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MATH Mastery: Development of 2D Mathematics Learning Application for Matriculation Students

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Mathematics, learning application, gamification, real time feedback.

Abstract

The MATH Mastery application solves fundamental issues encountered by Malaysian matriculation students when studying mathematics, such as fragmented tools and a lack of real time feedback. This study is to develop 2D mobile learning application adapted to the matriculation syllabus, develop it with gamified approach on the Android platform using Unity and C#. The approach used in the development was Multimedia Mobile Content Development (MMCD). Findings indicate that gamification and real-time feedback considerably improve engagement, learning efficiency, and satisfaction with the application. The study finds that MATH Mastery provides an integrated and engaging learning platform, with possible future enhancements such deeper chapter material, improved gamification components, and broader usability testing. The average score of respondents using the System Usability Scale (SUS) was 72.25 which falls in acceptable range. To improve learning outcomes and user engagement, future work will include cross-platform support, AI-driven hints, extended content modules, and extensive longitudinal research.

1. Introduction

Matriculation Programme is a pe-university program in Malaysia that prepares students for pursue degrees in STEM (Science, Technology, Engineering and Mathematics) fields at universities. Matriculation programme offers a demanding curriculum for subjects like mathematics, chemistry, biology, and physics, depending on the chosen stream and typically requires one to two years. Since mathematics forms the foundation of many technical and scientific fields, it is very important in the Matriculation Programme. Students must think critically, solve problems and interact with difficult mathematical ideas. However, learning mathematics can be challenging, particularly for people who might find it difficult to learn using conventional methods that frequently do not provide quick feedback or interaction.

In contrast to learn using conventional methods, mobile learning, also known as m-learning, is an educational practice of accessing learning resources and participating in academic activities using mobile devices, such as laptops, tablets, and smartphones [1] can enhance the learning process and accommodates a variety of learning methods by supporting a wide range of interactive elements and multimedia formats. A 2D mobile learning application is well suited for this framework that provides an interactive learning platform that uses graphics, animations and engaging user interfaces to provide the content into dimensional format. This application which frequently focus on topic, offer tools like interactive activities, quizzes and visual aids that assist in breaking complicated concepts into easier way. This flexibility and accessibility learning method allowing students to learn on their own schedule and at their pace because they can access it anytime and anywhere without limitations [2].

Currently, the use of conventional learning methods and disjointed internet resources such as Quizizz and Google Forms in matriculation programs causes challenge to students' ability to learn mathematics. This will make students difficult to track their progress, having fragmented learning experience and they are unable to receive immediate feedback when they rely on manual processes and specific online resources [3].

Therefore, this project aims to design the MATH Mastery 2D learning application for matriculation, develop the MATH Mastery learning application with 2D gamification approach on Android platform and perform the functionality and user acceptance testing of the proposed application. The proposed application is designed for matriculation students in 'Program Dua Tahun' (PDT) in semester 1 to help them practice their mathematics revision through mobile learning. MATH Mastery application contains four modules: the Notes Module, Quizzes Module, Progress Tracker Module and Mission Module. Notes Module and Quizzes Module were based on matriculation PDT semester 1 syllabus focusing on Chapter 1 to Chapter 8. The content of this application is delivered in English language. By using MMCD methodology, a systematic and structured process is followed throughout the development process. By addressing the current issue, MATH Mastery application is expected to function smoothly on Android device. Thus, this application could be proposed to be used by matriculation students in mathematics subject with integrated platform with notes, quizzes, gamification, and instant feedback, promoting active learning and self-evaluation to enhance mathematical comprehension.

The rest of the paper is arranged as follows: Section 2 covers the domain of the study, the technology used and the result of comparative analysis. Section 3 describes MMCD methodology that has been chosen to be used in this project, as well as the output of analysis and design phases of this project. Then, Section 4 discusses the result and discussion while Section 5 states the conclusion of the current progress.

2. Literature Review

This section covered to provide the project's background, evaluate the technology used, and compare three current applications.

2.1 Mathematics Subject for Matriculation Programme

In Malaysia, Matriculation Programme is an important pre-university pathway for students that are preparing for higher education, especially in science, technology, engineering and mathematics (STEM) courses [4]. Mathematics is one of core subjects in this programme, which covers a variety of subjects like geometry, algebra, calculus and statistics. The curriculum is designed to help students improve their analytical and problem-solving abilities, which are critical for success in college level coursework.

In order to develop their capacity critical thinking and provide a strong basis for more challenging topics in their chosen courses, students must apply concepts from mathematics to real world issues. In addition to offering students with necessary abilities, the emphasis on mathematics also gets them ready for the demanding requirements of STEM-related courses in higher education. The traditional teaching methods used in matriculation programs to teach mathematics might be difficult for students, especially those who have trouble with traditional learning approaches that usually don't offer immediate feedback or engagement.

Effective mathematics learning may be challenged by students' dependence on fragmented online tools like Quizizz [5] and Google Forms. Their ability to track their progress limits their ability to keep an eye on their academic achievement and concentrate on areas that want development. Furthermore, the fragmented learning experience brought about by the usage of several instruments causes difficulties for educational institutions as well as students. Quick corrections and active learning are less likely when there is no immediate feedback. A more responsive and integrated approach to education could greatly improve students' comprehension and performance in STEM subjects. However, the implementation of 2D learning application in learning mathematics said otherwise. By implementing 2D learning application that offer real time feedback, lecturers can assist students in identifying areas for growth and modifying their learning pathways.

2.2 Mobile Learning

Mobile learning, also known as m-Learning, is a method of using mobile devices such as smartphones, tablets, and laptops to access educational materials [6]. In order to give students access to educational materials and allow them to interact with content while on the road, this strategy makes use of the portability and connection of mobile technology. A range of learning activities that take place via mobile devices are included in the concept of mobile learning, such as self-directed study, informal learning and formal education. Among the many important features of mobile learning is accessibility, which allows students to access learning resources at any time and from any location, minimizing the limitations of conventional classroom settings.

In order to keep students interested, it also uses games, stimulations and quizzes to create interactivity. Social learning encourages interaction via messaging apps and social media, while personalization allows customization to individual learning preferences. Mobile learning's advantages include ease of use, which enables students to study while going about their daily lives, improved engagement through gamified components, instant

assessment feedback, and encouragement of lifelong learning. Nevertheless, it has it owns limitations, including distractions from multipurpose gadgets, poor connectivity in underserved areas, device constraints that restrict usage to advanced applications and inconsistent educational resource quality.

