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Development of Malaysia's Traditional Instruments Mobile Application with Marker-less Augmented Reality

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Abstract: Traditional musical instruments have been around in Malaysia for many years. It is used in traditional and classical musical instruments. However, in this modern era, it is rare to see these instruments in real life. Mobile application that displays these instruments are scarce on Google Play and the existing applications are yet to be implemented with marker-less augmented Reality (AR) technology. Therefore, this project is proposed to develop a mobile application using marker-less AR technology namely "Malaysia's Traditional Instruments" that allows users in the range of age of 7 years old and above to learn and play the instruments. The project is developed using the Multimedia Mobile Content Development (MMCD) approach. The application will allow users to learn without the need to visit museums and attend traditional performances. This application is tested by 30 users in the range of 7 years old and above and has passed the user acceptance and functional test.

Keywords: Mobile Application, Malaysian Traditional Instruments, Traditional Instruments, Augmented Reality, Marker-less AR

1. Introduction

Malaysia is a multi-racial country widely known for the wide range of ethnicities that brought many cultures and heritages. This contributes to the existence of many traditional musical instruments in Malaysia that goes back to hundreds of years. Each ethnicity has their own traditional instruments such as Rebana, Kompang and Gambang Kayu from the Malay society; Erhu, Gong, and Yangqin from the Chinese Society; and Sitar, Tabla and Tambura from the Indian society. These are the few examples of instruments that can be found, and some became exhibits in the Malaysia National Museum [1]. These instruments serve many purposes in the past but nowadays it is mainly used for entertainment in traditional performances such as Zapin, Gamelan, Tarian Piring and many more.

It is noted that the traditional musical instruments are not very popular among Malaysians nowadays. While some may know the existence of the instruments, it is agreeable that some Malaysians barely recognizes the instruments and may have forgotten about them. One of the many reasons that contributes to this problem is by the lack of documentation on the functions and uses of the instruments

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[2]. In the past, the way to learn more about the traditional instruments is by learning from the elders of the respected society. In the modern days, these instruments are only seen during traditional performances or are exhibit in museums. This can be a hassle to some people as the need to attend an event might be not worth it just to see a couple of instruments displayed. By implementing augmented reality technology can help the public to recognise and learn about the traditional instruments at their own comfort.

Augmented reality (AR) is considered as the bridge between the physical world and the digital world. It is the integration between the digital information and the user's real time environment. AR creates generated perceptual information laid on to of a real-world environment [3]. By using AR technology, the shape and the sound of the traditional instruments can be mimic digitally which in return can reintroduce these instruments to a whole new range of audiences that may be interested in Malaysia's traditional instruments.

Furthermore, there are existing mobile and web-based applications available in Google Play and the Internet that showcases traditional musical instruments but there are only a few that are Malaysian-focused. While there are traditional instrument mobile applications developed using AR technology, but it is not available in Google Play and Play Store thus only leaves applications that only displays the pictures of the instruments and plays the repeated sound of the instrument. Therefore, a mobile application, Malaysia's Traditional Instrument with AR is proposed to be developed that allows users to learn about the traditional instruments in Malaysia while also being able to interact with a digital replica of the traditional instruments and play with it.

The objectives of this application are to design a Malaysia's Traditional Instruments with AR (MTIAR) mobile application using AR design principle, to develop an interactive mobile application using augmented reality that introduces the traditional instruments in Malaysia by using marker-less AR, and to implement functional testing and user acceptance test on the developed application to the target user. The proposed application is developed to introduce traditional musical instrument that are involved in a Zapin performance. The target users of this application are public aged 7 years old and above. The subject matter expert (SME) participating in this project is En. Mohd Nazri Bin Mohd Nawi, who works as a cultural artist in the music department from UTHM Cultural Centre. Furthermore, the MMCD methodology will be implemented in this project.

The rest of the paper is arranged as follows: Section 2 covers the domain of study, the technology used, and the result of the comparative analysis. Section 3 describes the Multimedia Mobile Content Development (MMCD) methodology that is chosen to apply in this project, as well as the output of the analysis and design phases of this project. Furthermore, Section 4 stated the conclusion of the current progress.

2. Related Work

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

2.1 Traditional Musical Instruments

Traditional instruments can be described as musical tools that are created by the common folk to accompany folk stories and performances. In Malaysia, traditional musical instruments are cultural musical tools that serves as an entertainment and communication channel with a way of accompanying the performing arts in the local community through the production of a wide range of sound strains [1].

