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Let's Learn Math: Design and Development of an Android-based Mathematics Learning Application for Dyscalculia Kids

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Abstract: Mathematics is one of the core subjects that students should achieve. Nowadays, most jobs need to predominate mathematics skills. However, people who suffer from dyscalculia may have difficulty in crunching numbers. The existing applications to learn mathematics available on Google Play are yet to be implemented for the person with dyscalculia symptoms. Therefore, this project is proposed to design and develop a mobile mathematics learning application on the Android-based platform with a gamification approach based on the KSPK Pendidikan Khas syllabus and the functional and usability testing will be performed to the target users. The users targeted are children aged 4 to 6 years old. The Multimedia Mobile Content Development (MMCD) methodology is used to develop Let's Learn Math application. Based on the System Usability Scale (SUS), the acceptable range was obtained with a resulting score of 91.88. This application is expected to assist dyscalculia people to learn basic numbers.

Keywords: Android-based, Mobile Learning Application, Mathematics, Dyscalculia

1. Introduction

The term dyscalculia means a barrier when doing mathematics. Based on the experts' research, they estimate 4.38% of girls and 3.47% of boys in any setting are likely to suffer from dyscalculia in Malaysia [1]. People who suffer from dyscalculia will have severe difficulty in crunching numbers and are otherwise perfectly normal. It is usually discovered in childhood, especially when they start to learn basic mathematics. Moreover, their symptoms will become more apparent as children grow. Many symptoms represent dyscalculia and different age groups will have different symptoms. For example, for kindergarten kids who suffer from dyscalculia, they will often forget one or more numbers in a series, some of them do not know the comparison of size, and so on [2].

Nowadays, there are different types of Mathematics learning mobile applications in the Google Play store. However, finding a Mathematics learning application explicitly designed for dyscalculia kids in the Google Play store is difficult. Even though there are some Mathematics learning apps that are suitable for dyscalculia kids but it does not provide learning and assessment modules. It just allows the

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user to provide questions and the system will provide a step-by-step solution. Therefore, the user cannot test their understanding through the application. In addition, finding a Mathematics learning application that follows the syllabus of KSPK Pendidikan Khas is more difficult. Therefore, the mobile learning application, Let's Learn Math is proposed to be developed.

The objectives of this application are to design Let's Learn Math for dyscalculia kids based on the KSPK Pendidikan Khas syllabus, to develop a mobile mathematics learning application on the Android-based platform with a gamification approach, and to perform functional testing and user acceptance test on the developed application for dyscalculia kids. The proposed application is developed for kindergarten kids from 4 to 6 years old, especially dyscalculia kids. The subject matter expert of this project is Officer Lim Guan Kai from the *Pertubuhan Kebajikan Pemulihan dalam komuniti Maharani*. The content of this application is based on the latest Mathematics syllabus from the KSPK Pendidikan Khas and will focus on the number concept from numbers 1 to 10.

Let's Learn Math application will contain 3 learning modules such as Learning Numbers, Matching Numbers, and Sequencing Numbers. All interactive buttons in this application are expected to perform well. The reward stickers will be given if the user answers all correctly to encourage and award them in the learning process. Lastly, the speaker button in the Learning Numbers module is expected to play the pronunciation of the numbers.

The rest of the paper is organized as follows: Section 2 discusses the domain of study, the technology used, and the result of the comparative analysis. Next, the Multimedia Mobile Content Development (MMCD) methodology used to develop the application including the analysis and design is described in Section 3. Furthermore, Section 4 presents the results and discussion, and Section 5 states the conclusion of the project.

2. Related Work

In this section, the study domain, approach used, and result of the comparative analysis are discussed.

2.1 Dyscalculia

Mathematics is one of the core subjects that students should achieve in their academic life. It plays an essential role in understanding the concept of other subjects. It is known that the students who solve math problems in their daily life have higher logical skills than those students who don't solve the problems. However, some people have a disability that causes difficulty learning or comprehending arithmetic such as difficulty in understanding numbers, calculating numbers, and so on which is called dyscalculia. People who suffer from dyscalculia are creative, strategic thinking, and intuitive thinking [3]. Therefore, it is crucial to design a suitable and interactive user interface design of mobile application for them. There are five strategies that can be applied to design the user interface which are intonation, image, assessment, user layout, and font [12].

2.2 Approach used

Nowadays, mobile learning (M-learning) applications are becoming popular and a trend to be developed especially during the pandemic of Covid-19. In order to provide students with additional learning resources, many mobile application developers have started creating educational apps. In addition, the way of delivering information for mobile learning applications decreases the limitations of traditional education. Therefore, M-learning is considered a new and useful learning model for people who use it to gain knowledge anywhere and anytime using their own devices such as smartphones or tablets. In order to motivate and attract students to learn, a gamification approach is needed in this twenty-first century. According to Gartner Research, 79% of the participants, both corporate learners and university

students said that if their learning environment was more like a game, they would be more motivated and productive [4].

Secondly, gamification is an application that contains all the fun and addictive aspects of games to real-world or productive non-game activities to increase motivation and engagement in learning. It is an active learning method that has proven to be extremely beneficial for twenty-first-century education [5]. Based on the study, implementing mobile learning applications with gamification does improve learning outcomes and motivation levels [6]. This is because gamification involves game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems [7]. Achievement, reward, storyline, and time are the features that can be implemented in gamification for education to make the learning process of the user interesting and fun. Duolingo is one of the examples that applied the gamification approach, which can be accessed via web-based or application.

2.3 Comparative Analysis

In this section, a comparison has been made between existing applications such as Numbers – 123 games for kids [8], 123 Numbers – Count & Tracing [9], and Learn Numbers 123 Kids Game [10], and the proposed application. Figure 1 shows the main menu interface of the three existing applications. Meanwhile, 3 features have been discussed, as shown in Table 1. It includes platform, learning outcome, learning and assessment module, and content.

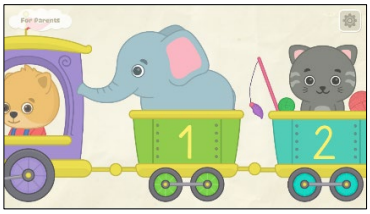


Figure 1(a) : Numbers – 123 games for kids [8]

Figure 1(b) : 123 Numbers – Count & Tracing [9]

Figure 1(c) : Learn Numbers 123 Kids Game [10]

Table 1: Comparison between existing applications and proposed applications

Features	Numbers – 123 games for kids	123 Numbers – Count & Tracing	Learn Numbers 123 Kids Game	Let's Learn Math
Platform	Android	Android and IOS	Android	Android
Learning Outcome, Learning, Activity, Assessment, and Challenge Module	Contains only a learning module.		Contains only a learning, and assessment module.	Contains all modules.
Content	Recognize, count, and trace numbers from 1 to 20.		Recognize, count, and sequence numbers from 1 to 20, and trace numbers from 1 to 50.	Recognize, count, trace, sequence, and color numbers from 1 to 20.