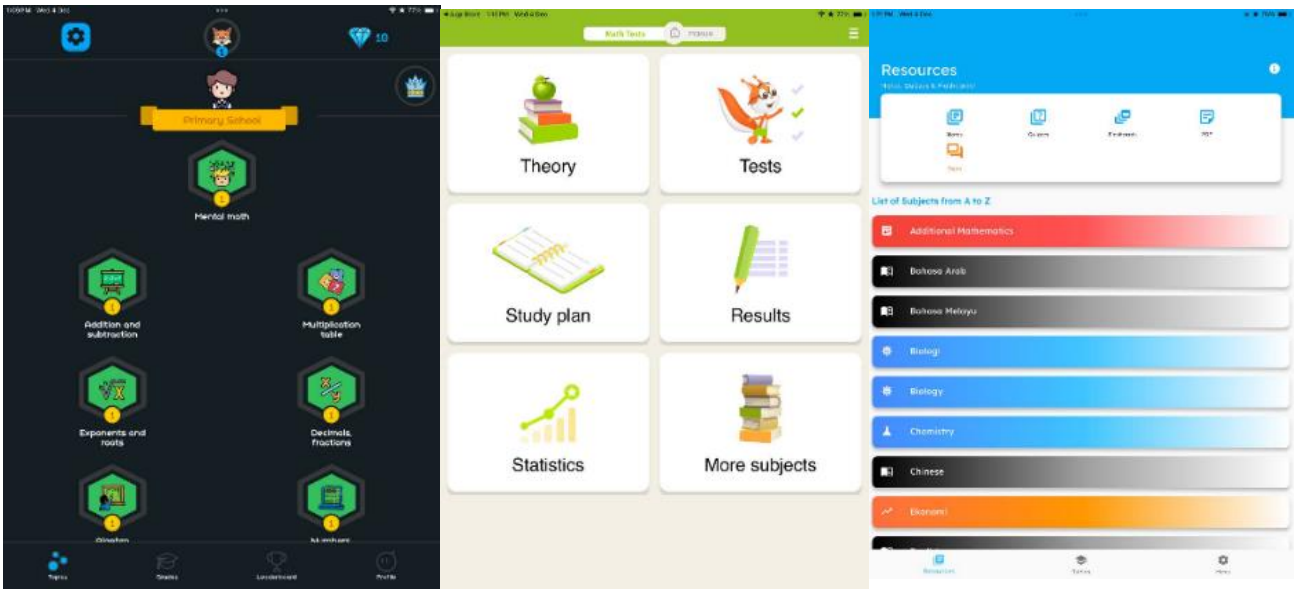
2.3 Gamification Approach

Gamification is an improve behavior, motivation, and engagement by incorporating game mechanics and design aspects into non-gaming contexts [7]. Drawing from behavioral psychology and game theory, it uses external rewards, like badges or points, and internal motivators, like a sense of accomplishment, to make tasks more engaging. As businesses from a variety of sectors looked for creative approaches to increase engagement and retention, this idea became well-known in the early 2010s.

By adding enjoyable and rewarding components to everyday chores, gamification turns mundane work into interesting, goal-driven experiences that increase user engagement. There are two primary categories of gamification, which are content-based and structural. Without changing the material, itself, structural gamification improves current procedures by placing game mechanisms like leader boards, points and prizes. On the other hand, content gamification transforms the content into something more like a game by adding interactive tasks, challenges, or narratives to make the content more interesting. Leader boards, progress tracking, badges, point systems and reward systems are typical gamification elements. These components motivate users by taking use of human signals toward success, competitiveness and teamwork.

2.4 Comparative Analysis

Comparative analysis was conducted in three related applications to the proposed system. The three applications are 1st – 12th Grade Math Problems[11], Math Tests: Learn Mathematics[12], JomStudy: Form 1-5 Study App[13] as shown in Fig 1(a),(b) and (c) respectively. Table 1 shows the result of the comparative analysis.



(a) **(b)** **(c)**

Fig.1 *(a) 1st – 12th Grade Math Problems,(b) Math Tests: Learn Mathematics, (c)JomStudy: Form 1-5 Study App*

Table 1 *Application Comparison*

Features/ Applications	1st – 12th Grade Math Problems	Math Tests: Learn Mathematics	JomStudy: Form 1-5 Study App	MATH Mastery
Target Audience	Elementary to high school students	Students of all ages	Malaysian students in Forms 1 to 5	Malaysian students in Matriculation Programme
Curriculum Focus	Broad rage of grade levels and topics	Systematic testing aligned with curricula	Tailored to Malaysian education system	Specific to Malaysia Matriculation syllabus
Key Features	Practice problems, quizzes,interactive games	Timed tests, immediate feedback,performance tracking	Interactive notes, AI chatbot, live tutoring	2D interactive learning,notes Adaptive quizzes, gamification
Accesibility	Accessible across devices	Easy access on various devices	Accessible but needs better navigation	Designed for Android devices only
Feedback Mechanism	Limited feedback on errors	Instant feedback with detailed explanations	Self-evaluation and progress tracking	Adaptive quizzes adjust to performance
Gamification element	Provided	Provided	Limited gamification	Provided

3. Methodology

The MATH Mastery learning application has been developed using the MMCD methodology, as shown in Fig. 2. This is because mobile learning application development is the focus of the MMCD methodology and suitable for the development process. The five phases of this methodology are the application idea creation phase, analyze the structure phase, design the process phase, develop main functions phase and testing phase.

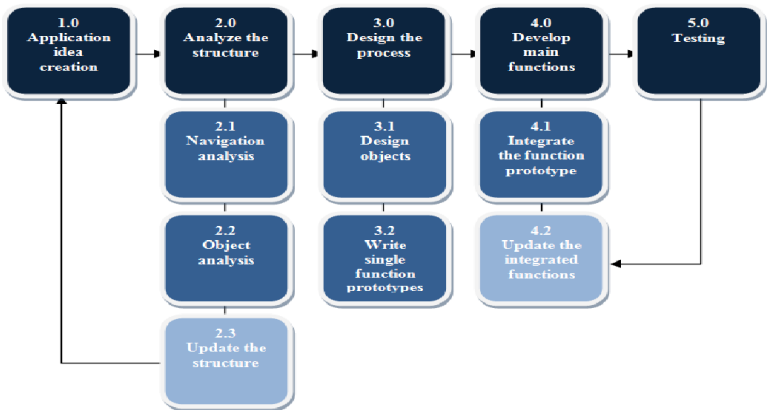


Fig. 2 MMCD Methodology [14]

3.1 Application Idea Creation

This phase is the first phase in the MMCD methodology. Several processes are carried out to study ideas related to the project to be developed. This includes preparing a proposal paper that contains the introduction, objectives, scope of the project, expected results, and target users for the application to be developed. The checklist's user and application requirements are shown in Table 2.

Table 2 *Application idea creation checklist*

Item	Note
Type of application	Mobile Learning
Target Device	Android Device
Target Users	Matriculation students (18-19 years old)
FPS and application settings	-Unity Version: 2022.3.50f1 -Resolution: Adaptable for all Android device
Images	2D images (notes page and quiz page)
Video	None
Audio	-Background sound music -Clicking audio -Success and fail sound in quiz module
Application synopsis	MATH Mastery is a mobile learning application for Matriculation students that are currently enrolled in 'Program Dua Tahun' (PDT) semester 1. This application will consist 4 module which are notes module, quizzes module, progress tracker module and mission module. It will consist of multimedia elements in process of learning such as images and text.