The traditional musical instruments can be categorised into four different classifications, which are, Aerophones for wind instruments, Chordophones for stringed instruments, Idiophones for percussive instruments that are struck or shaken and Membranophones for drums which are derived from the membrane stretched over the instrument that produces sound when struck [4].

Traditional musical instruments play a vital role in traditional performances. They add interests and mystery to a traditional performance. Each performance requires different musical instruments to give the perfect feel of the performance as every traditional instrument come from different cultures in Malaysia. For example, Gambus, Gendang, Rebana, Rebab and Marakas are used in a Zapin performance. Zapin originates from Johor which is well known for using Gambus in many of the state's traditional performances.

Although there have been improvements made to promote traditional instruments towards a wider range of audience such as the implementation of augmented reality there are still many ways that can further be improved. Augmented reality has been used as a medium to teach about traditional instruments around the world. It is an alternative that allows users to learn about the traditional instruments without the need to be in museums or musical festivals.

2.2 Marker-based and Marker-less AR

Marker-based AR is also known as image recognition AR. The specific technology requires a trigger known as "markers." The trigger is a static image that a user can scan using their mobile phones via an augmented reality application [5]. Marker-based AR requires a unique image that can be scanned and translated into additional content such as a video, animation, 3D object or etc. The setback with this technology that it requires a well-lit environment for the mobile device to scan the trigger properly. Reflecting light can cause interference and will make the AR object to disappear. It also noted that moving away from a certain distance between the trigger can cause the AR object to also disappear.

Marker-less AR does not require the use of triggers. It scans the surrounding environment before displaying the additional content on that environment. It usually requires a flat surface to place AR object so it will not be floating on air [5]. Marker-less AR is more flexible than marker-based AR. The only setback it has is that the content made with this technology may not be logical for the user. It is sometimes quite hard to execute AR contents on a flat surface when the content is not known to be put on top of a flat surface.

2.3 Comparative Analysis

In this section, a comparison has been made between existing applications, such as Malaysia Musical Instruments [6], Malaysian Music Augmented Reality [7], and Musical Instruments of Peninsular Malaysia [8], and the proposed application. Figure 1 shows the main menu interface of the three existing applications. Meanwhile, 9 features have been discussed, as shown in Table 1. It includes the platform, language, technology used, modules, content, multimedia elements, metaphors and themes, strengths, and weaknesses.

The proposed application, Malaysia's Traditional Instruments with AR, will implement the use of marker-less AR technology to promote the traditional instruments of Malaysia specifically instruments used in a Zapin performance. The application proposes two modules, the Get to Know module and Try Out module. In the Get to Know module, user is introduced to several types of traditional instrument in Malaysia. The application will teach five instruments that are involved in a Zapin performance which are Gambus, Gendang, Rebana, Rebab and Marakas. Each instrument introduced will be shown the name as well as the illustration of the instrument. A button will show a video demonstration of how the instrument is played. Another button is provided to learn how the instrument is pronounced.

The Try Out module can only be accessed through learning one of the instruments in the Get to Know module. This is where the augmented reality approach will be implemented. In the Try Out module, users can use their camera to display a 3D replica of the instrument. The 'Rotate' button will allow

users to rotate the instrument to explore the various parts of the instrument while the 'Play' button will be zoomed in to the playable parts of the instrument so the players can play with it.

Figure 1(a): Malaysia music augmented reality [6]

Figure 1(b): Malaysia music augmented reality [7]

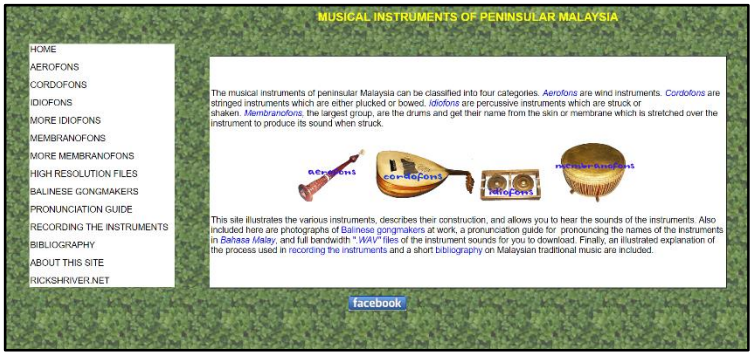


Figure 1(c): Musical instruments of peninsular malaysia [8]

