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Development of a Mobile Learning Application for Form 5 Mathematics with a Gamification Approach

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Abstract: Mathematics is one of the compulsory subjects to be taken in Malaysia Certificate of Education (SPM). In 2020, some new topics including insurance and taxation were added-in the syllabus. These topics are causing difficulty to the students and feel more challenging to learn mathematics. Therefore, a mobile learning application named SPM Math Treasure with a gamification approach is developed to help Form 5 students improve their mathematics skills and increase students' learning preferences in learning both insurance and taxation topics. SPM Math Treasure application has 3 modules including Lesson module, Tutorial module and Quiz module. Besides, Multimedia Mobile Content Development (MMCD) methodology is used to develop the SPM Math Treasure application. System Usability Scale (SUS) method is used to obtain the results of user acceptance test. It gets 80.75% positive feedback through this testing. In conclusion, SPM Math Treasure is an application that is suitable for learning Mathematics.

Keywords: Mathematics, Mobile Learning Application, Gamification

1. Introduction

Mathematics teaches students how to solve issues using numerical calculations and finding solutions. In Malaysia, mathematics is a fundamental subject that is compulsory to be learned in the school curriculum. Mathematics is often considered among the most difficult subjects which causes students to lose their confidence to learn Mathematics [1]. In 2020, a new syllabus for Form 5 textbooks was introduced by the Ministry of Educational (MOE) with additional topics such as Consumer Mathematics Insurance and Consumer Mathematics Taxation [2]. These two topics are considered difficult and require much time to acquire and assimilate new knowledge with conventional learning methods. Thus, to attract their interest in these new topics, gamification is seen as one of the good approaches to be implemented.

Gamification is the practice of applying game design features, game mechanics, and game thinking in non-game environments to motivate people [3]. It has drawn much attention and increased students' learning preferences. Recently, gamification has become a general and integrative teaching tool [4]. In

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learning applications such as STEPapp [5], and Habitica [6]. Meanwhile, the introduction of these new topics has yet to be developed in any mobile learning application. Moreover, most of the existing applications in the Google Play Store present the contents of Form 5 mathematics only with texts and images without implementing a gamification approach [15-17]. Therefore, a mobile learning application for Form 5 mathematics with a gamification approach named SPM Math Treasure is implemented and presented in this paper.

The objectives of this project are to design an SPM Math Treasure mobile learning application using the VARK approach, to develop a mobile learning application for Form 5 Mathematics by implementing the gamification approach on the Android platform and to perform functional testing and user acceptance testing to the target user. SPM Math Treasure was developed for Form 5 students who have basic knowledge of mathematics to consolidate their mathematics skills. The Subject Matter Expert (SME) is Miss Vivian Goh who teaches Mathematics at Sekolah Menengah Kebangsaan Kampung Jambu, Taiping, Perak. Furthermore, visual, auditory, read and kinesthetic learning styles of the VARK model were implemented in designing the content. The SPM Math Treasure application allows users to self-learning at anytime and anywhere.

Three modules were developed such as Lesson module, Tutorial module and Quiz module. The lesson module consists of two lessons which are Insurance and Taxation. Video with storylines and mind maps are provided in each lesson to help users understand the topics. Next, the Tutorial module provides a gamification approach of a 2D side-scrolling game to engage users with the lessons. The Quiz module is provided to test the performance of students in these topics.

This paper is organized as follows: Section 2 discusses the domain of study, mobile learning technology and a review of the existing applications and comparison. Next, Section 3 explains the Multimedia Mobile Content Development (MMCD) methodology and Section 4 demonstrates the result and discussion of the developed application. Furthermore, Section 5 presents the conclusion of the project.

2. Related Work

In this section, the domain of study, mobile learning technology, and the comparison between existing applications and the developed application is discussed.

2.1 KSSM Mathematics

KSSM mathematics is one of the compulsory subjects in Sijil Pelajar Malaysia (SPM). Mathematics has an essential role in our daily life, and it applies in many aspects such as accounting, finance, engineering, banking and software. In the new KSSM syllabus for Form 5 mathematics subject, the MOE has launched financial education elements in the Curriculum and Assessment Standard Document (DSKP). The goal of this initiative is to produce Malaysians who are financially literate and capable of managing their funds sensibly and successfully. Beginning in 2020, new topics in the mathematics curriculum, Consumer Mathematics: Insurance and Consumer Mathematics: Taxation were introduced for Form 5 students [7]. This change causes many topics in the mathematics syllabus to become harder for the students [8]. The topics focus on different types of insurance and taxation where each of the topics consists of formulae, procedures, shortcuts, and theorems [9].

2.2 Technology Used

In this section, two technologies have been executed in this project that are mobile learning and, gamification. Firstly, mobile learning has been applied to replace electronic learning (e-learning) due to its potential similar to electronic learning used in distance education [10]. Furthermore, mobile learning technology focuses on the mobility of the learner, interacting with portable technologies that allow learning through mobile devices at anytime and anywhere. It uses mobile tools for creating

learning aids and materials becomes an important part of adaptive learning [11]. Mobile learning applications involve multimedia elements such as images, audio, animation, text, and video to enhance interactivity with students. This can increase the interest of students in learning the lessons.

Secondly, gamification is suitable for learning mathematics because gamification which in game-based mechanics, aesthetics and game thinking could develop and engage the learning of students as well as promote efficient ways to learn [3]. Additionally, gamification can encourage students to study themselves at home and students also will feel easy to get the piece of knowledge by using the game. Gamification of learning environments might be an effective tool for information acquisition and could improve crucial abilities like communication, cooperation and problem-solving [12]. Subsequently, gamification is suitable for learning mathematics because the design of gamification features used in the education process guarantees that students participate in their lessons and are engaged so they may give feedback as it happens [1].

In any learning application, the content must correspond with the learning style in order to create learning applications with high-quality content. The VARK learning style is the most widely used model for classifying learners according to their sensory traits [13]. It has four modalities such as visual, auditory, read/write, and kinesthetic. For visual modality, the visual learner can comprehend a theory through charts, graphs, infographics, pictures, videos, and others to absorb the knowledge. In addition, auditory modality is used by learners who are difficult to remember what they are learning, therefore audio or reading aloud is useful to them. The read or write modality is applied to learners who are suitable to read through text resources and list down the essential information. Lastly, the kinesthetic modality is suitable for learners to learn via practical learning experiences or physical activity. For mathematics subject, these four modalities are suitable to be applied to mobile learning.

2.3 Comparison of existing applications and the developed application

Several applications are similar in the market and most of them attempt a similar concept and lack of Form 5 learning content have implemented the gamification approach in the application [14]. In this section, a review of the existing applications such as Kuiz SPM [15], SPM [16], JomStudy [17] has been made and compared to the developed application. Meanwhile, six features being reviewed are tabulated in Table 1 including the modules, operating system, gamification approach, multimedia elements, learning content, strengths and limitations.