Based on Table 1, several strengths and limitations of the proposed application can be concluded. Firstly, a learning outcome, learning, assessment, and challenge module will be applied to the proposed application. Secondly, the proposed application provides the sequencing numbers in ascending and descending order, referring to the latest KSPK Pendidikan Khas learning format, and the content is

verified by the subject matter expert compared to the other three existing applications. On the other hand, the proposed application does not support IOS devices and only supports mobile devices with Android version 4.1 and above.

3. Methodology

The proposed application, Let's Learn Math is a mobile learning application designed as a tool for dyscalculia kids to learn mathematics. Meanwhile, Multimedia Mobile Content Development (MMCD) consists of MMCD Methodology for developing mobile learning (m-learning) applications [11]. Therefore, it is chosen to apply to this project. The five stages of the MMCD methodology are shown in Figure 2. Next, each phase of the MMCD is discussed in the following subsections.

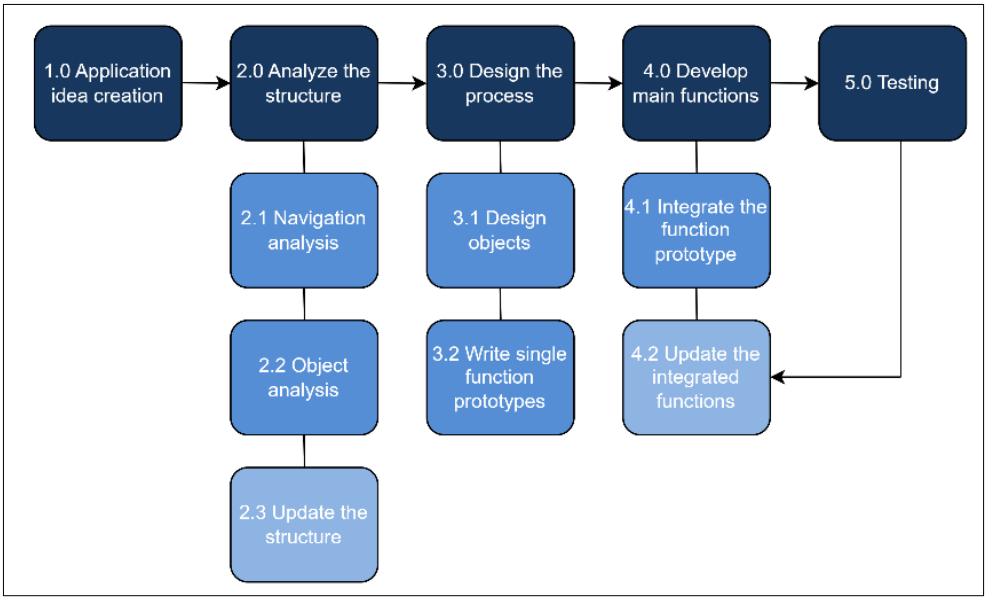


Figure 2 : MMCD Methodology [11]

3.1 Application Idea Creation

The application idea creation is the first stage of MMCD Methodology. An online interview session through Google Meet was conducted with Madam Lim Guan Kai, an officer from *Pertubuhan Kebajikan Pemulihan dalam komuniti Maharani*. She is also the Subject Matter Expert (SME) of this project development. At the same time, a questionnaire survey through an online Google Form was distributed to 30 kindergarten kids who suffer from dyscalculia. They were required to answer 7 questions in the questionnaire. The analysis has been tabulated in Table 2. Table 3 shows the application idea creation checklist.

Table 2: User Analysis

Stakeholder Category	Role in product	Design Implication	Action Needed
Subject Matter Expert (Madam Lim Guan Kai)	Content consultant expert in the Mathematics field for dyscalculia kids	Easy to navigate	• It contains back and home buttons. • The size of the buttons must be consistent. • Simple navigational structure.

Stakeholder Category	Role in product	Design Implication	Action Needed
		Simple, interesting and clean user interface	• More icon-based buttons will be used as compared to text-based buttons. • Provide cartoon picture. • A readable font style and size will be used.
		Content must be based on KSPK Pendidikan Khas syllabus	• Refer to the latest KSPK Pendidikan Khas syllabus as a guideline for the application's content.
General user (kids from 4 to 6 years old)	End-user of the system	• Free to download • Simple, interesting, and clean user interface design • Offline based	• Let's Learn Math must be created as a free to download in Play Store. • The interface of Let's Learn Math must be simple, interesting, and clean. • Let's Learn Math must be created as an offline-based application.

The analyzed results of the questionnaire survey are shown in Figure 3(a) and Figure 3(b).

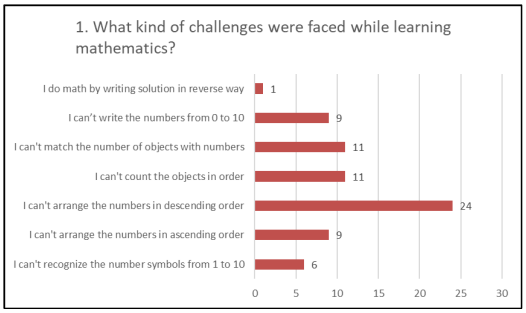


Figure 3(a) : Analysis of challenges faced while learning mathematics

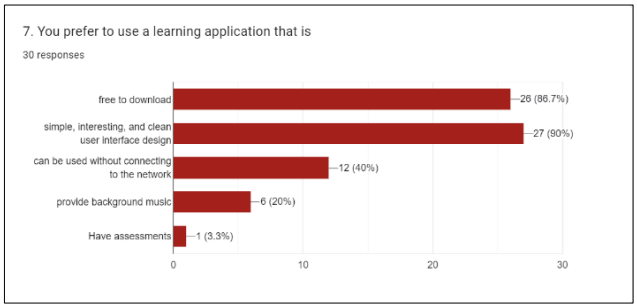


Figure 3(b) : Analysis of the features of Let's Learn Math

Table 3 : Application Idea Checklist

Item	Description
Type of application	Mobile learning application.
Target device	Android platform.
Target users	Dyscalculia kindergarten kids.
Graphic User Interface (GUI)	Reward module, Learning Outcome module, Learning Numbers module, Matching Numbers module, Sequencing Numbers module, Activity module, Assessment module, Challenge module
Images	Icons, buttons, and background.
Animation	Application opening transition, bubbles floating in Main Menu and Learning Outcome module.
Audio	Background music, pronunciation of numbers in Learning Numbers module.
Application synopsis	Let's Learn Math is a mathematics learning application for dyscalculia kindergarten kids that follow the latest KSPK Pendidikan Khas syllabus of learning which allow kids to recognize, count, match, and sequence numbers from 1 to 10 in anywhere and anytime to improve their mathematics knowledge. The application provided audio and images to deliver the learning content.