Table 1: Comparison between existing applications and proposed applications

Features	Malaysia Musical Instruments	Malaysia Music Augmented Reality	Musical Instruments of Peninsular Malaysia	Malaysia's Traditional Instruments with AR
Platform	Mobile Application (Android)		Web-based	Mobile Application (Android)
Language	English			
Technology used	- 2D Approach	- Marker-based Augmented Reality with 3D approach	- 2D Approach	- Marker-less Augmented Reality with 3D Approach
Modules	- Contains a learning module and a play module.	- Contains an AR learning module and a quiz module.	- Contains a learning module, play module and pronunciation module.	- Contains a learning module and AR play module.
Content	- Covers fourteen types of musical instruments	- Covers explanations of the different classifications	- Covers all types of instruments available in	- Covers the classification of musical instruments,

Features	Malaysia Musical Instruments	Malaysia Music Augmented Reality	Musical Instruments of Peninsular Malaysia	Malaysia's Traditional Instruments with AR
	with explanation of origins.	of musical instruments	Peninsular Malaysia.	explains the origins and functions of musical instruments involved in Zapin performance.
Multimedia Elements	- Text, graphics, and audio.	- Text, graphics, and audio.	- Text, graphics, and audio.	- Text, graphics, audio, and video.
Metaphors and Themes	- Malay traditional instruments.	- Colourful theme.	- Green colour theme.	- Zapin performance metaphor.
Strengths	- Free to use. - Consistent button	- Colourful interface - Interactive 3D Models	- Easily accessible because it's web based. - Consistent theme and interface.	- Free to use. - Interactive 3D Models - Consistent buttons
Weaknesses	- Plays a repeated recording of the instrument. - No sense of theme in application	- Not available in Google Play	- Plays a repeated recording of the instrument.	- Only covers instrument involved in a Zapin performance.

3. Methodology

In this section, the methodology used for the proposed project will be discussed. The Multimedia Mobile Content Development (MMCD) [9] approach is used to develop mobile learning application. The methodology comprises of five main phases shown in Figure 2(a). The methodology is then modified in Figure 2(b) as the sub-phase "update the structure" will not be performed after the structure analysis phase as the process would consume a lot of time thus the removal.

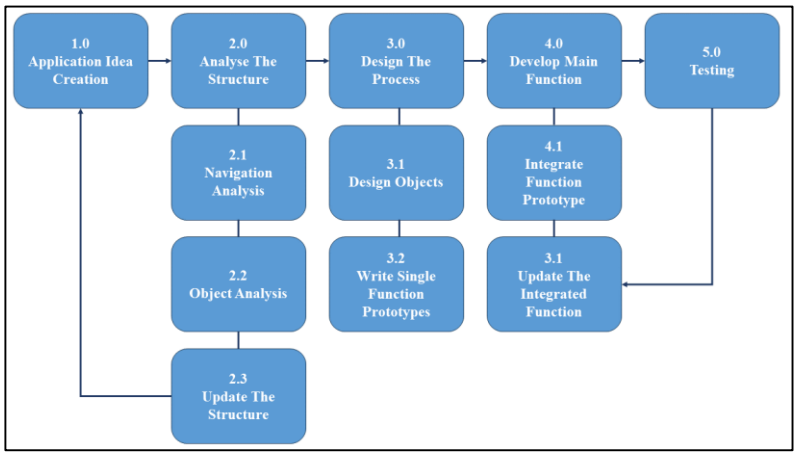


Figure 2(a): MMCD Methodology [9]