Table 3 *User Analysis*

Information Gathering Method	Role in the project	User Requirements	Actions Required
Recorded Interview with Subject Matter Expertise (SME)	Content consultant expert in education and visual learning application	Implement minimalist design on the interface	Use a neutral color palette with 1-2 accents, high contrast for readability, and clean, modern fonts with minimal styles or sizes for clear hierarchy.
		Arrange the content for this application according to the matriculation lesson syllabus	Work with lecturers to align content, discuss structure, and get feedback for refinement.
		Questions are arranged according to the difficulty, starting from easy to difficult.	Sort questions into Easy, Medium, and Hard by complexity and required skills. Start with simple ones to build confidence, then progress to harder challenges.
		Provide link video for explanation video for each chapter.	Implement a clickable image linked to the playlist video explanations of each chapter from the matriculation lecturer's YouTube channel.

3.2 Analyze the Structure

The second phase is to analyze the structure. This phase involves object analysis and navigation analysis involved. Functional requirements explain what needs to be done by identifying the tasks, actions or activity requirements that must be achieved in the developed application. Non-functional requirements describe the nature or quality of an application. In this phase, the content structure, navigation structure and application flow chart are also drawn. Table 4 and Table 5 show the Functional and non-functional requirements of the proposed application. The system flowchart, navigation structure, diagram, and content structure of each module flowchart application module are shown in Figure3 to Figure 5.