3.2 Analyze the Structure

The structure analysis is the second stage of the MMCD Methodology. In this stage, navigation and object analysis have been conducted. The system flowchart is shown in Figure 4. Figure 5 shows the navigational structure whereas the content structure is shown in Figure 6. Functional and non-functional requirements are listed in Table 4 and Table 5.

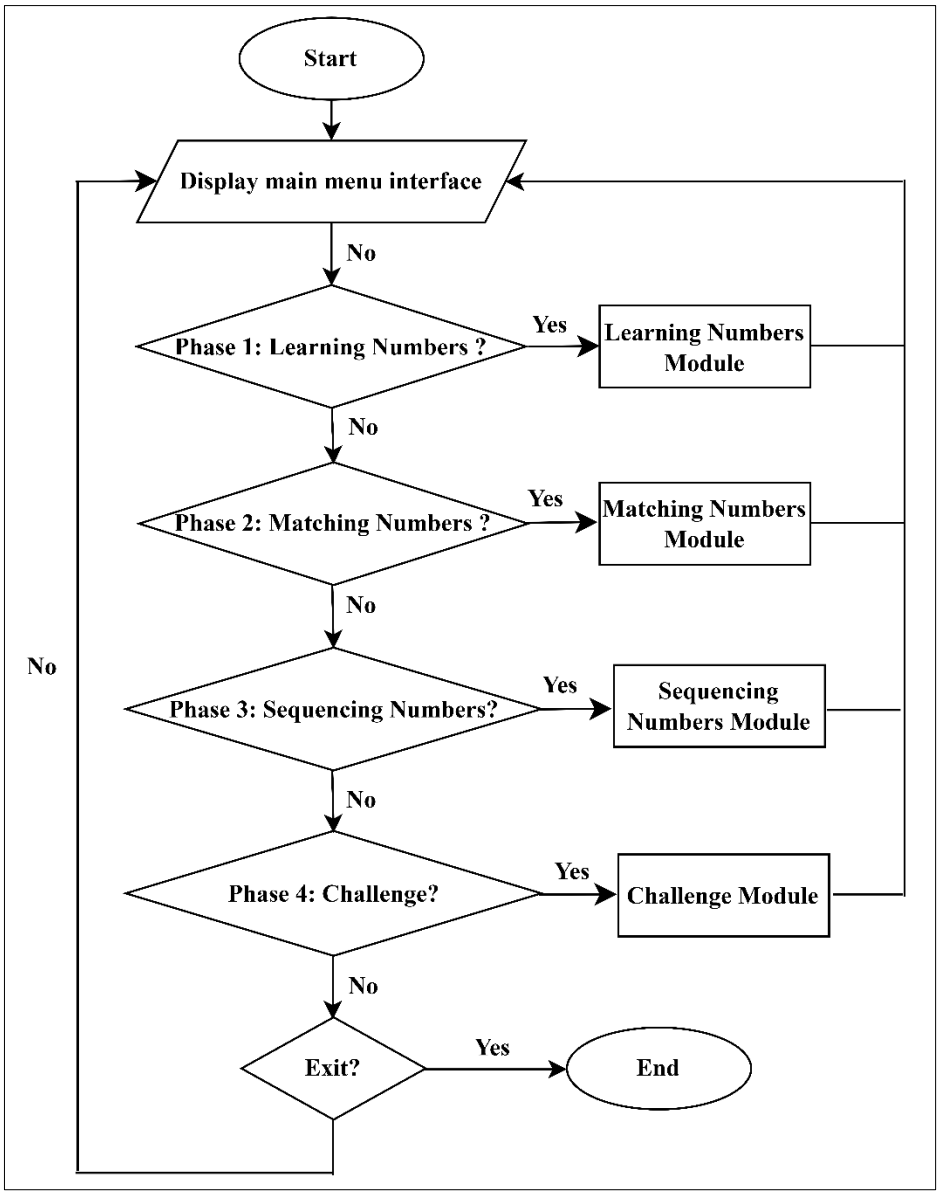


Figure 4 : System Flowchart

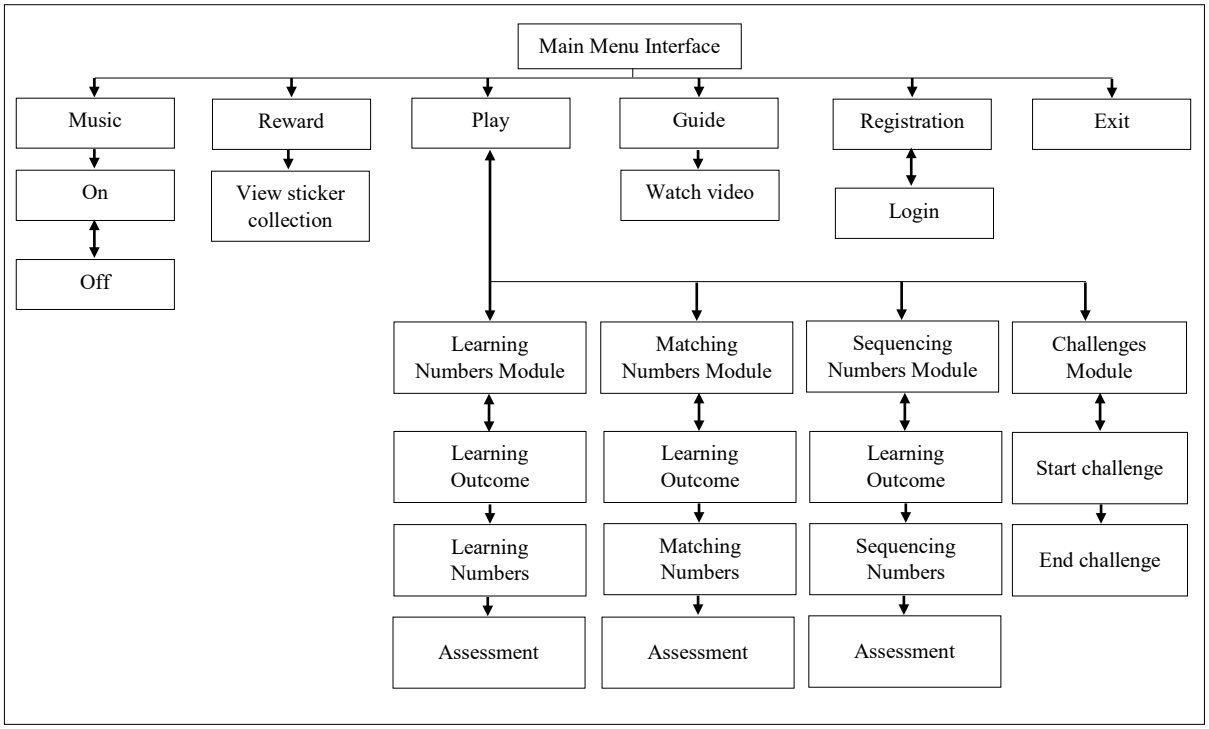


Figure 5 : Navigational Structure

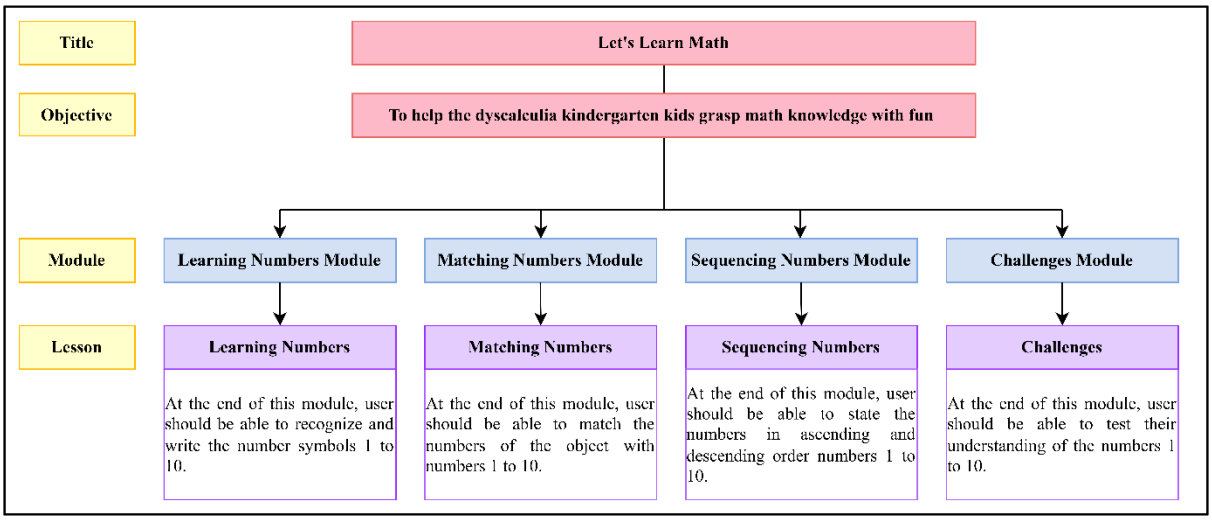


Figure 6 : Content Structure

Table 4 : Functional requirements

Functional Requirement	Module	Description
Autonomous System	Main Menu	• The buttons shall be displayed automatically after the users open the application.
	Reward	• In the Reward Module, the relative sticker shall be unlocked when the users get the sticker in the game. • The application should provide a reward sticker to the users after the users answer all the questions correctly.
	Module Selection	• The application shall allow the users to choose the four modules in the Module Selection interface with the button provided.

Functional Requirement	Module	Description
	Phases	• The application shall provide the user with the ability to recognize the basic numbers from 1 to 10. • The application shall display the correct sign when the user answers correctly. • The application shall display the wrong sign when the user answers wrongly. • The application shall display a button that allows the user to go to the next questions.
User Interaction	Guide	• The user shall be able to understand the instruction to play the application by watching the guide video.
	Main Menu	• For the first time user, user shall be able to key in their username.
	Module Selection	• The application shall provide the user with the ability to choose phase 1 to phase 3 and challenge modules.