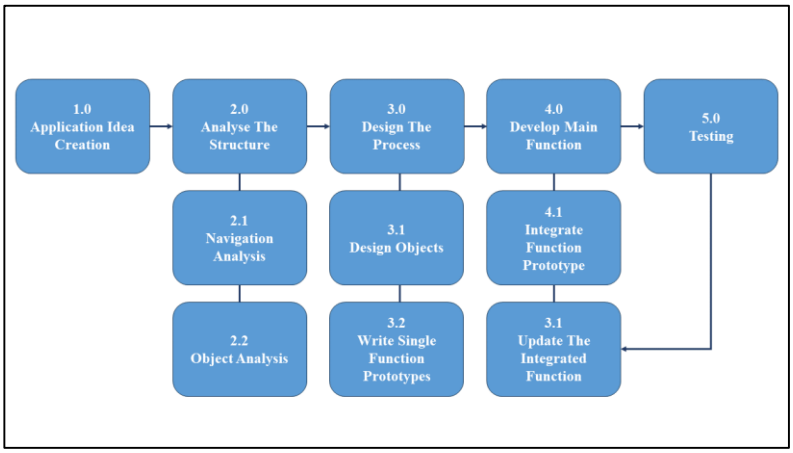


Figure 2(b): Modified MMCD Methodology

3.1 Application Idea Creation

Application idea creation is the first phase of MMCD Methodology. From this stage, the information required before the design and development of MTIAR is determined such as the user and application requirements. The application idea creation checklist is shown in Table 2 and the user analysis of subject matter expert and target users are as in Table 3.

Table 2: Application idea creation checklist [9]

Item	Description
Application type	Mobile
Target device	Android-based smartphone
Target users	General (7 years old and above)
Graphical user interface (GUI)	Background (main menu, intro, Get To Know module, Try Out module)
Unity 2020	• Unity 2020.3.43f1 • For application development
Blender	For 3D modelling
Canva	For designing background images, icon buttons
Autodesk Sketchbook	For designing graphics
Visual Studio 2019	For script writing
Text	Explanation for instruments functions and body parts.
Images	2D images (main menu, Get To Know module)

Item	Description
Video	Introduction to instruments and how the instruments is played
Audio	For pronunciation of instruments
ARCore for Unity	For implementing augmented reality (AR) to the application
Application synopsis	Malaysia's Traditional Instruments with AR is an augmented reality-based mobile application designed specifically to introduce traditional instruments to users using a marker-less AR.

Table 3: User analysis

Stakeholder category	Role in product	Design implication	Action needed
Subject Matter Expertise (SME)	Content consultant expert in traditional instruments in Malaysia	Based on the interview, simple user interface design	• Use icon-based buttons instead of text buttons. • Use font types that are easy to read. • Navigation buttons should be consistent in term of shape, colour, position, and sizes.
		reliable content, use simple words and short sentences	• Include tutorials on how to navigate the application. • Provide introductions of the instruments correctly
		easy to navigate	• Application should contain previous, next, home, exit buttons for easy navigation.
		Multimedia content	• Use clear videos for introduction of instrument. • Use clear audio for pronunciation of instrument. • Use colourful graphics to attract users. • 3D models must mimic the actual instruments.
General User (5 years old and above)	End-user of the proposed application	Based on the questionnaire, The user preferences	• Create an application that is free to use. • Create an application that provides easy navigation of interfaces.

3.2 Analyse the Structure

The next phase of the MMCD methodology is to analyse the structure. The analysis of the navigation and objects has been completed. The navigation framework shows the basic navigation of the application is illustrated in Figure 3. Figure 4 displays the flowchart for the system that shows a more detailed navigation of the application including the different instruments that are displayed in this application. The content structure checklist is shown in Table 4.