Based on Table 1, the existing applications do not apply gamification as part of the learning method. For existing applications, they provided multimedia elements such as text and graphics. To improve the limitations of the existing applications, the developed application applies gamification to engage students with the content of the new topics. Meanwhile, the developed application is not only applied text, and images, it also provides animation and audio to enhance the content presentation. Subsequently, this application applies VARK learning model to help users understand the content. Visual modality is presented by mind maps in the lesson module which allows users to understand the content by viewing the words. Next, auditory modality is applied in storylines to read aloud the learning materials. Read modality is applied in the storyline of the content and kinesthetic modality is used in the gamification by collecting hints to solve the questions.

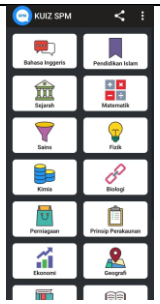


Figure 1: Kuiz SPM[15]

Figure 2: SPM [16]

Figure 3: JomStudy [17]

Table 1: Comparision between existing applications and proposed application

Features	Kuiz SPM	SPM	JomStudy	SPM Math Treasure
Modules	Consists of quiz module only.	Consists of lesson module only.	Consists of revision notes, flashcards, quiz module, and e-books.	Consists of a lesson module, tutorial module and quiz module.
Operating system	Available for Android version 6.0 and above.	Available for Android version 4.0 and above.	Available for IOS and Android version 4.0 and above	Available for Android 12.0 and above.
Gamification	Do not consist of gamification technology.			Provide 2d-side scrolling games to the users.
Multimedia elements	Present with texts and graphics.	Present with texts and graphics	Present with texts and graphics	Present with animation, graphics, texts, video, and audio.
Content	Covers all old syllabi in mathematics with objective questions.	Covers all chapters presented in the past year paper.	Covers all chapters with explanations.	Covers the top two difficult topics and presents the mathematics contents using mind maps and games.
Quizzes and assessment	Provide eight sets of quiz to the users.	Does not provide quiz to users.	Provide quiz and upload new quizzes every week.	Provide two sets of random 15 questions to the users.
Learning style	Consists visual modality only.	Consists visual modality only.	Consists visual and read/ write modalities.	Consists of visual, auditory, read and kinesthetic modalities.

3. Methodology

SPM Math Treasure is a mobile learning application that is designed for Form 5 student to learn their mathematics course. Hence, Multimedia Mobile Content Development (MMCD) model is used for completing this project. Multimedia Mobile Content Development (MMCD) is the method that formulated the framework and methodology for developing mobile learning (m-learning) application [10]. There are 5 main stages of the MMCD methodology shown in Figure 4 and Figure 5 In Figure 5, the sub-stage named “Update the structure” under phase 2 structure analysis stages has been excluded because this project is not planned to be updated the structure and returned to the application idea creation stage. This is because repeated to update the structure required more times. Therefore, the limitation of time causes developer to plan not to repeat this sub-stage when developing this application. After sub-stage of “Object analysis”, the project will proceed to the third stage which is the process design stage. Each stage of the MMCD is described in the following subsections.

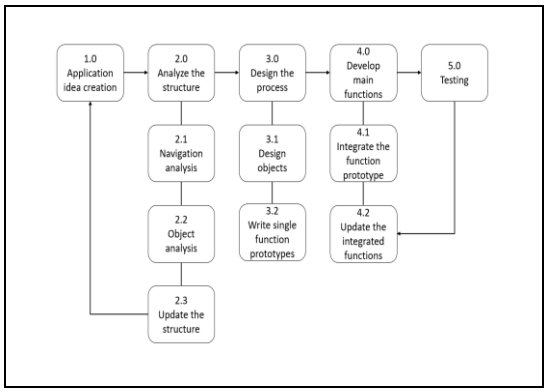


Figure 4: MMCD methodology [10]

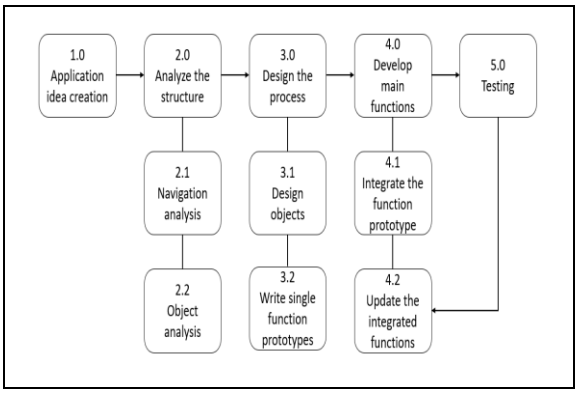


Figure 5: Modified MMCD Methodology

3.1 Application Idea Creation Stage

From the first stage in MMCD methodology, it has two requirements implemented in this SPM Math Treasure application such as user requirements and application requirements. Two information-gathering methods were used to identify the user requirements. The interview session was conducted with a Subject Matter Expertise (SME), teacher Vivian Goh who is a Mathematics subject teacher at SMK Kampung Jambu, Taiping, Perak. Moreover, a survey of 30 respondents' questionnaires from secondary school teachers and form 5 have been collected. In conclusion, 90% of the respondents have used a mobile phone for learning purposes. Besides, 90% of the respondents agreed to use the mobile-based application to learn mathematics, because 93.9% of respondents are Android phone users. In addition, images and animation are the most popular multimedia elements preferred by 70% of the respondents to be implemented in the mobile learning application. Table 2 presents the user analysis from the perspective of SME and target users. In addition, multimedia objects such as images, audio, video, and animation have been identified as listed in the application idea creation checklist shown in Table 3.

Table 2: User Analysis

Stakeholder Category	Role in product	Design implications	Actions needed
Subject Matter Expert	Content consultant expert in the related field	Based on interview Simple user interface design	• Instead of text, icon-based buttons shall be used. • Choose fonts type and sizes that are readable to the users such as Fundamental Brigade with a font size bigger than 60pt.
		Easy to navigate	• Contains home, back, next, retry, volume, and settings buttons. • Consistency of buttons. • Simple navigation buttons that can lead users to the selected interfaces.
		Easy to learn	• Clear instructions are given, narrator and textual. • Simple English provided. • Gameplay style is easy to understand, and a clear storyline is provided.

Stakeholder Category	Role in product	Design implications	Actions needed
		Reliable content, simple word choice, better with one syllabus word	• Content should follow the syllabus in Form 5 mathematics.
General user (Form 5 students)	End-user of the system	Based on the questionnaire through Google Form Can be used anytime, anywhere with the user preferences	• The application should be developed on mobile devices. • The application should be developed on the Android platform. • Images and animation should be implemented in the application.

Table 3: Application Idea Creation Check List

Item	Description
Type of application	Mobile Learning with gamification.
Target device	Android Smart Phone.
Target users	Aged 17-18 years old and studying in Form 5.
Software (Unity2020)	• Version: 2020.3.32f1 • Resolution: Full Screen Window
Abode Illustrator CC 2020	• Design 2D buttons • Design 2D graphics
Abode Photoshop CC 2020	• Design background
Images	• 2D images (launching page, home page, lesson page, tutorial page and quiz page)
Video	• 2D scenes for situations faced such as insurance and taxation
Animation	• The storyline on the lesson page
Audio	• Background music, Narration audio in storylines
Application synopsis	• SPM Math Treasure is a mobile learning application based on gamification for Form 5 students in secondary schools in Malaysia. This application provides Form 5 students to learn and improve their skills in mathematics subject which already change the syllabus in 2020. It consists of multimedia elements in the process of learning and teaching such as images, audio, text, animation and audio.