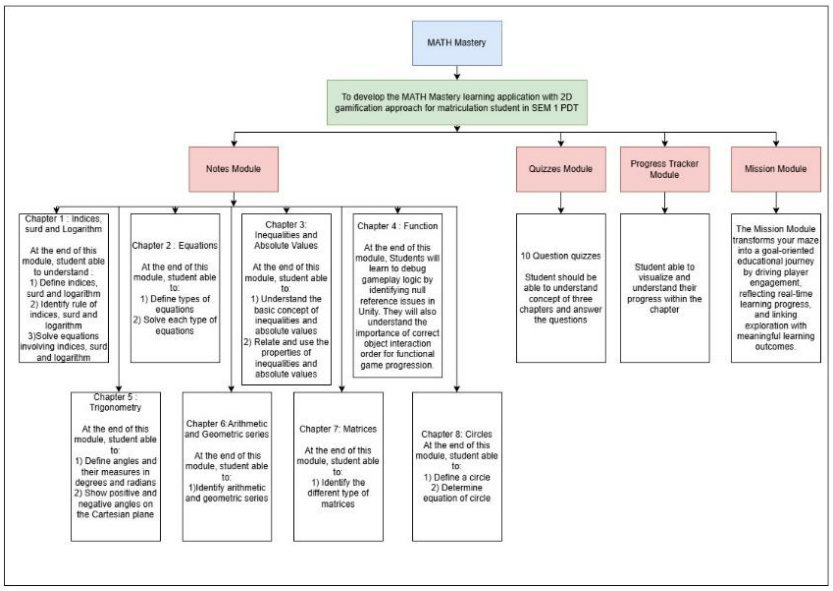


Fig.3 *Content Structure*

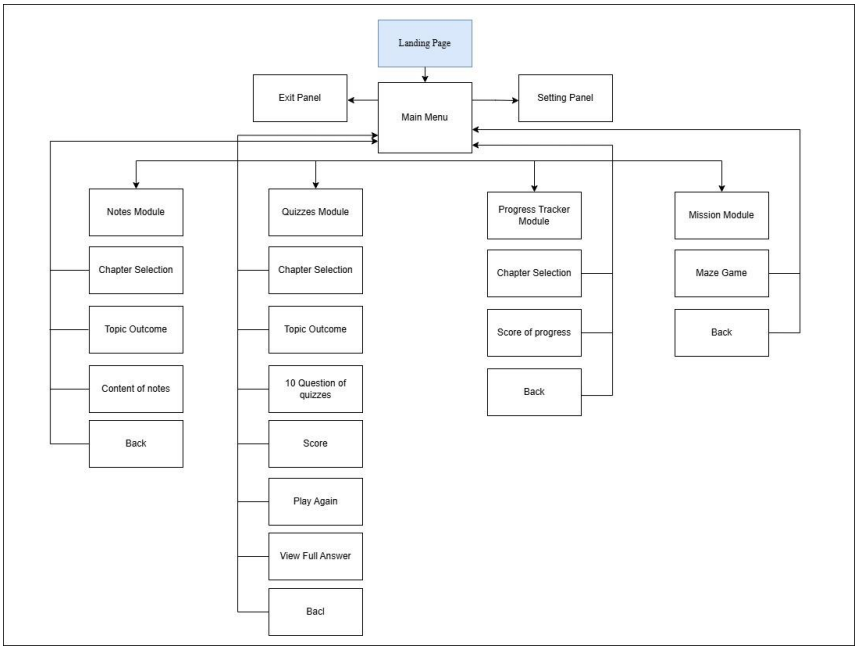


Fig. 4 *Navigation Structure*

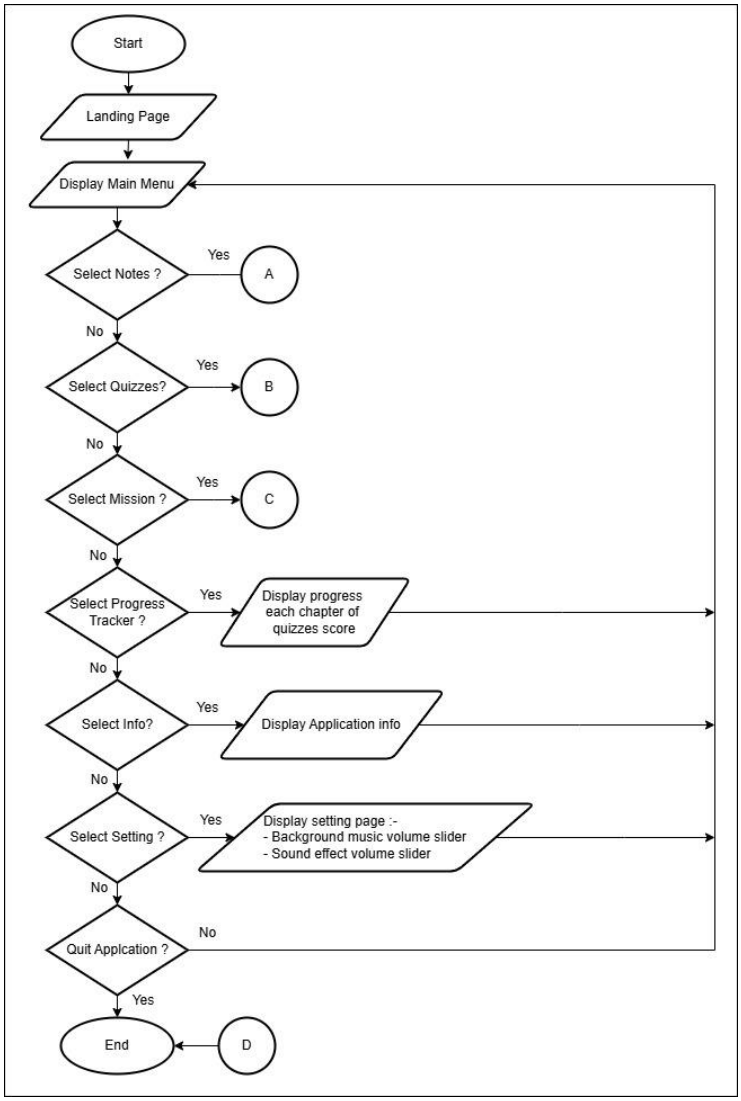


Fig. 5 *System Flowchart*

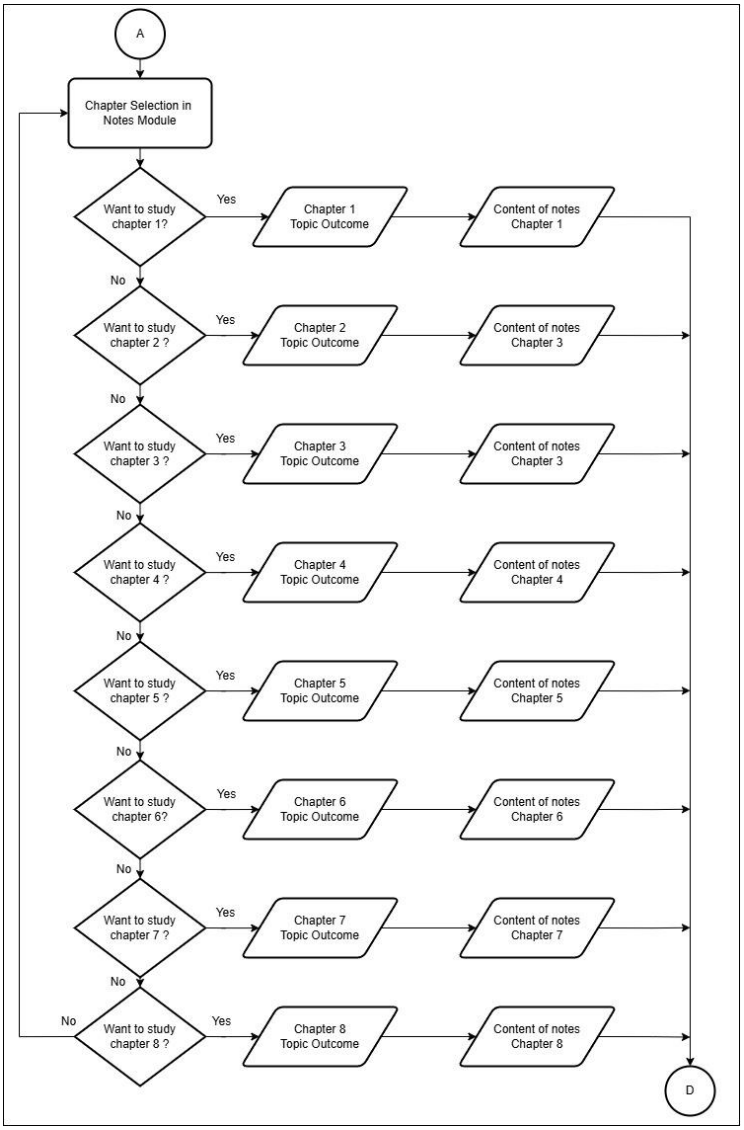


Fig. 6 *Flowchart for Notes Module*

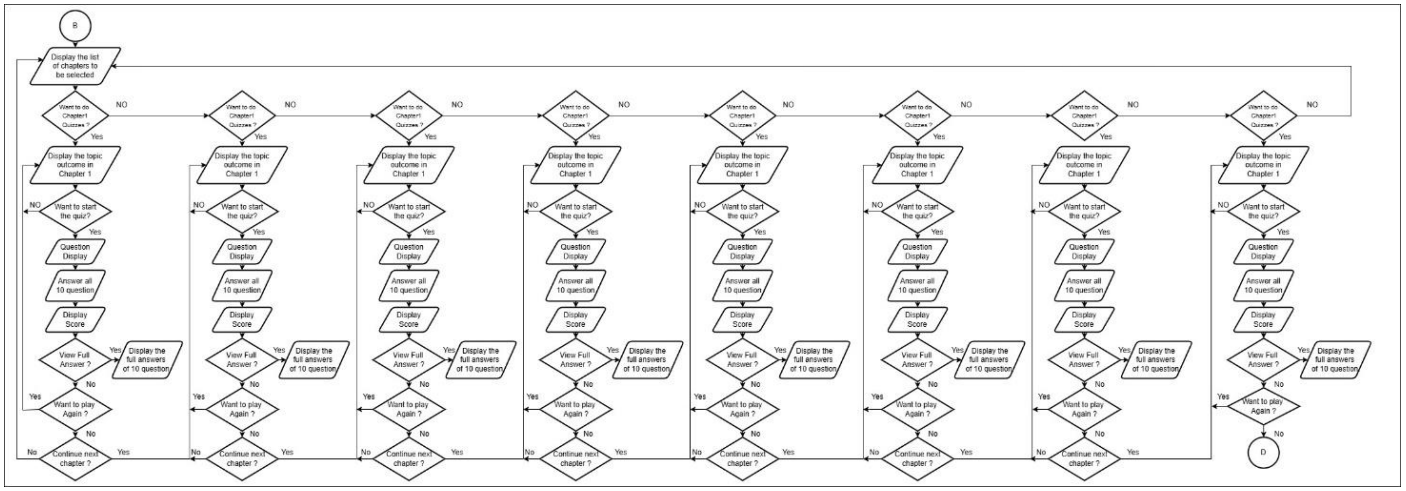


Fig. 7 *Flowchart for Quizzes Module*

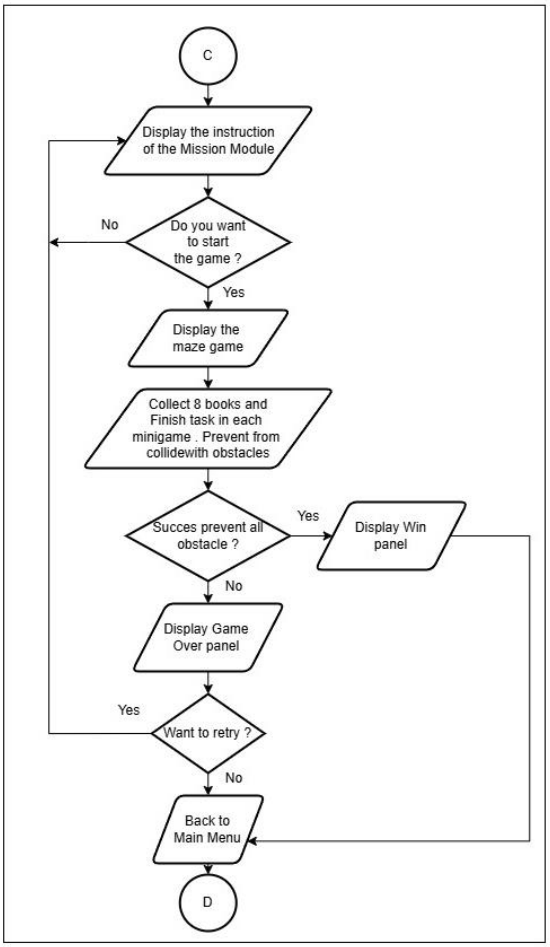


Fig.8 *Flowchart for Mission Modules*

Table 4 *Functional Requirements*

Funtional Requirements	Module	Description
User Interaction	Landing Page	The system shall provide users with the ability to start the application
	Main Menu	The system shall provide users with the ability to select modules.
		-The system shall provide users with the ability to navigate through the application by clicking the appropriate buttons.
	Notes Modules	The system shall provide users with the ability to select one topic between 8 chapter.
	Quizzes Module	The system shall provide users with the ability to answer the questions by multiple choice.
	Mission Module	The system shall provide users with the ability to complete 8 missions.
	Progress Tracker Module	The system shall allow users to track their progression after answering the quizzes.
Autonomous System Activities	Quizzes Module	-The system shall allow users to get their quiz results after answering all 10 questions
		-The system shall provide users the badges after answering the quizzes.

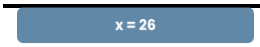
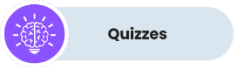
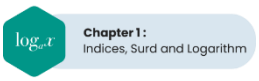
Table 5 *Non-functional Requirements*

Non-Funtional Requirements	Description
Performance	-The application shall operate online -Any interaction between the user and system should not exceed five seconds for an Android device
Operational	The application shall be operated on any Android device.
Cultural	The application shall be developed in English
Legal	Users only can review the information displayed in the application, but they cannot modify.
Usability	The application shall be user-friendly and easy to use anywhere and anytime.

3.3 Analyze the Structure

This stage in MMCD, which analyses the application's structure in order to efficiently plan and decide on its overall appearance, especially for mobile learning apps. A clear navigation structure must be made, complete with menus that well-organized and easily accessible buttons. It is also important to make sure that these buttons are properly labelled to avoid confusion. Table 6 will show the button used in the application.

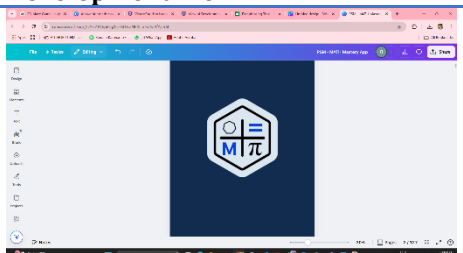
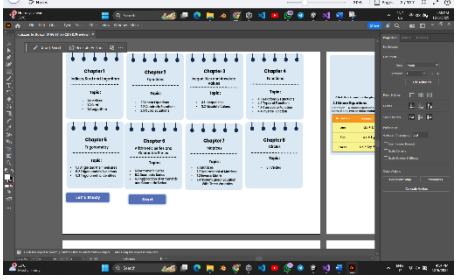
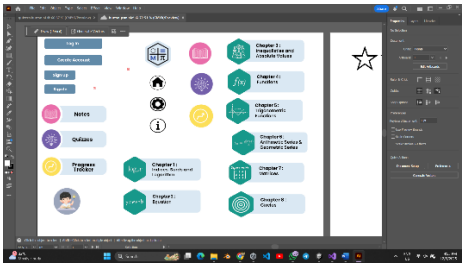
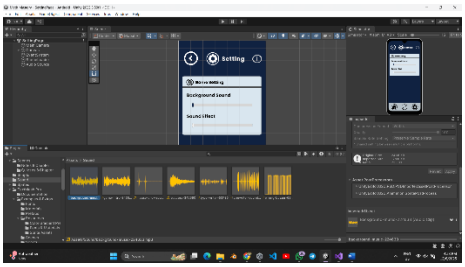
Table 6 *Button design*

Button and Icon	Description
	Answer button to allow user choose answer in quizzes module