	Phases	• The application shall provide the user learning outcomes of each lesson. • The application shall provide the user with the ability to answer the question in the challenge, phases 2 and 3. • User should be able to return to the main menu with the "Home" icon button. • User should be able to continue to the next question by clicking "Next" icon button.
	Challenge	• User should be able to shuffle the puzzle in all direction if that direction is empty.

Table 5 : Non-functional requirements

Non-functional Requirement	Description
Performance	• The application is online-based when play the sound from YouTube. • The application should not exceed two seconds of response time for any interaction. • The application should be available for use 24 hours per day, 365 days per year.
Operational	• The application shall be able to operate on any Android mobile phone with Android version 4.1 and above.
Usability	• The application shall be user-friendly and easy to use for the user. • User able to access this application anywhere and anytime.
Legal	• User cannot modify or change any content displayed in this application but can view only.
Cultural	• The application will apply simple English language. • The application shall use a familiar metaphor such as a symbol or text that is easy to understand by all users.

3.3 Design the Process

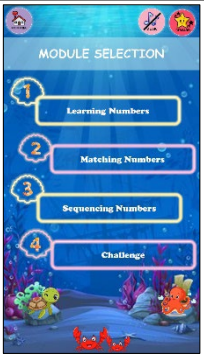
Design the process is the third stage of the MMCD Methodology. This design stage consists of design objects and write the single function prototype scripting. The specific design software was utilized in

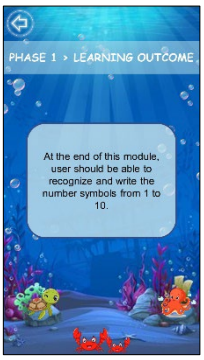
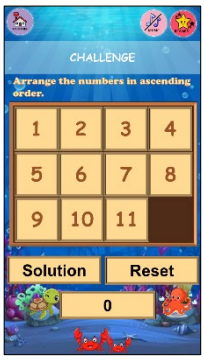
the development process, such as Adobe Photoshop used for graphical designs, and Unity was used to compile and integrate all the essential items into the development of the Let's Learn Math application with the scripting process. Table 6 shows the button design, while Table 7 shows the interface design.