3.2 Structure Analyze Stage

In this stage, the navigation analysis and object analysis have been executed. From Form 5 Mathematics textbook referred, the contents have been selected. For instance, Consumer Mathematics: Insurance and Consumer Mathematics: Taxation topics are applied in this application and three modules are created such as Lesson module, Tutorial module and Quiz module. This content structure includes title, objective, module, lesson and topic as shown in Figure 12. Based on Figure 12, the navigation structure in Figure 17 is designed to illustrate the structure built in the application and detailed structure of the application is realized in a system flowchart presented in Appendix B. Then, functional and non-functional requirements are demonstrated in Table 4 and Table 5. Next, the object analysis is demonstrated in Table 6.

Table 4: Functional requirements

Functional requirements	Description
User interaction	• The system shall allow user to select the module by clicking on the navigation buttons in the main menu. • The system shall allow user to choose topics in the sub-menu. • The system shall allow user to select an answer in quiz module. • The system shall provide a pop-up menu for users in mind maps. • The system shall provide skip button for the user to skip the storyline.
Autonomous system activities	• The animation in the storyline will auto-display. • The narration shall play when the user enters the storyline page. • The system shall calculate the total score of the quiz.

Table 5: Non-functional requirements

Non-functional Requirements	Description
Performance	• The application shall operate fully offline. • Any interaction between the user and the system should not exceed three seconds for an Android mobile phone.
Operational	• The application shall be able to operate on any Android device with Android version 12 and above.
Cultural	• The application shall be developed in English.
Legal	• Users only can review the information displayed in the application but they cannot modify any information in it
Usability	• The application shall be user-friendly and easy to bring anywhere at any time.

Table 6: Object analysis

Object Analysis	Description
Video	• In video should involve captions. • It should have audio. • It needs play and pause buttons.
Audio	• It should be pronouce clearly. • It should avoid using AI voice.
Graphic	• It should have 2D graphics.
Text	• It applies Fundamental Brigade with a font size bigger than 60pt.

3.3 Process Design Stage

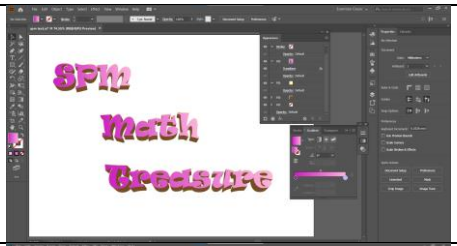
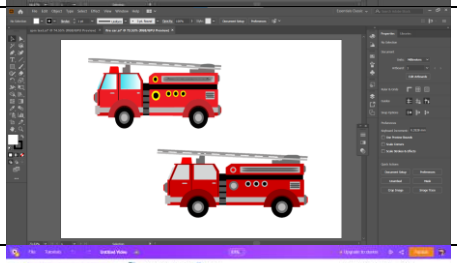
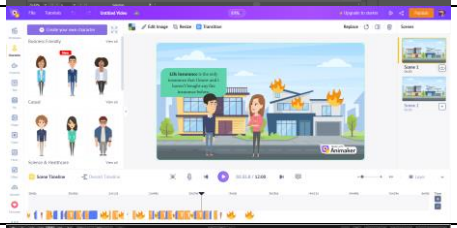
The third stage is the process design stage which involves designing the objects and writing single-function prototypes. The assets and elements in the Lesson module, Tutorial module and Quiz module were designed using Adobe Illustrator, Adobe Photoshop and Canva. The objects that were designed are buttons, backgrounds, assets, and images. Subsequently, the Unity software is used to compile the assets with scripting. Table 11 and Table 12 show the button design and interface design attached in Appendix C.

3.4 Main Function Development Stage

The main function of the application will be conducted in this stage. It included the development of assets for the application using software and integration using C# scripting in Unity software. In the

lesson module, the main function is to deliver the learning content by using storyline and mind maps. In Lesson module, it consists of animated videos and audio in the storyline. Then, the main function such as pop-up content in mind maps. In the Tutorial module, the main function is to allow the users to navigate the player through game actions such as jumping and moving left and right. In addition, navigate from one scene to another. Additionally, the other main function of Tutorial modules is to calculate scores automatically after users finish answering the questions. The assets developed for this application are 2D graphics, audio, animation, and videos as tabulated in Table 7.

Table 7: Development of Assets in Application

Types of Assets	Development View	Description
2D Graphics		In the Launching module, Adobe Illustrator is used to design the title "SPM Math Treasure". It was created by using a gradient color with the "Ravia" font type.
2D Graphics		Canva elements are used to design the background, buttons icons, and images in the application. Then, the elements that are applied to the design background are imported into Abode Photoshop. It is used to adjust color and combine the different types of images.
2D Button		In addition, the Canva elements such as icons and graphics are imported into Abode Illustrator, and they are used to form buttons that can be used in different scenes in the application.
2D Graphics		Abode Illustrator is used to trace images and change the part of the image colour and form a new graphics.
Video & Animation		Animaker software is used to create the storylines in the Lesson module. It includes the animation of video such as the action of characters, movement of objects in scenes, and audio of narrator.
Audio		The audio files in the SPM Math Treasure application are downloaded from free online resources such as "OpenGameArt.Org" and no copyrighted music from the Youtube website. Its format is MPEG Audio Layer 3 (MP3).

Subsequently, the C# scripting is applied to ensure the main functions of the application can be operated properly. The main functions involve player movement, hint manager, change scenes, background music, quiz manager, question and answer, and answer script are tabulated in Table 8.

Table 8: C# Scripting for Integration in Unity

Functions	C# Scripting	Description

Player Movement (Left Move & Right Move & Jump in Tutorial module)	using System.Collections;
	using System.Collections.Generic;
	using UnityEngine;
	using UnityEngine.EventSystems;
	
	public class LeftMove : MonoBehaviour, IPointerDownHandler, IPointerUpHandler
	{
	bool isPressed = false;
	public GameObject Player;
	public float Force;
	public SpriteRenderer spriteRenderer;
	
	void Update()
	{
	if (isPressed)
	{
	Player.transform.Translate(Force * Time.deltaTime, 0, 0);
	spriteRenderer.flipX = true;
	}
	}
	
	public void OnPointerDown(PointerEventData eventData)
	{
	isPressed = true;
	}
	
	public void OnPointerUp(PointerEventData eventData)
	{
	isPressed = false;
	}
	}
		In this script, the Boolean variable "isPressed" is used to let the button be set to active, allowing users to press the button to move the player and stop moving when the button is unpressed.