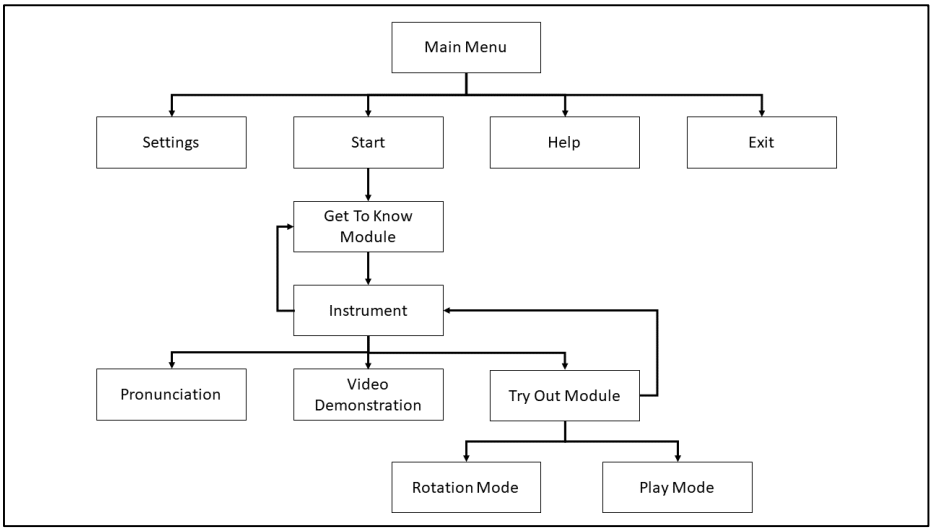


Figure 3: Navigation Structure

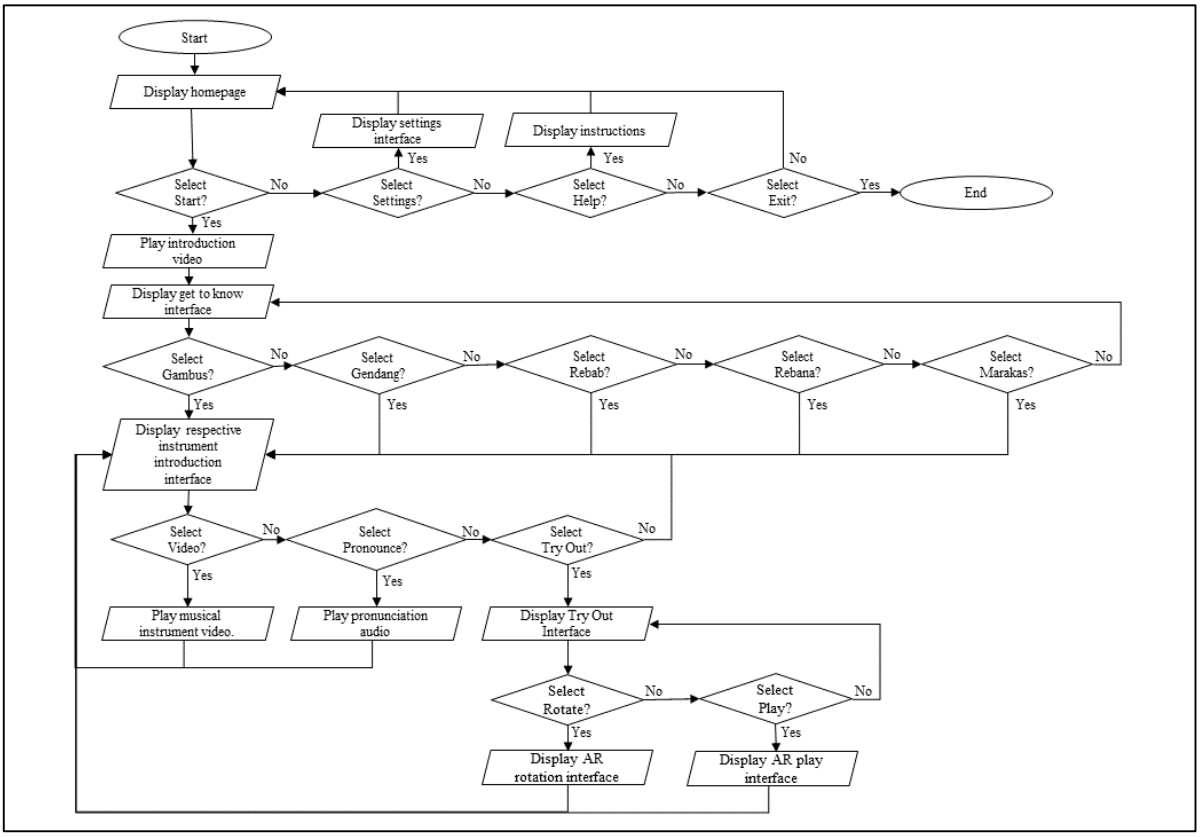


Figure 4: Main flowchart

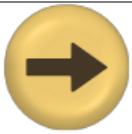
Table 4: Content structure checklist

Item	Description
Number of main GUI (Graphical User Interface)	• Application logo
2D Graphic	• Static image and graphics, button icon
3D Graphic	• Traditional musical instruments
Video	• Introduction to instrument video (mp4) in the intro and Get To Know module.
Audio	• Background music (mp3), sound effects (mp3), pronunciation audios (mp3)
Text	• Canva font: Intro Rust and Canva Sans
Colour	• Black songket with golden trims.