Table 6 : Button Design

Button	Description	Button	Description
	This is a play button.		This is a submit button.
	This is a guide button.		This is a main menu button.
	This is an exit button.		This is next and previous button.
	This is the music on and off button.		This is a Learning Numbers Module button.
	This is a reward button.		This is a Matching Numbers Module button.
	This is a no button.		This is a Sequencing Numbers Module button.
	This is a yes button.		This is a Challenges Module button.
	This is a song button.		This is a audio button.
	This is a back button.		This is a check button.
	This is a solution button.		This is a reset button.

Table 7 : Interface Design

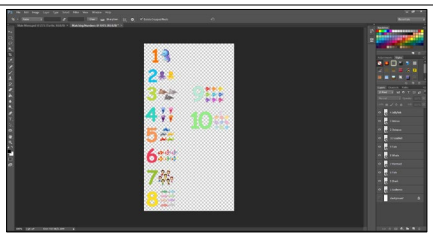
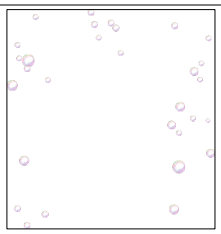
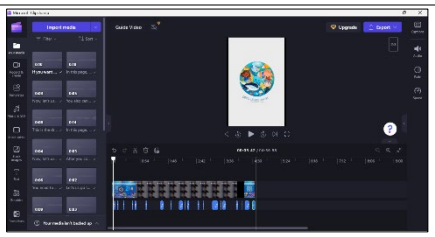
Interfaces	Description	Interfaces	Description
	This is the main menu interface of the proposed application. The user clicks the play button to go to the module selection.		This is the learning numbers interface that contains a sound button to allow the user to play the pronunciation of numbers. The next button allows the user to go to the next number.
	This is a module selection interface that contains four buttons which are Learning Numbers, Matching Numbers, Sequencing Numbers, and Challenges. Each button navigates to each module respectively.		This is the matching numbers interface that contains three choice answers that allow the user to choose the correct answer.

Interfaces	Description	Interfaces	Description
	This is the phase 1 interface that contains three buttons which are Learning Outcome, Learning Numbers, and Assessment. Each button navigates to each module respectively. Phase 2 and Phase 3 interfaces will be similar to this.		This is the challenge interface that allows the user to key in their answer in the box given.

3.4 Develop Main Function

The fourth stage is the main function development stage. It involved developing assets for the application and the integration of the assets into Unity software. There are 4 multimedia elements developed as assets of the application which are audio, graphics, animations, and video, as tabulated in Table 8.

Table 8 : Application Assets Development

Assets	Development	Description
Audio		The audio files in the Let's Learn Math application are in the Moving Picture Experts Group Layer-3 Audio (MP3) format. It is generated via text to speech method in SEOMagnifier.
Graphics		The software used to develop the graphics of Let's Learn Math was Adobe Photoshop. It is important to apply graphic assets in the application to attract the attention of the target users. The background of the elements is set to transparent.
Animation		The bubbles are scrolling from bottom to top of the screen. The background will keep looping this animation until users exit the application.
Video		The software used to develop the guide video is Microsoft Clipchamp. The guide video is exported in 1080 HD format and then uploaded to YouTube channel. Therefore, the user can select different resolution to watch the video.

Aside from that, the C# scripts are developed to enable the main functions of the application. It including the implementation of pick puzzle, quiz game, update point, drag and drop, shuffle puzzle,

and reward system. These functions are explained in Table 9. Meanwhile, the interfaces of the developed application are presented in Table 10.

Table 9 : Integration in Unity

Functions	C# scripts	Description

Reward system	public void CheckAscendingOrder()
	{
	levelCompleteUI.SetActive(true);
	GetSticker();
	int stickerGot = PlayerPrefs.GetInt(whichStickerGot);
	}
	
	void GetSticker()
	{
	int randomIndex = Random.Range(0, stickerImages.Length);
	rewardSticker.GetComponent<Image>().sprite = stickerImages[randomIndex];
	if(rewardSticker.GetComponent<Image>().sprite == stickerImages[0])
	{
	whichStickerGot = "JellyfishGot";
	PlayerPrefs.SetInt(whichStickerGot, 1);
	}
	else if(rewardSticker.GetComponent<Image>().sprite == stickerImages[1])
	{
	whichStickerGot = "DolphinGot";
	PlayerPrefs.SetInt(whichStickerGot, 2);
	}
	}
		There are twelve stickers provided to the user. The reward sticker is randomly generated to the user when he/ she arrange the numbers in ascending order correctly. An array of sticker image is assigned and if the rewardSticker is equal to the sprite at index 0 of stickerImages, it will set the whichStickerGot variable to "JellyfishGot" and update the corresponding Player Preference value to one using PlayerPrefs.SetInt().

Shuffle puzzle (Challenge module)	public void CheckerSpot(Text DataButton1, Text DataButton2)
	{
	if(DataButton2.text == "")
	{
	DataButton2.text = DataButton1.text;
	DataButton1.text = "";
	}
	}
	
	public void btnData1_Click()
	{
	CheckerSpot(btnData1, btnData2);
	CheckerSpot(btnData1, btnData5);
	Solutions();
	}
		CheckerSpot() is to swap the text content between two text numbers if DataButton2 is empty. The btnData1_Click() function is an example of swap content of first button. The user can shuffle the puzzle to right or down if that position's text content is empty.

Functions	C# scripts	Description

Drag and drop (Phase 3: Assessment)	void Start()
	{
	numberOneIni = numberOne.transform.position;
	}
	
	public void DragNumberOne()
	{
	numberOne.transform.position = Input.mousePosition;
	}
	
	public void DropNumberOne()
	{
	float Distance1 = Vector3.Distance(numberOne.transform.position, boxOne.transform.position);
	if(Distance1 < 50 && oneCorrect == false)
	{
	numberOne.transform.localScale = boxOne.transform.localScale;
	numberOne.transform.position = boxOne.transform.position;
	oneCorrect = true;
	boxOne.name = numberOne.name;
	}
		The DragNumberOne() function allows the user to move the position he/ she wants using mouse cursor. Vector3.Distance() is used is to calculate the distance between the current position of number one and the position of the answer box one. If the calculated distance less than 50 units and oneCorrect is false, it means that numberOne is close enough to boxOne and it can be considered as a correct match. Then, it will set the scale and position of numberOne to match with the scale and position of boxOne. Hence, the user can drag the numberOne block and drop it inside boxOne.