Hint Manager (Tutorial module)	public class HintManager: MonoBehaviour
	{
	public int hintCount;
	public Text hintText;
	public GameObject Info1;
	public GameObject Info2;
	public GameObject Info3;
	
	void Start()
	{
	Info1.SetActive(false);
	Info2.SetActive(false);
	Info3.SetActive(false);
	}
	void Update()
	{
	hintText.text = "Hints: " + hintCount.ToString() + "/3";
	if (ScoreTextScript.coinAmount == 3)
	{
	gameObject.SetActive(false);
	}
	}
	void OnTriggerEnter2D (Collider2D other)
	{
	if(other.gameObject.CompareTag("Info1"))
	{
	Destroy(other.gameObject);
	Time.timeScale = 0f;
		In this script, the Start() function is used to set active the information in hint panel when users collect the hints. In addition, Update () function is used to display the score and allow the game objects to destroy. Next, OnTriggerEnter2D() method is used to trigger the game object that collide by player and after collision, the score will increase.

Functions	C# Scripting	Description

	Info1.SetActive(true);
	hm.hintCount++;
	}
	if (other.gameObject.CompareTag("Info2"))
	{
	Destroy(other.gameObject);
	Time.timeScale = 0f;
	Info2.SetActive(true);
	hm.hintCount++;
	}
	
	if (other.gameObject.CompareTag("Info3"))
	{
	Destroy(other.gameObject);
	Time.timeScale = 0f;
	Info3.SetActive(true);
	hm.hintCount++;
	}
	}	

Quiz Manager (Random Question in Quiz module)	public class QuizManager: MonoBehaviour
	{
	public List<QuestionAndAnswers> QnA;
	public GameObject[] options;
	public int currentQuestion;
	public int currentQuestion;
	public Text QuestionTxt;
	
	void generateQuestion()
	{
	if(QnA.Count > 0)
	{
	currentQuestion = Random.Range(0, QnA.Count);
	
	QuestionTxt.text = QnA[currentQuestion].Question;
	SetAnswers();
	questionCount++;
	}
	else
	{
	Debug.Log("Out of Questions");
	GameOver();
	}
	
	}
		Furthermore, the script can allow the questions to randomly occur every time the user tests it. The generateQuestion() function applies Random.Range() to generate the questions randomly. The developer can add-on the questions according to their needs.

Score in Quiz Manager (Quiz module)	void GameOver()
	{
	Quizpanel.SetActive(false);
	
	if (score > 7 && score <= 15)
	{
	GoPanel.SetActive(true);
	ScoreTxt.text = score + "/" + totalQuestions;
	}
	else
	{
	GoPanel1.SetActive(true);
	ScoreTxt2.text = score + "/" + totalQuestions;
	}
	}
		The script is set for the range that users can pass the quiz. In this script, the if-else statement is applied to form the passing rate. The users will win the quiz when they get a score more than 7, however, they will fail when they get less than 7.

Functions	C# Scripting	Description

AnswerScript (Quiz module)	public class AnswerScript : MonoBehaviour
	{
	
	public bool isCorrect = false;
	public QuizManager quizManager;
	
	public Color startColor;
	
	private void Start()
	{
	startColor = GetComponent<Image>().color;
	}
	
	public void Answer()
	{
	if(isCorrect)
	{
	GetComponent<Image>().color = Color.green;
	Debug.Log("Correct Answer");
	quizManager.correct();
	}
	else
	{
	GetComponent<Image>().color = Color.red;
	Debug.Log("Wrong Answer");
	quizManager.wrong();
	}
	}
	}
		Afterward, this script is used to display the result of the answer. If the answer is correct, the button will turn green, however, the button will turn red if the answer is wrong.

3.5 Testing Stage

Lastly, the testing stage allows the developer to test the functionality of the application, bug detection, and ensure the system is in good condition. To solve the bugs that occur, the developer should check the coding and update the integrated functions to fix the errors. The functional testing is described in Table 9. It is used to test whether the buttons can work well as expected or not. Besides, user acceptance testing is used to determine whether this application can be published and whether it consists of market value.

Table 9: Functional Testing

Test	Expected Result	Actual Result	Corrective Action
Play button	Navigate to the main menu.	Works well as expected.	Not needed.
Exit button	Pop-up the exit panel.	Works well as expected.	Not needed.
Credit button	Pop-up the credit button.	Works well as expected.	Not needed.
Sound button	On and off the background music.	Works well as expected.	Not needed.
Lesson button	Navigate to Lesson page.	Works well as expected.	Not needed.
Tutorial button	Navigate to Tutorial page.	Works well as expected.	Not needed.
Quiz button	Navigate to Quiz page.	Works well as expected.	Not needed.
Home button	Navigate to the main menu.	Works well as expected.	Not needed.
Next button	Navigate to the next scene.	Works well as expected.	Not needed.
Back button	Navigate to the previous scene.	Works well as expected.	Not needed.

Test	Expected Result	Actual Result	Corrective Action
Insurance button	Navigate to insurance storyline.	Works well as expected.	Not needed.
Taxation button	Navigate to the taxation storyline.	Works well as expected.	Not needed.
Skip button	Skip the whole storyline.	Works well as expected.	Not needed.
Setting button	Navigate to volume setting panel.	Failed to function in insurance storyline page.	Reset the button and use the correct script onClick().
Retry Button	Replay the game.	Works well as expected.	Not needed.
Volume Option Button	Adjust the background music.	Works well as expected.	Not needed.
Resume Button	Continue the game.	Works well as expected.	Not needed.
Game Level Button	Navigate to each level.	Works well as expected.	Not needed.
Left Button	Allow player to move left.	Works well as expected.	Not needed.
Right Button	Allow player to move right.	Works well as expected.	Not needed.
Jump Button	Allow player to jump.	Works well as expected.	Not needed.
Question Button	Pop up the question panel.	Works well as expected.	Not needed.
Menu Button	Pop-up menu panel	Works well as expected.	Not needed.
Quiz Option Button	Navigate to the Quiz page.	Works well as expected.	Not needed.
Answer Option Button	Identify the correct or wrong answer.	Option A failed to function.	Reset the button or redo the new interface.
Score system	Track the current hints and record the score.	Failed to record higher score.	Set the public integer variable for the point.

According to functional testing, there are few bugs that were detected. For the setting button, the default to pop up the volume setting panel was caused by the error in the Unity system and a missing file in onClick() function. To solve this error, a new button was set. Answer Option Button also occurs the same bug as the setting button, therefore the developer reset and tested the button. In Tutorial module, due to the error of setting the score, users can win the game without collecting all hints or scores. Hence, the solution the public integer variable should be set for the score in each game level. Meanwhile the user acceptance testing was conducted to collect the opinions of the target users toward the application. This testing was conducted after the application is fully completed. The questionnaire consists of four sections, which are demography of user, learning outcome acquisition, user acceptance level and functionality and performance. There are 6 questions in learning outcome acquisition, 10 questions in the user acceptance level and 5 questions in the functionality and performance. 30 respondents who have basic knowledge of Form 5 Mathematics were involved in testing this application. The user acceptance testing survey was collected by using Google Forms. Detailed results of the user acceptance testing is presented in Section 4. The user-testing image were attached in Appendix A.