	Quizzes button to navigate to quizzes module.
	Progress tracker button to navigate to progress tracker module
	Chapter button to navigate to the selected chapter either in notes or quizzes module
	Let's study button to navigate to the quizzes module
	Start button to navigate to start answering 10 questions in quizzes module.
	Play Again button will navigate users to start again the quiz.
	Next chapter button will navigate users to move to next chapter of quiz.
	Done button will show up after users done all of the quizzes and redirect to main menu.
	Resume button will navigate user back to the question in the quizzes module.
	Exit Quiz button will navigate user to the main menu.
	Back button will navigate user to previous page.
	Info button will navigate user to info interface.
	Setting button will navigate user to setting interface.
	Home button will navigate user bak to main menu.
	Pause button will pause user from the maze game in Mission Module.

3.4 Develop main function

In this phase, the application's essential features are created and implemented in application. This phase focuses on turning the conceptual framework developed in earlier stages into a functional product that satisfies user requirements and educational objectives. At the application development stage, key functions such as the notes module will be designed with theoretical elements, reading notes, and interactive quizzes to aid student understanding. Gamification elements such as receiving badges where students will receive rewards when they successfully answer quizzes. Additionally, the main function of Mission module converts the maze game into a goal-oriented educational adventure by increasing player engagement, tracking real-time learning progress, and connecting a discovery to meaningful learning outcomes. The assets developed for this application are 2D graphics, 2D buttons and audio as tabulated in Table _.

Table 7 *Development of Assets in Application*

Type of Assets	Development View	Description
2D Graphics		In the Landing Page, Canva Pro is used to design the logo of MATH Mastery.
2D Graphics		Adobe Illustrator is used to create the content for Notes module.
2D Button		Canva elements such as icons and graphics are imported to Adobe Illustrator to design 2D that can be used in different scene in the application.
Audio		The audio files in the MATH Mastery application are downloaded from free online resources such as Pixabay.com and no copyrighted music from the Youtube website. Its format is MPEG Audio Layer 3 (MP3).

Then, the C# scripting is applied to ensure the main functions of the application can be operated properly. The main function involve changes scene, player movement, quiz manager, answer checker, and progress tracker are tabulated in Table 8.