Pick puzzle (Activity module)	public void PickAPuzzle()
	{
	if(!firstGuess)
	{
	firstGuess = true;
	firstGuessIndex = int.Parse(UnityEngine.EventSystems.EventSystem.current.currentSelectedGameObject.name);
	firstGuessPuzzle = gamePuzzles[firstGuessIndex].name;
	btns[firstGuessIndex].image.sprite = gamePuzzles[firstGuessIndex];
	}
	else if(!secondGuess)
	{
	secondGuess = true;
	secondGuessIndex = int.Parse(UnityEngine.EventSystems.EventSystem.current.currentSelectedGameObject.name);
	btns[secondGuessIndex].image.sprite = gamePuzzles[secondGuessIndex];
	countGuesses++;
	StartCoroutine(CheckIfThePuzzlesMatch());
	}
	}
		It is a memory game. There are twenty cards provided and the user needs to match the pairs of the number cards. If the puzzle pieces match, the user allows to see the two matching puzzle pieces within 0.5 seconds before they disappear. Boolean variables are used to check the first guess or the second guess of the card by the user. The user can click and switch the card, then he/ she can see a number in the card. The int.Parse() function is to get the index of the selected puzzle piece by parsing the name of the card.

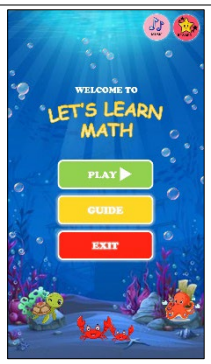
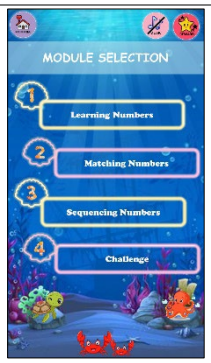
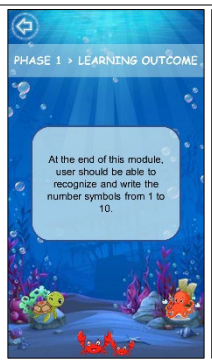
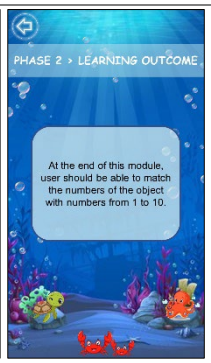
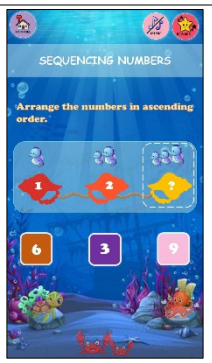
Functions	C# scripts	Description

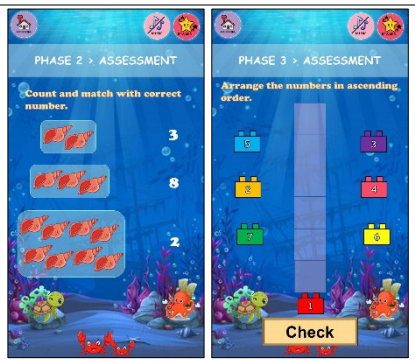
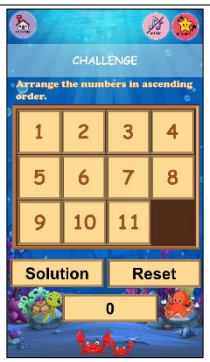
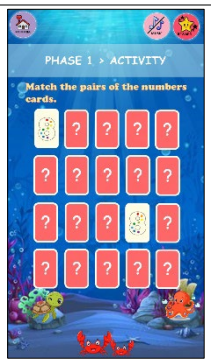
Quiz game (Matching and Sequencing modules)	public void correct()
	{
	answeredQuestions++;
	QnA.RemoveAt(currentQuestion);
	StartCoroutine(waitForNext());
	}
	public void wrong()
	{
	answeredQuestions++;
	QnA.RemoveAt(currentQuestion);
	StartCoroutine(waitForNext());
	}
	IEnumerator waitForNext()
	{
	yield return new WaitForSeconds(1);
	generateQuestion();
	}
	void SetAnswers()
	{
	for(int i = 0; i < options.Length; i++)
	{
	options[i].GetComponent<Image>().color =
	options[i].GetComponent<AnswerScript>().startColor;
	options[i].GetComponent<AnswerScript>().isCorrect = false;
	
	options[i].transform.GetChild(0).GetComponent<Image>().sprite = QnA[currentQuestion].Answers[i];
	
	if(QnA[currentQuestion].CorrectAnswer == i+1)
	{
	options[i].GetComponent<AnswerScript>().isCorrect = true;
	}
	}
	}
	void generateQuestion()
	{
	if(QnA.Count > 0)
	{
	currentQuestion = Random.Range(0, QnA.Count);
	QuestionTxt.text = QnA[currentQuestion].Question;
	QuestionImg.GetComponent<Image>().sprite = QnA[currentQuestion].QuestionImage;
	SetAnswers();
	}
	else if (answeredQuestions == totalQuestions)
	{
	levelCompleteUI.SetActive(true);
	}
	}
		There are three options provided for each question. The user can only select one option to answer the question. it will count the questions in the QnA list and store in totalQuestions variable. Then, it will call the generateQuestion() method to display the first question. The question will be randomly generated to the user by using Random.Range() function. Besides, the SetAnswers() function is created to notify the user whether he/ she answers correct or wrong. If the user answer correctly, it will display green color while red color for user who answer wrongly. Aside from that, the waitForNext() coroutine with yield return new WaitForSeconds(1) allows the user to wait a second and it will display the next question.

Functions	C# scripts	Description

Update point (Phase2: Assessment)	public static void AddPoint()
	{
	AddPoints(1);
	}
	
	public static void AddPoints(int points)
	{
	Instance.points += points;
	Instance.UpdatePointsText();
	}
		AddPoint() is a public static method that can add a point to the point counter conveniently. It needs the user to count and match with corresponding number using line. When the user matches a number correctly, the point will update asynchronously.

Table 10 : Interface of the developed application

Module	Interfaces	Module	Interfaces
Main Menu		Learning Numbers module	
Module Selection		Matching Numbers module	
Learning Outcome module	 	Sequencing Numbers module	

Module	Interfaces	Module	Interfaces
Assessment module		Challenge module	
Activity module		Reward module	

3.5 Testing

The testing stage is the last stage in MMCD Methodology. It is a crucial stage in the development process because it can help the developer to test whether the target users can accept the application or not. In this project, alpha and beta testing will be applied among the developer and the target users. The complete application was tested on Unity to ensure that each button and interface could run smoothly and function well. For the alpha testing, installing the Let's Learn Math APK file into an actual mobile phone is needed to ensure the actual result of the application meets the expected result. Once errors are found during the testing process, the errors will be noted down and fixed or improved to ensure the application can function well as planned. For the Beta testing, it was conducted one by one and a tablet is prepared to them to using the apps. After exploring the apps, a few questions that based on the Google Form will be ask to the kids. At the same time, a set of questionnaires was sent to the teacher to answer.