4. Results and Discussion

In user acceptance testing, the System Usability Scale (SUS) [18] was carried out to measure user acceptance and usability of the application. For this purpose, all respondents are required to install the

apk file of SPM Math Treasure application using the link provided in Google Forms. The application is compatible with a minimum of Android version 12.

The survey involved 63.3% females and the remaining are male respondents. Meanwhile, 70% of the respondents are at the age of 17 years old while the remaining are 18 years old. In addition, 93.33% have experienced using the mobile learning application, however, the remaining 6.67% do not have experience in using mobile learning application.

Figure 6 shows the result of learning outcome acquisition that was collected from the respondents. There are six sets of questions in the learning outcome acquisition section that are related to Lesson module, Tutorial module and Quiz module. For questions 1,3, and 4 all respondents agreed that they can understand the topics presented in this application. All respondents gave positive feedback which they can learn to use formula to solve questions step by step in Tutorial module. For question 2, there have 93.33% of respondents agreed mind maps are useful to learn Mathematics. Furthermore, 96.67% of respondents had chosen "Yes" for questions 5 and 6, whereas only one respondent chose "No" for using games and quizzes to learn Mathematics. To finalize the questionnaire, the majority of respondents gave good responses to this application, therefore it has the ability to provide a positive learning outcome to target users.

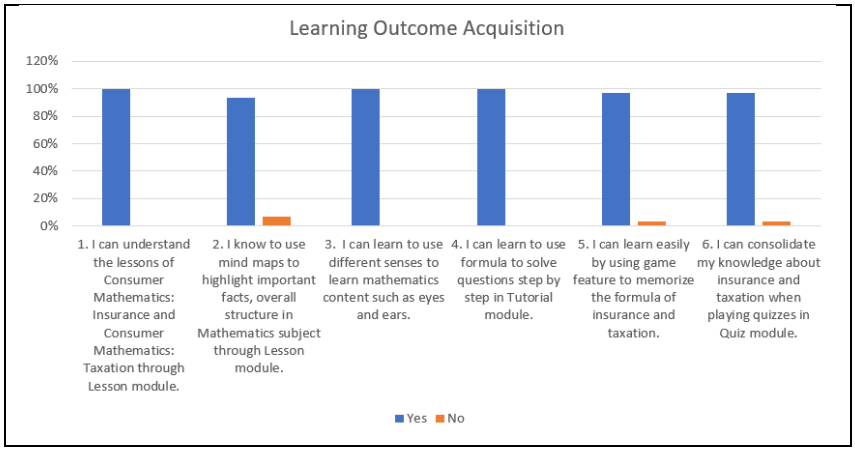


Figure 6: Learning outcome acquisition of respondent

Besides, the user acceptance level toward this application is collected from this survey which consists of 10 questions. The bar chart in Figure 7, shows most of the respondents (66.7%) strongly agreed that they would like to use this system frequently, but only one respondent strongly disagreed to use this system frequently. Meanwhile, 50% of respondents strongly disagreed that this application is unnecessarily complex. Next, 70% of respondents strongly agreed, 20% agreed, and 6.7% stayed neutral about statement 3. Then, one respondent strongly disagreed about the application was easy to use. The majority of respondents 46.7% strongly disagreed, 16.7% disagreed, and 23.3% were neutral that they required the technical person to help them when they test the application. Furthermore, 73.3% of respondents strongly agreed this application's functions are well integrated. The majority of respondents, 90% disagreed this application is inconsistency, in contrast, 10% agreed with this statement. Most of the respondents agreed that they can learn to use this application very quickly. 53.3% strongly agreed, 13.3% disagreed and 10% with neutral opinion about using this application is trouble. Next, 96.6% of respondents felt confident to this application. Lastly, 4 respondents think they need to learn a lot of things before going with this application.

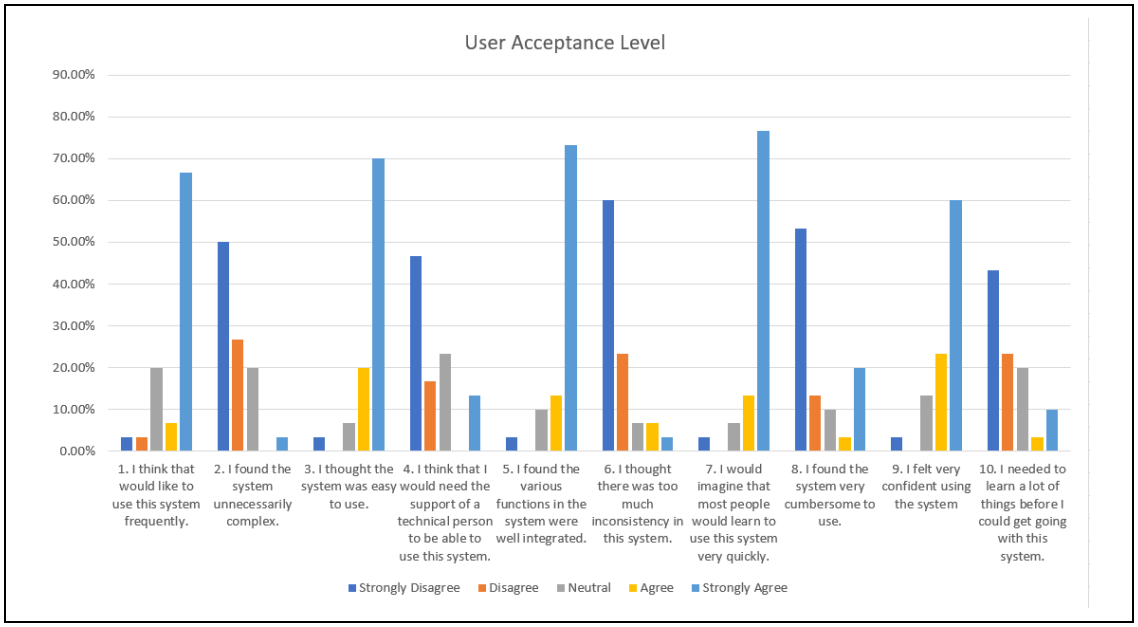


Figure 7: User acceptance level of respondent

Figure 8 presents functionality and performance of the application where all the respondents agreed the navigation buttons work well. Next, 6 respondents agree with this statement and 3 respondents are neutral with this statement. In addition, 22 respondents strongly agree that the lesson objectives and instructions given in each module are clear and simple to understand. However, one respondent strongly disagrees because the lesson objectives and instructions are unclear. Subsequently, 21 respondents supported that animated videos are implemented well, 18 respondents strongly agree that 2d side-scrolling games are well implemented and 23 respondents strongly agree that the Quiz module is functioning well.