3.3 Design the Process

The third phase of the MMCD methodology is to design the process. Two subphases of this level are object design and writing the single function prototype scripting. At the conclusion of this phase, the prototype for the Try Out and Get To Know modules will be completed. In this project, storyboards, 2D and 3D animations, and pictures are all created using authoring tools like, Autodesk Sketchbook, Blender, and Canva. Scripting is performed while using the Unity software. Table 5 shows the button design, while Table 6 shows the interface design.

Table 5: Buttons and Icons Design

Button / Icons	Description	Button / Icons	Description
	This is a Start button.		This is a Gambus button.
	This is a Help button.		This is a Gendang button.
	This is a Settings button.		This is a Marakas button.
	This is an Exit button.		This is a Rebab button.
	This is a next button.		This is a Rebana button.

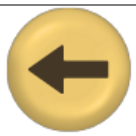
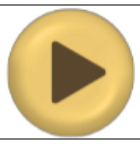
Button / Icons	Description	Button / Icons	Description
	This is a previous button.		This is a Play button for the Get To Know module.
	This is a home button.		This is a Play button for the Try Out module.
	This is a Try Out button.		This is a Rotate button for the Try Out module.
	This is Sound and Music icons.		This is a Pronunciation button.

Table 6: Interface Design

Interface	Description	Interface	Description
1) 	This is the homepage interface. Users can access the settings, Get To Know, help interfaces here.	7) 	This is the Get To Know interface. Users can learn about the traditional instruments in a Zapin performance.
2) 	This is the introduction interface; this is where user will watch a video that introduces traditional instruments.	8) 	This is the learning interface on one of the instruments based on the users selection from the Get To Know interface.
3) 	This is the instruction interface regarding on the Get To Know interface.	9) 	This is the video demonstration interface that will play a video of the instrument being played.
4) 	This is the instruction interface regarding the learning interface.	10) 	This is the Try Out rotation interface. Users can learn more about the instrument by rotating the 3D instrument.

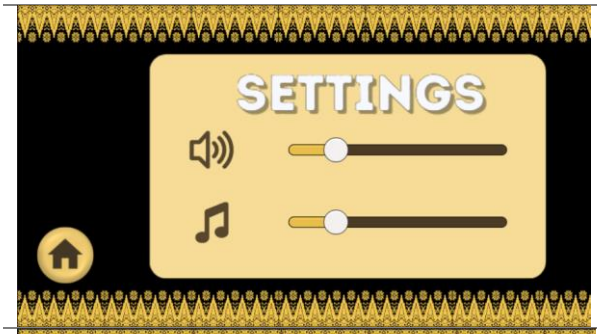
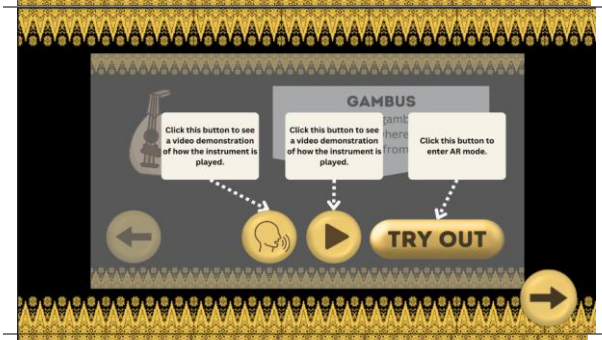
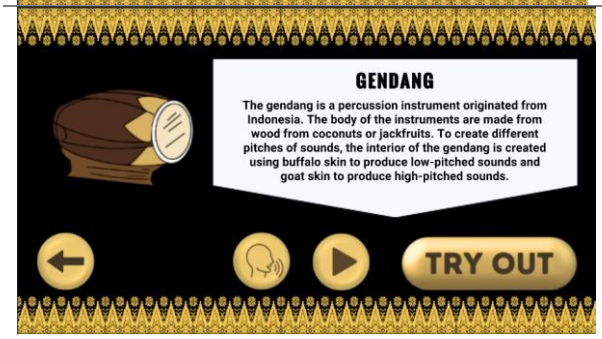
Interface	Description	Interface	Description
5) 	This is the instruction interface regarding the Try Out interface.	11) 	This is the Try Out play interface. This is where the application zoomed in to the instrument so users can play the instrument.
6) 	This is a settings interface. User can adjust the volume and sound of the application.		