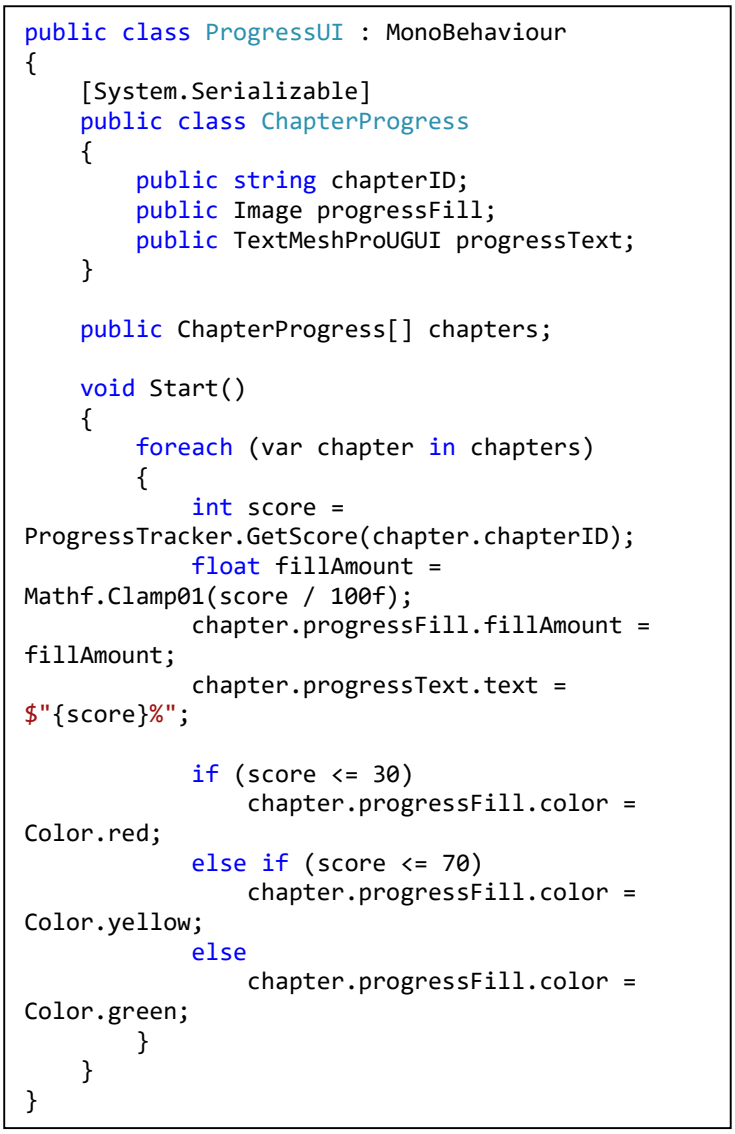
Table 8 *C# Scripting for Integration in Unity*

Functions	C# Scripting	Description

Scene Loader (For changing scene)	`using UnityEngine;`
	`using UnityEngine.SceneManagement;`
	
	`public class SceneLoader : MonoBehaviour`
	`{`
	`  public void LoadSceneByName(string sceneName)`
	`  {`
	`  SceneManager.LoadScene(sceneName);`
	`  }`
	`}`
		This script allows user to load a different scene in Unity project by specifying the scene's name.

Player Movement (using Joystick)	`public Joystick joystick;`
	`void Update()`
	`  {`
	`  if (isInMinigame) return;`
	
	`  Vector3 move = new Vector3(joystick.Horizontal, joystick.Vertical, 0f);`
	
	`  // Prevent tiny joystick input from moving the player`
	`  if (move.magnitude >= 0.1f)`
	`  {`
	`  transform.Translate(move.normalized * speed * Time.deltaTime);`
	`  }`
	`  }`
		This script allows players to walk in Maze game in MATH Mastery application using a virtual joystick. It reads the horizontal and vertical input values form the joystick every frame and moves the player in the appropriate direction.

Quiz Manager	```
	public class QuizManager : MonoBehaviour
	void Update()
	void Start()
	    {
	        int index =
	Mathf.Clamp(QuizSession.selectedChapterID - 1, 0,
	allChapterBanks.Length - 1);
	        questionBank = allChapterBanks[index];
	
	        if (questionBank == null)
	        {
	            Debug.LogError($" QuestionBank for
	Chapter {QuizSession.selectedChapterID} is null!");
	            return;
	        }
	
	        Debug.Log($"Loaded bank for Chapter
	{QuizSession.selectedChapterID}:
	{questionBank.name}");
	
	        SetupChapter();
	        SetupButtons();
	        StartQuiz();
	
	        if (bgmSource && !bgmSource.isPlaying)
	        {
	            bgmSource.loop = true;
	            bgmSource.Play();
	        }
	    }
	
	    void Update()
	    {
	        if (Input.GetKeyDown(KeyCode.Escape))
	            ShowResumePopup();
	    }
	
	    void SetupChapter()
	    {
	        if
	(QuizSession.chapterNames.TryGetValue(QuizSession.s
	electedChapterID, out string chapterName))
	            chapterTitleText.text = chapterName;
	        else
	            chapterTitleText.text = $"Chapter
	{QuizSession.selectedChapterID}";
	    }
	``
		This script handle MATH Mastery's quiz system. It loads the relevant question bank for the chapter, configures the UI and buttons, begins the quiz, and plays background music. It also listens for the escape key to display a resume popup and adjusts the chapter title based on the currently chosen chapter.

Progress tracker		This script is used to show the user's quiz progress for each chapter in Unity UI. It pulls scores from a 'ProgressTracker' scene using chapter IDs, updates each progress bar's fill quantity and percentage text, and changes the bar color based on the score

3.5 Testing

The testing phase is the final phase which includes functional testing, user acceptance testing, performance testing, and bug fixing. In functional testing, the buttons and features of the completed application will be tested. System Usability Scale (SUS) user tests was conducted. If there are bugs or improvements that need to be made during testing, a repair process will be carried out to solve the problem. Once all the bugs are fixed and the application is working properly, user acceptance testing will be done with the target users.

Table 9: *Functional Testing*

Test	Expected Result	Actual Result	Corrective Action
Notes Button	Navigate to the list of chapters of notes.	Work well as expected	
Quizzes Button	Navigate to the list of chapters of quizzes.	Work well as expected	Not needed
Mission Button	Navigate to the instruction of Mission Module	Work well as expected	Not needed

Table 9: *(continued)*

Test	Expected Result	Actual Result	Corrective Action
Progress Tracker Button	Navigate to Progress Tracker Page	Work well as expected	Not needed
Info Button	Navigate to Info Page	Work well as expected	Not needed
Setting Button	Navigate to Setting Page	Work well as expected	Not needed
Back Button	Navigate to the previous scene	Work well as expected	Not needed
Pause Button	Pause the Maze game in mission module	Work well as expected	Not needed
Answer Option Button	Identify the correct or wrong answer	Work well as expected	Not needed
Volume slider	Adjust the volume of background music and sound effect	Work well as expected	Not needed
Quit Button	Quit the game.	Work well as expected	Not needed
Resume Button	To resume the game play.	Work well as expected	Not needed
Score system	Track the current score that achieved by users	Work well as expected	Not needed
Done Button	Close the mini game popup panel	Failed to continue the maze game after closing the mini game popup panel	Reset the button and use the correct script for close mini game popup panel.