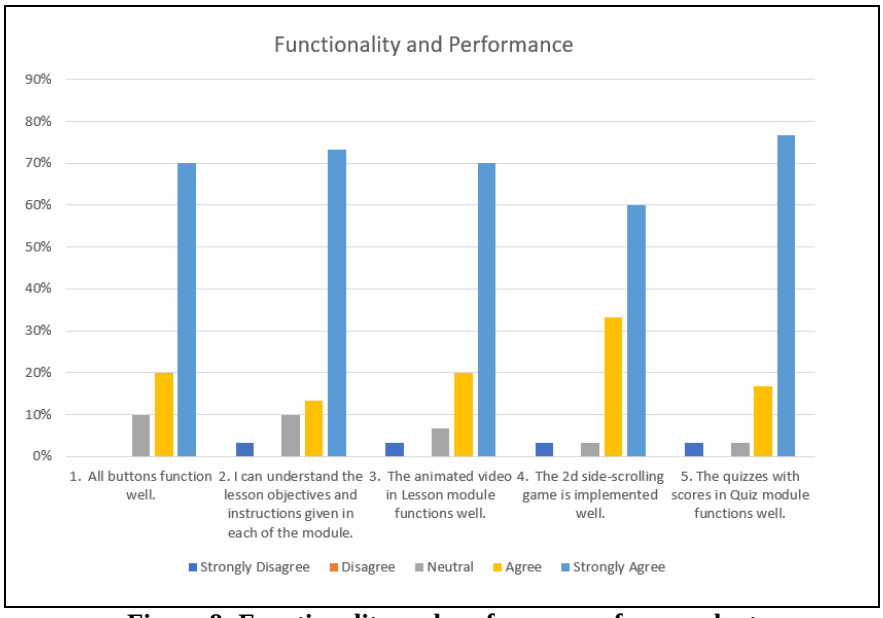


Figure 8: Functionality and performance of respondent

Table 10: Respondent's Score (User Acceptance Test)

Respondent	Item Score										Odd items	Even items	SUS score (/100)
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10			
R01	3	2	3	2	3	4	3	4	3	2	10	11	52.5

Respondent	Item Score										Odd items	Even items	SUS score (/100)
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10			
R02	5	1	4	1	5	1	5	1	5	1	19	20	97.5
R03	2	3	3	3	4	4	4	2	3	5	11	8	47.5
R04	3	3	4	3	3	2	4	2	4	2	13	13	65
R05	3	1	4	5	5	2	5	1	4	3	16	13	72.5
R06	5	2	5	2	5	1	5	5	5	1	20	14	85
R07	3	2	4	3	3	2	3	3	3	3	11	12	57.5
R08	5	2	5	1	5	1	5	2	3	4	18	15	82.5
R09	4	3	5	3	4	3	4	2	5	3	17	11	70
R10	5	3	5	2	5	1	5	1	5	1	20	17	92.5
R11	5	1	5	1	5	1	5	5	5	1	20	16	90
R12	5	1	5	1	5	1	5	5	5	1	20	16	90
R13	5	2	5	1	5	1	5	5	5	1	20	15	87.5
R14	3	3	5	3	5	3	5	3	4	5	17	8	62.5
R15	5	1	5	1	5	1	5	5	5	2	20	15	87.5
R16	4	2	5	5	4	2	4	1	4	3	16	12	70
R17	1	3	1	1	1	1	1	1	1	1	0	18	45
R18	3	2	5	5	4	2	5	3	4	2	16	11	67.5
R19	5	1	5	3	5	1	5	1	5	1	20	18	95
R20	5	1	5	1	5	1	5	1	5	2	20	19	97.5
R21	5	1	4	1	5	2	5	1	4	3	18	17	87.5
R22	5	1	5	1	5	1	5	1	5	1	20	20	100
R23	5	2	4	3	5	2	5	1	4	2	18	15	82.5
R24	5	1	5	2	5	1	5	1	5	3	20	17	92.5
R25	5	1	5	1	5	1	5	1	5	1	20	20	100
R26	5	1	5	1	5	1	5	1	5	1	20	20	100
R27	5	1	5	1	5	1	5	1	5	1	20	20	100
R28	5	5	5	5	5	5	5	5	5	5	20	0	50
R29	5	1	5	2	5	1	5	1	5	2	20	18	95
R30	5	1	5	1	5	1	5	1	5	1	20	20	100
											Average Score		80.75

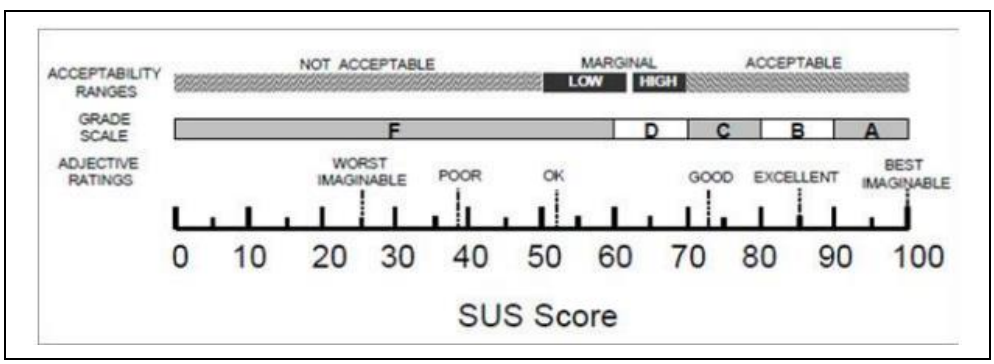


Figure 9: Scale of SUS Score [18]

To conclude, the average score of the respondents using the System Usability Scale (SUS) was 80.75% which falls in the acceptable range based on Figure 9. Therefore, the application with a gamification approach is acceptable.

5. Conclusion

In this project, the mobile learning application named 'SPM math Treasure' was developed for Form 5 students to learn Mathematics. In this application two new topics based on KSSM new syllabus which are Consumer Mathematics: Insurance and Consumer Mathematics: Taxation have been used as the main content.

According to the result obtained from the user acceptance test, the majority of the respondents are strongly agreed and agreed with the statements, hence SPM Math Treasure application has ability to be developed and suitable to use to learn Form 5 Mathematics. Additionally, this application consists of various multimedia elements such as video, animation, audio, text and images which make the learning contents become more interesting. The mind maps and storylines provided in Lesson module is attractive for students to learn the concept of Mathematics, then gamification approach provided in the Tutorial module make it become more challenges and new experiences can be gained. In addition, the quiz module with multiple choice questions are provided to train and consolidate the knowledge of students.

Despite the many advantages that will be gained through the development of this mobile learning application, it still has some limitations after carrying out the functional testing and user acceptance test. This application does not cover all chapters in Form 5 Mathematics syllabus. Therefore, students need to focus more on these two topics when using this application. Subsequently, the compact learning contents and crowded font that are present in the Lesson module may cause users to learn hard. However, the limitations of application can be improved in the future following the request of users.

In conclusion, SPM Math Treasure application was successfully developed, and it achieved all three objectives of the project with the methodology such as Multimedia Mobile Content Development (MMCD). Hopefully, this application can contribute benefits to Form 5 students.

Acknowledgment

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support.

Appendix A

Figure 10 and Figure 11 show the image collected that Form 5 students involved in user testing.

Figure 10: User 1 Testing

Figure 11: User 2 Testing

Appendix B

This section presents the content structure, system flowchart and navigation structure mentioned in Section 3.2.