4. Results and Discussion

This section presents data and analysis of functionality and user acceptance testing. The functional testing is presented in Table 11.

Table 11 : Functional testing

Test	Expected Result	Actual Result	Corrective Action
Username input field	Add a name and detect if the input field is empty.	Cannot detect the input field is empty.	Add the if statement.
Submit button	Submit the username if the input field is not empty when clicked.	Cannot disable the submit button when the input field is empty.	Add submit.interactable.

Test	Expected Result	Actual Result	Corrective Action
Music button	On and off the background music.	Works well as expected.	Not needed.
Song button	Navigates to the YouTube app and play the song.		
Reward system	Get a reward sticker when answering all correctly.		
Learning Numbers button	Navigates to Phase 1: Learning Numbers interface.		
Matching Numbers button	Navigates to Phase 2: Matching Numbers interface.		
Sequencing Numbers button	Navigates to Phase 3: Sequencing Numbers interface.		
Challenge button	Navigates to Challenge interface.		

Based on Table 11, the functionality of the input field and buttons in Let's Learn Math was tested and corrected. The input field of the username and submit button were having problems. Actions were taken to solve the problems before conducting user acceptance testing on the target users.

For the beta testing, the target users are kindergarten kids in Pusat Perkembangan Awal Kanak-kanak UTHM, Johor. There are 25 respondents were involved in the beta testing that divided into three categories which are dyscalculia kindergarten kids, teacher, and random people.

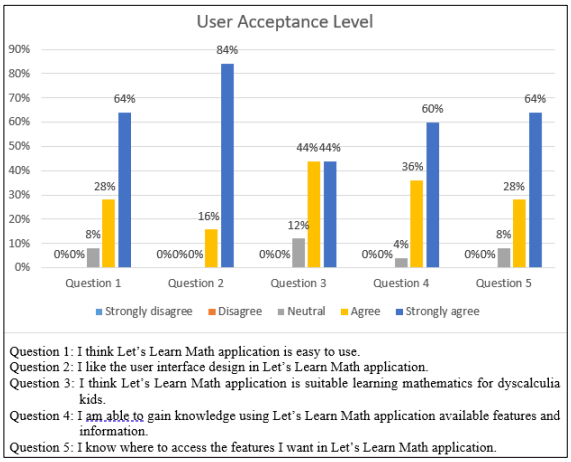


Figure 6(a) : Analysis of user acceptance level

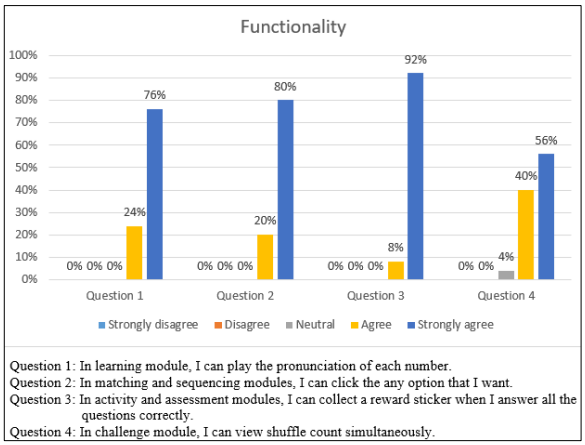


Figure 6(b) : Analysis of functionality

Based on Figure 6(a), there are five questions to determine the user acceptance level. From the chart generated, more than 80% of respondents agree with the question asked about the app. For Question 1, 92% of respondents think that Let's Learn Math application is easy to use, while only 8% of respondents are neutral. For Question 2, all respondents liked the user interface design in the Let's Learn Math application. For Question 3, 88% of respondents think that the Let's Learn Math application is suitable for learning mathematics for dyscalculia kids. For Question 4, 96% of respondents think they can gain knowledge using the Let's Learn Math application with available features and information. Finally, for

Question 5, 92% of users know where to access the Let's Learn Math application features. As a result, most of the respondents provided positive feedback in the user acceptance testing.

Figure 6(b) shows the analysis of the functionality of Let's Learn Math. A total of four questions were included in this section. In response to Question 1, more than half of the respondents where 76% of them strongly agreed that the buttons were functioning well while 24% of the respondents agreed. Next, all the respondents agreed with Question 2, where they agreed that they could click any buttons in Matching and Sequencing module. Besides, 92% of the respondents strongly agreed with Question 3 where they can get a reward sticker after answering the question correctly in the Activity and Assessment module. Meanwhile, 8% of the respondents agreed with this question. In response to Question 4, 56% of the respondents strongly agreed that they can view shuffle count when moving the puzzle in the Challenge module. Only 40% agreed and 4% of them felt neutral with Question 4.

Besides, System Usability Scale (SUS) has been carried out and used for the usability test to calculate the average score of user acceptance [13]. The test was performed by conducting feedback via Google Form to 12 kids as selected respondents with five questions per section. These questions were measured using the Likert scale ranging from 1 to 5, from strongly disagree to strongly agree.

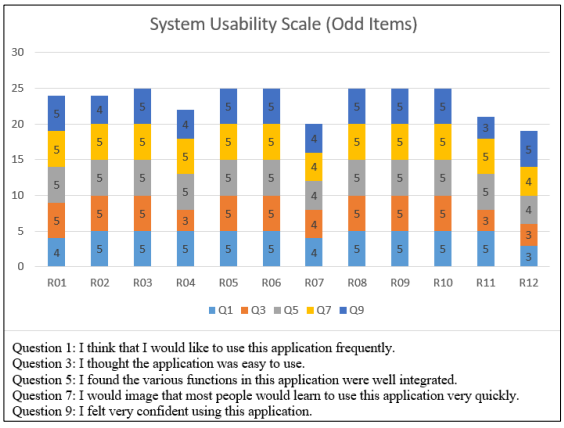


Figure 7(a) : Analysis of positive questions

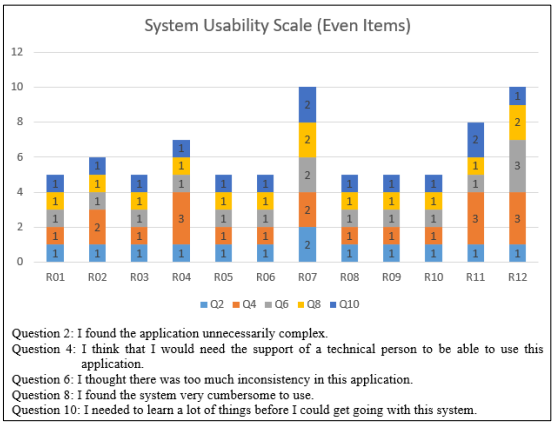


Figure 7(b) : Analysis of negative questions

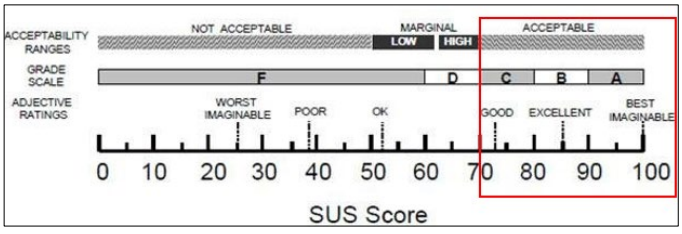


Figure 8 : System Usability Scale (SUS)