According to the functional testing, in my maze game scene in Mission module, when the player collides with a book, a mini game panel appears. After completing the quiz and selecting the "Done" button, the panel should close, the book destroyed, the mission text updated, and the player should proceed to gather the other books. However, this is presently only applicable to the first book. Although the window closes after the first minigame, the book is not destroyed, the mission text is not updated and the user is unable to continue, indicating that the currentBook reference was lost or incorrectly assigned before CloseMinigame() was executed. Hence, the solution is ensure the player collides with the book first to assign currentBook, then only allow the Done button to call CloseMinigame(). 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 developed. The questionnaire only consists of one section, which consist of 10 question of user acceptance level. 30 respondents who have study in matriculation program 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. Result and Discussion

In user acceptance testing, the System Usability Scale (SUS) 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 MATH Mastery application using the link provided in the Google Forms. The application is compatible with a minimum of Android version 12.

The survey involved 73.3% females and the remaining are male respondents. Meanwhile, 70% of the respondents are at the age of 19 years old while the remaining are 18 years old. Figure 9 shows the result of user acceptance level that was collected from the respondents that consists of 10 questions. The bar chart in Figure 9 shows that most of the respondents (55%) strongly agreed that they would like to use this system frequently. Meanwhile, 20% respondents strongly disagreed that this application is unnecessarily complex. Next, 60% strongly agreed for statement 3. Then, 30% respondent strongly disagreed that they would need support to use

this application. Furthermore, 46.7% respondent agree that they found the various functions in this MATH Mastery application were well integrated. Other than that, 33.3% respondent disagreed that there was too much inconsistency in this application and 66.7% respondents thinks that most people would learn to use this MATH Mastery application very quickly. Then, 30% respondents strongly disagree that found the application very cumbersome to play and 46.7% respondents very confident using the MATH Mastery application. Lastly, 23.3% respondents needed to learn a lot of things before I could get going with this application.

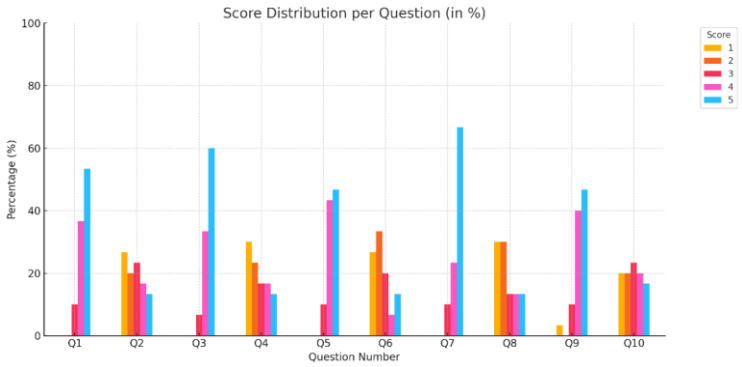


Fig. 9 *User Acceptance Level of respondent*

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

Responden	Skor Item										Skor Ganjil	Skor Genap	Jumlah Skor
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10			
R01	4	2	4	5	4	2	5	2	4	3	16	11	67.5
R02	4	3	4	2	4	3	3	3	3	3	13	11	60
R03	3	3	4	2	3	3	5	2	4	2	14	13	67.5
R04	4	3	4	4	4	3	4	4	4	4	15	7	55
R05	5	4	5	2	5	2	5	4	5	5	20	8	70
R06	3	3	3	3	3	3	3	3	3	3	10	10	50
R07	5	1	5	2	5	2	4	2	4	2	18	16	85
R08	5	4	5	4	5	4	4	4	4	4	18	5	57.5
R09	5	3	4	4	4	2	4	2	4	4	16	10	65
R10	4	3	4	3	4	2	4	2	4	3	15	12	67.5
R11	5	4	5	3	5	2	5	2	1	1	16	13	72.5
R12	5	1	5	1	5	1	5	1	5	1	20	18	95
R13	4	1	5	1	4	1	5	1	5	3	18	18	90
R14	3	2	3	2	4	3	3	3	3	2	11	20	77.5
R15	5	5	5	5	5	5	5	5	5	5	20	0	50
R16	5	2	5	2	5	2	5	3	5	2	20	14	85
R17	4	2	4	3	4	2	4	2	4	3	15	13	70
R18	5	3	5	1	5	3	5	1	5	1	20	16	90
R19	5	1	5	1	5	1	5	1	5	1	15	20	87.5
R20	5	2	4	1	3	2	5	1	5	2	20	17	80
R21	5	1	5	1	5	1	5	1	5	1	20	20	100
R22	4	4	4	4	4	4	4	4	4	4	15	5	50
R23	5	5	5	3	5	1	5	1	5	5	20	10	75
R24	5	1	5	1	5	1	5	1	5	1	20	20	100
R25	5	5	5	5	5	5	5	5	5	5	20	0	50
R26	4	2	5	2	4	2	5	2	4	2	17	15	80
R27	5	5	5	5	5	5	5	5	5	5	20	0	50
R28	4	4	4	4	4	5	5	5	4	3	16	4	50
R29	4	1	5	1	4	1	5	2	5	4	18	16	85
R30	4	1	5	1	4	1	5	1	4	4	17	17	85
												Skor Purata	**72.25**

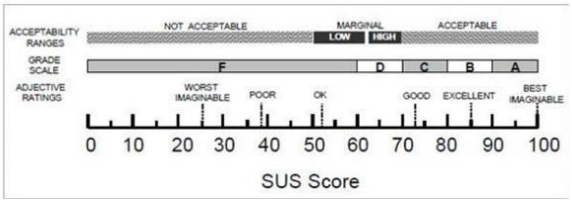


Fig. 10 *Scale of SUS Score*

To conclude, the average score of the respondents using the System Usability Scale (SUS) was 72.25 which falls in the acceptable range based on Figure 101. Therefore, the application with a gamification approach is acceptable.

5. Conclusion

In conclusion, the mobile learning application named 'MATH Mastery' was developed for Malaysian Matriculation Programme students that are currently enrolled in Semester 1 PDT. There are 8 chapters that consists in this application. According to the result obtained from the user acceptance test, most of the respondents are strongly disagreed and agreed with the statements, hence MATH Mastery application has ability to be developed and suitable to use to learn Mathematics subject in matriculation. Additionally, this application consists of multimedia

elements such as animation, audio, text and images which make the learning contents become more interesting. The minigame in Mission module is attractive for students to learn the concept of Mathematics, then gamification approach provided in Quizzes and Mission module make it become more challenges and new experiences can be gained. In addition, the quizzes 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 in detail in notes module. Therefore, students need to focus more on the topics when using the application. However, the limitations of application can be improved in the future following request of users.