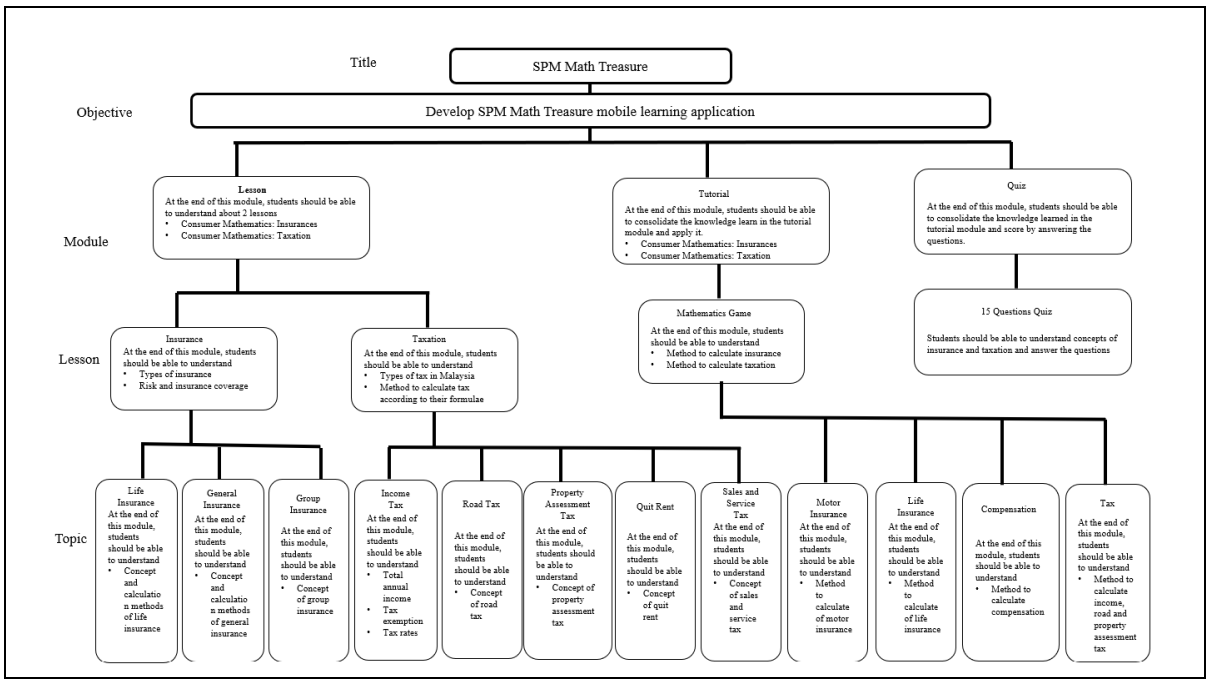


Figure 12: Content Structure

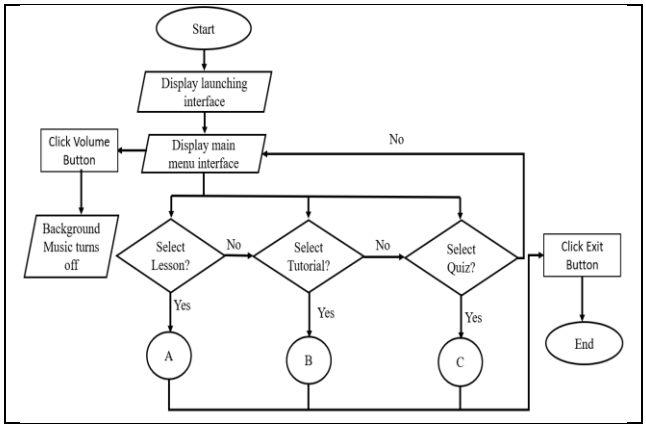


Figure 13: System flowchart

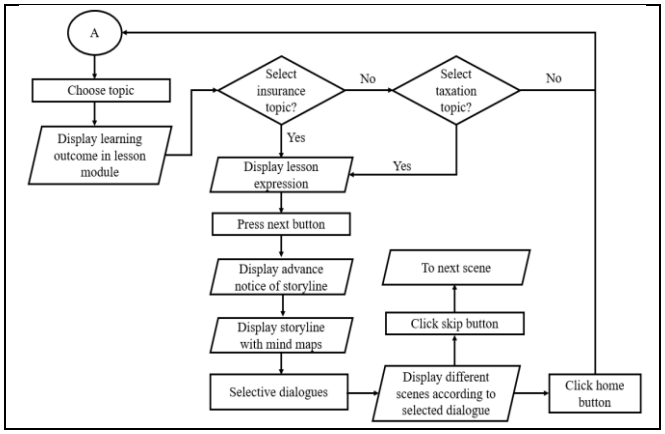


Figure 14: Lesson module flowchart

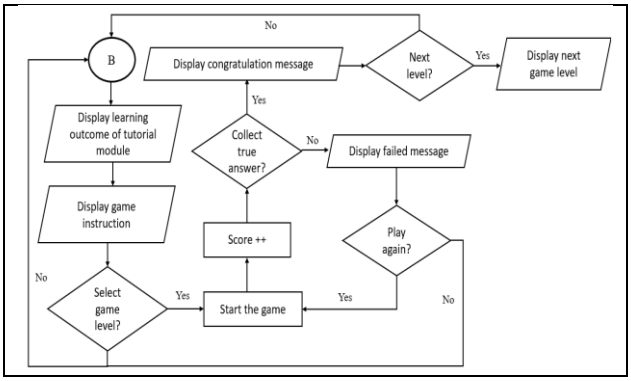


Figure 15: Tutorial module flowchart

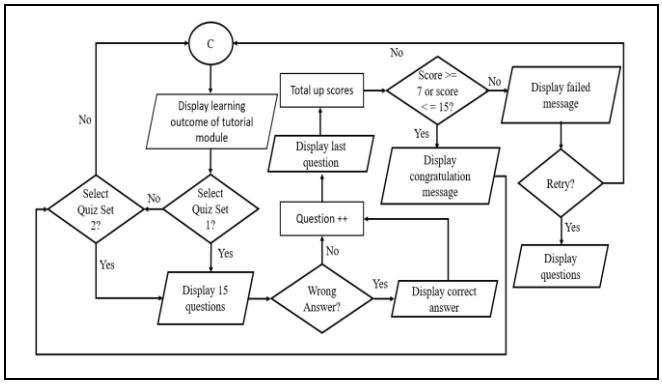


Figure 16: Quiz module flowchart

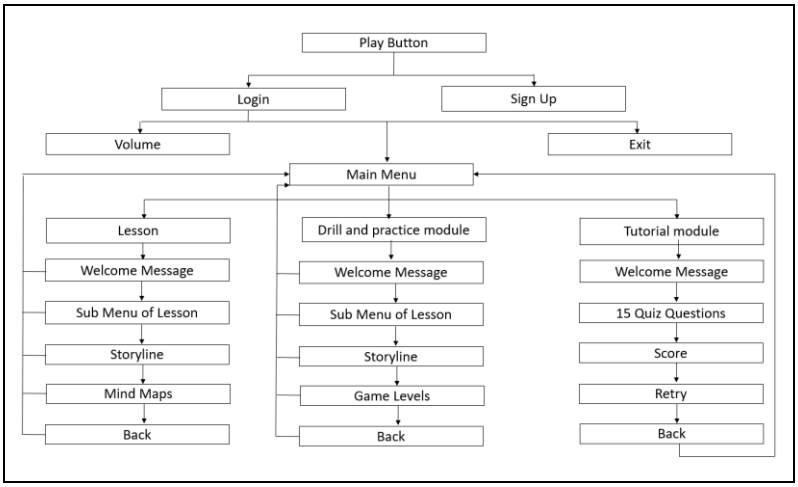


Figure 17: Navigation Structure

Appendix C

Table 11: Button Design

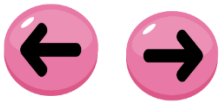
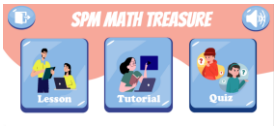
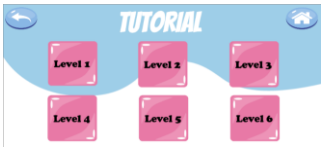
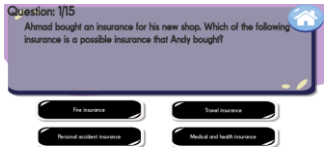
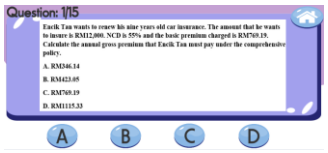
Button	Description	Button	Description	Button	Description
	This is lesson module button.		This is taxation topic button.		This is home button.
	This is tutorial module button.		These is level 1 to 6 buttons.		This is skip button.
	This is quiz module button.		These is jump button.		This is back and next buttons.
	This is insurance topic button.		This is close button.		This is question button.
	This is play button.		This is Retry button.		This is left and right button.
	This is volume setting button.		This is sound button.		This is exit button.

Table 12: Interface design

Interfaces	Description	Interfaces	Description
	This Launching interface with play button to the main menu interface.		This is Lesson module. It consists of videos that present the storylines of insurance and taxation with mind maps.
 	This main menu interface consists of three buttons: Lesson, Tutorial and Quiz modules. Each button navigates to each module correspondingly.		The lesson module shows the conversation between the main character and the supporting character with audio and animation.
 	This is the Tutorial module. It includes 6 levels of the game. In the game interface, it has hints and answers that need to collect by users.	 	This is Quiz module. This is a multiple-choice quiz. The notice sound will play to inform users whether they answer correctly or not. The buttons also will change colour.
 	This is the learning objectives interface. The users will know which knowledge they will learn in each of the modules.	 	The quiz score screen is shown after answering all questions in the tutorial module. Then, the users will be inform whether they pass or fail the quiz.

References

[1] N. A. N. Ariffin et al., "Effectiveness of gamification in teaching and learning mathematics," Journal on Mathematics Education, vol.13, no. 1, pp. 173-190, 2022, doi: http://doi.org/10.22342/jme.v13i1.pp173-190.

[2] S. H. Ng et al., Teks book mathematics KSSM (F5), 1st ed. Anyflip, 2021. [E-book] Available: Anyflip ebook pages 1-50.

[3] R. Elshiekh & L. Butgerit, "Using Gamification to Teach Students Programming Concepts," Open Access Library Journal, vol.4, pp.1-7, 2017, doi: https://doi.org/10.4236/oalib.1103803.

