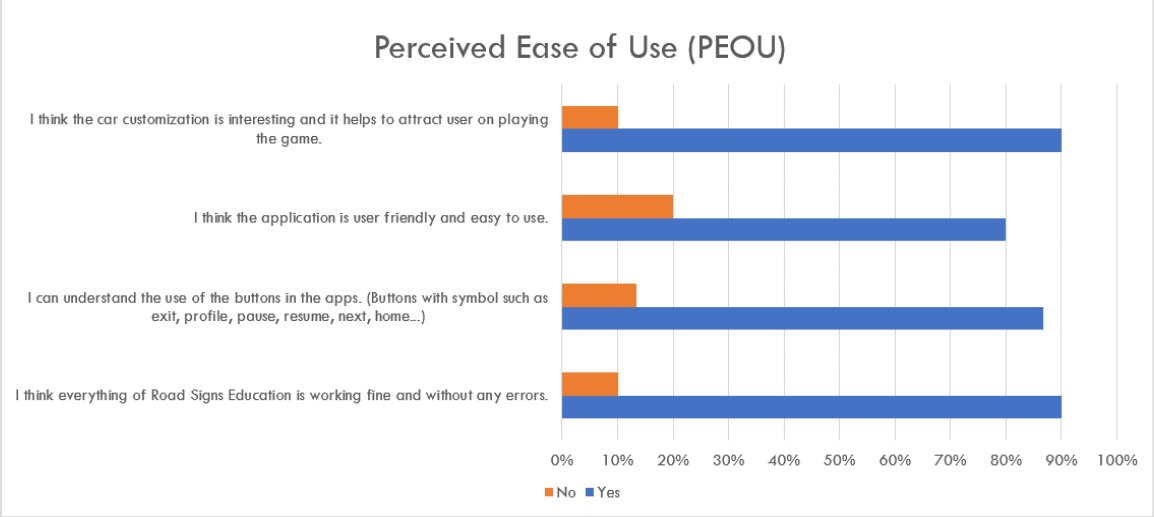


Figure 16: Perceived Ease of Use (PEOU)

After analyzed the result of the user acceptance test, it is indicated an overall positive feedback rate of 88.01%. To sum up, the user acceptance test is showing a positive result as most of the respondents are believed that Road Signs Education is developed successfully since it has a good user interface, well function and provides the learning outcome to the user.

4.2 Discussions

According to the outcome of the testing, certain positive aspects of the Road Signs Education application were discovered. In contrast, Road Signs Education has founded some limitations after the testing phase. The strengths and the limitations of Road Signs Education are outlined in Table 13.

Table 13: Strengths and limitations of road signs education

Strengths	Limitations
• Gets positive results in the user acceptance level. • The application has a colourful and attractive user interface. • The application contains multimedia components. • The application is well functionality.	• The application only contains 3 modes (Learn, Test, and Play). • The application does not provide the volume setting. • The application's resolution only fitted to the smartphone device with 1280 × 720. • The application supports only one language (English).

5. Conclusion

To be concluded, Road Signs Education is developed successfully, and the application has successfully delivered the learning outcome for Road Signs with the method of gamification. Also, by using a well-planned Mobile Application Development Life Cycle, Road Signs Education has been developed within a predetermined given deadline. Also, the testing phase yielded valuable feedback and the result of the user acceptance level is achieved an overall positive rate of 88.01%. Moreover, the objectives of this project are accomplished, and the strengths and limitations of the application have been outlined in the discussions. By improving these limitations, there are some suggestions to enhance the Road Signs Education. The future works recommended are depicted as follow:

• Expand the number of levels of the game in "Play" mode.
• Add a setting to adjust the volume of the music background and sound effect.
• Develop for another platform such as Windows PC.

- Add more languages such as Bahasa Malaysia, Chinese, and Tamil into the application's content.
- Enhance the intention of learning Road Signs in the "Play" mode.

Ultimately, several suggestions for future work to improve Road Signs Education were offered, and it is believed that this application will continue to improve in the future.

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