In conclusion, MATH Mastery application was successfully developed, and it achieved all three objectives of the project with the methodology such as Multimedia Mobile Content (MMCD). Hopefully, this application can contribute benefits to matriculation students.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nurul Syafiqah Farhanah Anwar, Muhammad Fakri Othman;* ***data collection:*** *Nurul Syafiqah Farhanah Anwar, Muhammad Fakri Othman;* ***analysis and interpretation of results:*** *Nurul Syafiqah Farhanah Anwar, Muhammad Fakri Othman;* ***draft manuscript preparation:*** *Nurul Syafiqah Farhanah Anwar, Muhammad Fakri Othman. All authors reviewed the results and approved the final version of the manuscript.*

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Appendix A: Recorded Interview Transcript with SME

Question: Assalamualaikum, Madam Rosnida. I am Nurul Syafiqah Farhanah binti Anwar, a student from Universiti Tun Hussein Onn Malaysia (UTHM). I am currently enrolled in final year project. In my project, I have to develop a mathematics learning application for matriculation students. I am doing this interview session with madam because I want to collect information about mathematics subject. First of all, can you introduce ypurself and tell me about your teaching experience?

Madam Rosnida: My name is Rosnida binti Ramli, I was teaching Mathematics subject in Labuan Matriculation College, Labuan for 8 years.

Question: What do you think about the design of the application that I will develop?

Madam Rosnida: In my opinion, this application is very good because it can be a tool for students to enhance knowledge that they have learned during lectures or tutorials. This is because I see that this application is self-learning, students can use the application to make revisions. In addition, this application also integrates the use of technology in learning. In my opinion, students are now fonder of using devices while studying than hand-written notes.

Question: In addition, are the app's features and navigation suitable for matriculation students?

Madam Rosnida: Yes, because this application is interactive because it has notes and quizzes that students can make to enhance their knowledge. So indirectly, it can be accessed anytime. this application can be a teaching aid for lecturers to improve teaching sessions in lectures or tutorials.

Question: Do you have any suggestions regarding the overall content of the application? What does the content should look like?

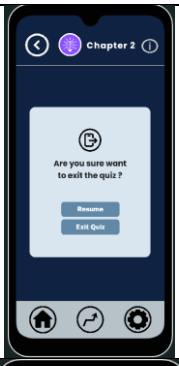
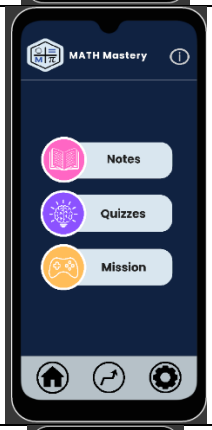
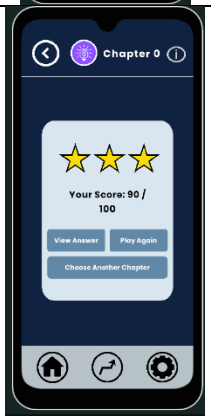
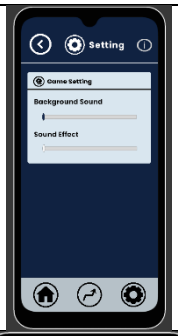
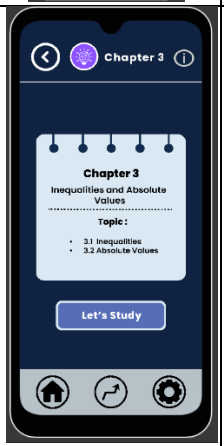
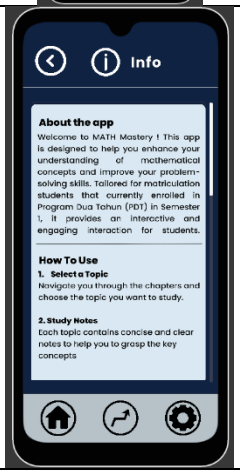
Madam Rosnida: In my opinion, this application needs to be made minimalistic because we don't want the application to look too complicated because the subject of mathematics is already complex and heavy. The development of this application needs to focus on color selection and font selection that can attract students to use this application. In my opinion, some improvements that can be made for this application include note features, it would be better if a YouTube link containing a video playlist about the relevant chapter could be included. The purpose is for this application to become a one stop center for students to do self-learning. The second, for quizzes, questions must be arranged in stages, starting from a low level to a higher one.

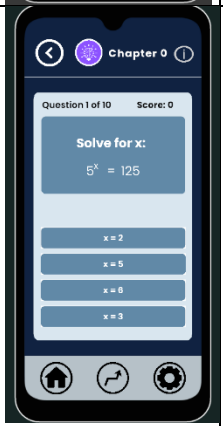
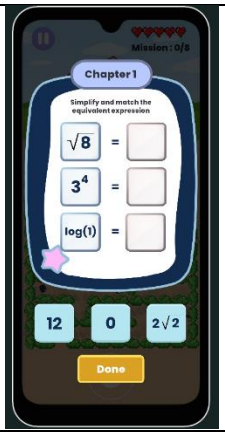
Appendix B

Figure 11 show the image collected that Matriculation students involved in user testing.

Fig. 11 *User Testing*

Appendix C: Storyboard

No.	Image	Description			
1.		Landing Page. This interface will appear few seconds after student enter the application.	10.		Exit Game Interface. This interface will show up if users click the "Back" button.
3.		Main Menu Interface. This interface allow user to make selection on modules that included in the application.	11.		Score Interface. This Interface will show up after users have finish in answering the quizzed. Badges are provided based on the score that achieved by users.
4.		Notes Module. This interface allows users to choose which topic that they want to study.	12.		Setting Interface. This interface will adjust the volume of background sound and sound effect.
5.		Notes topic outcome Interface. This interface will provide user the topic outcome of the chapter before entering the module.	13.		Info Interface. This interface will provide users the information about this application.

6.		Content in notes module. This interface allows users to study all the notes in this module. This interface provide a clickable picture to redirect users to the list of explanation of the topics.	14.		Progress Tracker Module. This interface will show users the score that they have been achieved in the quizzes.
7.		Quizzes Module. This interface allows users to choose which topic that they want to answer to quiz.	15.		Mini Game Interface. This interface allows user to play maze game and requires user to collect 8 books to retrieved the mini game on each books.
8.		Quizzes Question. This interface will provide the question and multiple-choice answer.	16.		Mini game popup interface. This interface allow user the finish the task on each mini game popup interface.
9.		Mission Module instruction Interface. This interface will show user the instruction of the mission module game.			