Based on Figure 7(a), all respondents gave 4 marks and above, which agrees to the positive statement in questionnaires. Although some of the questions obtained 3 marks which is neutral but none of them disagree with the positive outcome. Based on Figure 7(b), all the respondents gave marks in between 1 to 3, which disagrees with the negative statement in the questionnaires. The result shows that most respondents do not have much problem using the Let's Learn Math application.

Based on the SUS score scale shown in Figure 8, the average score of the usability value is 91.88 which is in the range of Acceptable in the score scale. The grading scale is A and the adjective ratings are excellent. Overall, the built-in applications can be classified as successfully meet the needs of the target users.

Aside from that, pre-test and post-test were carried out before and after using the Let's Learn Math application. It is used to measure whether the expected changes took place in the target users. The test

was performed by conducting feedback via Google Form to 12 kids with dyscalculia signs as selected respondents with two questions per section. The sections involved in these tests are learning numbers, matching numbers, and sequencing numbers. Each section has two questions.

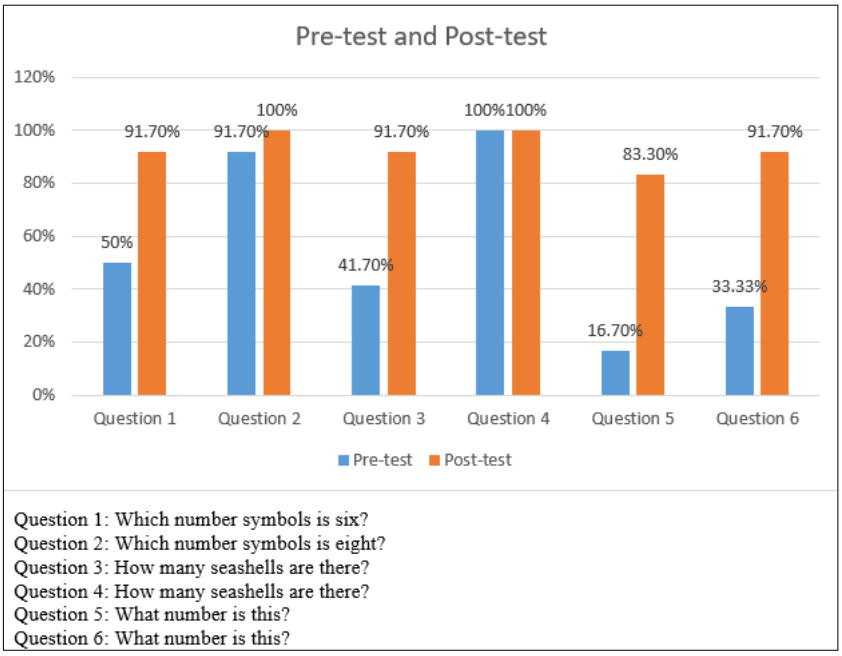


Figure 9: Analysis of pre-test and post-test

Based on Figure 9, the percentage of post-test results for all questions was higher than pre-test results. This means that the target users learned some basic mathematics knowledge and keep improving after using the Let's Learn Math application. Although not all the target users totally grasped the knowledge but none of them did not learned something.

5. Conclusion

As the testing phase has been carried out, including alpha testing and beta testing, it is proven that most target users gave positive feedback after installing and using Let's Learn Math. The three objectives of this project were fully accomplished by first designing the Let's Learn Math application for dyscalculia kids based on the KSPK Pendidikan Khas syllabus. In order to achieve this goal, the design phase of the MMCD methodology consists of the content structure, navigational structure, system flowchart, storyboard, and button design are discussed. Second, successfully developed a mobile mathematics learning application on the Android-based platform with a gamification approach. A memory game and the assessment with gamification approach was built successfully in the Activity Module and Assessment Module where the user can collect the reward sticker when answering the questions correctly. In Phase 2: Assessment Module, the user can view the points got in a game asynchronously. Lastly, performing functional testing and user acceptance test on the developed application for dyscalculia kids. Multimedia Mobile Content Development (MMCD) methodology assisted this project to be completed on time. The average score of the SUS value is 91.88 which in the range of Acceptable in the score scale. The grading scale is A and the adjective ratings is excellent. Besides, the advantages and limitations of the Let's Learn Math application are tabulated in Table 12. Last but not least, for future work, it is suggested that all chapters in the KSPK syllabus can be covered in the application. In the Sequencing and Matching Numbers module, the application can provide a list to review the answer result after the user answers all the questions. Other than that, in Phase 2: Assessment module, the width of drawing lines is flexible and suitable for all sizes of devices.

Table 12: Advantages and Limitations of the Let's Learn Math Application

Advantages	Limitations
• Let's Learn Math divided the number concept topic into three subsets which easier the kids grasp the knowledge.	• There are a total of six chapters for dyscalculia kids Mathematics syllabus, but the Let's Learn Math only covered one chapters.
• Let's Learn Math has been verified by kindergarten Mathematics teacher from Pusat Perkembangan Awal Kanak-kanak UTHM. Therefore, the application has the ability to improve kid's conceptual understanding and basic mathematical skills.	• Users cannot review their answer result after completed answer all the questions in Matching Numbers and Sequencing Numbers module.
• Let's Learn Math provided multimedia element such as audio for number pronunciation, video for number song, multi-color graphic for counting purpose, text, and animation to increase kid interest.	• The width of drawing lines in Phase 2: Assessment module is fixed so that the different sizes of devices used will have shorter or longer lines.
• Let's Learn Math compose of a high user acceptance level, where the target users agreed that the application is easy to use.	

Acknowledgment

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