[4] S. Y. Cheung & K. Y. Ng, "Application of the Educational Game to Enhance Student Learning," Frontiers in Education, vol.6, pp.1-10, 2021, doi: 10.3389/feduc.2021.623793.

[5] (2019). STEPapp (Version 2.0.30) [Mobile app]. Retrieved from Google Play Store. https://play.google.com/store/apps/details?id=com.EduIsFun.EduIsFun&hl=en_US&gl=US

[6] (2015). Habitica (Version4.0.5) [Mobile App]. Retrieved from Google Play Store. https://play.google.com/store/apps/details?id=com.habitrpg.android.habitica&hl=en_US&gl=US

[7] C. M. Chew et al., "Development of Financial Education Training Module for Secondary School Mathematics Teachers: Design and Development Research," International Journal of Academic Research in Progressive Education and Development, vol.11, no.1, pp.827-836,2022, doi: 10.6007/IJARPED/v11-i1/12342.

[8] C. Y. C Yeh et al. "Enhancing achievement and interest in mathematics learning through Math-Island," RPTEL, vol.14, no.5, pp. 1-19, 2019, doi: https://doi.org/10.1186/s41039-019-0100-9.

[9] H. Gholami et al., "Impact of lesson study on mathematics anxiety and mathematics achievement of Malaysia foundation programme students," Int J Eval & Res Educ., vol. 10, no.3, pp. 912-920, 2021, doi: 10.11591/ijere.v10i3.20502.

[10] W. S. N Saifudin, S. Salam, and M. H. L. Abdullah, "Multimedia Mobile Content Development (MMCD) Framework and Methodology for Developing M-Learning Application," J. Tech. Educ. Train., vol. 4, no. 1, pp. 15–21, 2012.

[11] V. Matzavela, E. Alepis. "M-learning in the COVID-19 era: physical vs digital class" Edux Inf Technol, vol.26, pp.7183-7203, 2021, doi: http://doi.org/10.1007/s10639-021-10572-6.

[12] J. Rabah, R. Cassidy & R, Beauchemin, "Gamification in education: Real benefits or edutainment?" in Proc. European Conference on eLearning, Greece: Academic Conferences and Publishing International Montreal, Canada, 2018, pp.1-12, doi:10.13140/RG.2.2.28673.56162.

[13] A. M. Mirza et al., "Impact of VARK Learning Model at Tertiary Level Eduction," Worls Academy of Science, Engineering &Tech Int.Journal of Educ & Pedagogical Sciences, vol. 14, no.5, pp. 354-361, 2020.

[14] W. J. Liew & M. F. M. Fudzee, "Development of Road Rules Learning Application Through Game-Based Approach," AITCS, vol. 2, no. 2, pp. 557-575, 2021, doi: https://doi.org/10.30880/aitcs.2021.02.02.037

[15] (2020). Kuiz SPM (Version 1.8) [Mobile app]. Retrieved from Google Play Store.

https://play.google.com/store/apps/details?id=com.msar.kuizspm

[16] (2014). SPM (Version 4.0) [Mobile app]. Retrieved from Google Play Store.

https://play.google.com/store/apps/details?id=com.MyProAcademy.SPMFree&hl=en&gl=US

[17] (2020). JomStudy Form 4&5 SPM (Version 2.0.47) [Mobile app]. Retrieved from Google Play Store.
https://play.google.com/store/apps/details?id=jomstudy.byxun.app

[18] J.Brooke, "SUS: A Retrospective" Journal of Usability Studies, vol.8, no.2, pp.29-40, 2013.