3.4 Develop Main Function

The main functions of the proposed application are be developed in this phase. In the Get To Know module, the main function is to deliver the content with good graphics and clear audios. In the Try Out module, the main function is to allow users to see the 3D replica of the instruments and be able to play it. The Get To Know module is developed in the Unity Editor, while the Try Out module is also developed in the Unity Editor with an added package called "ARCore XR Plugins" for the AR functions of the module. Table 7 shows the developed interfaces of Malaysia's Traditional Instruments with AR (MTIAR).

Table 7: Development of interfaces of MTIAR

Interface	Description of Development
	This is the main menu interface. Based on the interface, we can see the title and several buttons that are used to navigate around the application. The 'START' button will bring the user to the introduction interface. The '?' button will bring the user to the help interface where the user will learn how to use the application. There is also a settings button. The exit button will allow the user to exit application easily.
	This is the introduction interface. User will be shown a video that introduces the many types of traditional instruments that exist in Malaysia. User could also skip this interface by clicking on the next button shown in the bottom right of the interface.

Interface	Description of Development
	This is the settings interface. The user can adjust the volume of sound effects that exist in this application and adjust the volume of the background music that will be played throughout application.
	This is the help interface. In this interface the user will be guided on how to navigate throughout the application in case the user gets stuck. The interface shows a small video displaying the interface in Get To Know and Try Out module and the functions of each button in each of the interfaces.
	This is the Get To Know module interface. In this interface, user will choose any of the musician buttons to learn about the instrument. There are 5 musician buttons shown in this interface. Instructions are given in case users are unsure what to do on the interface. The home button shown in the bottom-left of the page will take the user back to the main menu interface.
	This is the instrument interface. Once the user has chosen an instrument, the user will be brought to an interface where the user will learn the history of the instrument. The user can listen to the pronunciation of the name of the instrument by clicking on the voice button. The play button will show the user a video of how the instrument is usually played. The try out button will bring the user to the Try Out module interface.
	This is the Try Out module interface. This interface will show the 3D model of the chosen instrument. The user can click on the rotating button to enter 'Rotate' mode. In this mode, the user can rotate the instrument. The user can click on the 'Play' button to enter playing mode where the user can interact with the instrument to play a sound.

The changing of scenes is a common function in the developed application to change scenes between different modules and instruments. Based on Figure 5, the given code snippet shows that a library that needs to be added for writing a single function prototype which is UnityEngine.SceneManagement. This library handles the object SceneManager, where it manages the behaviour of LoadScene with a parameter.

```
using System.Collections.
using System.Collections. Generic.
using UnityEngine.
using UnityEngine.SceneManagement.

public class MoveToNextScene: MonoBehaviour
{
   [SerializeField] private string settings = "Settings".

            public void settingsButton ()
            {
             SceneManager.LoadScene(settings).
```

Figure 5: Single function prototype of Malaysia's Traditional Instruments using AR.

The models used in the application are modelled using Blender software. Based on Figure 6, we can see the model of Gendang instrument being modelled in Blender.

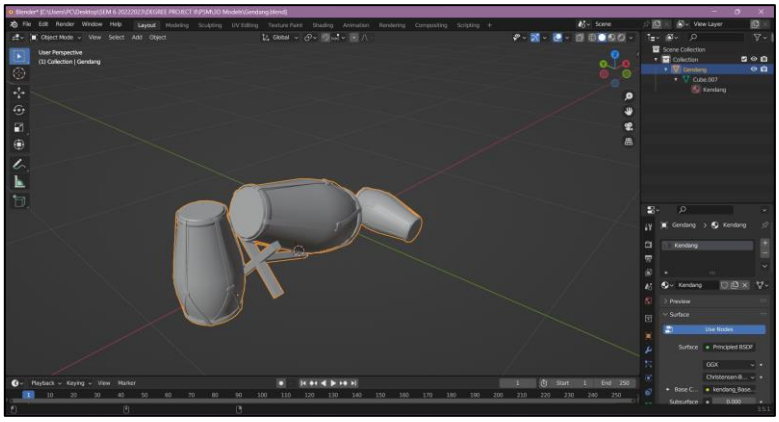


Figure 6: Development of 3D models in Blender

The application was developed in the Unity Editor specifically the 2020.3.43f1 version. In Figure 7, we can see the integration of the 3D model into application using Unity Editor with the help of ARCore package to develop a marker-less augmented reality application.

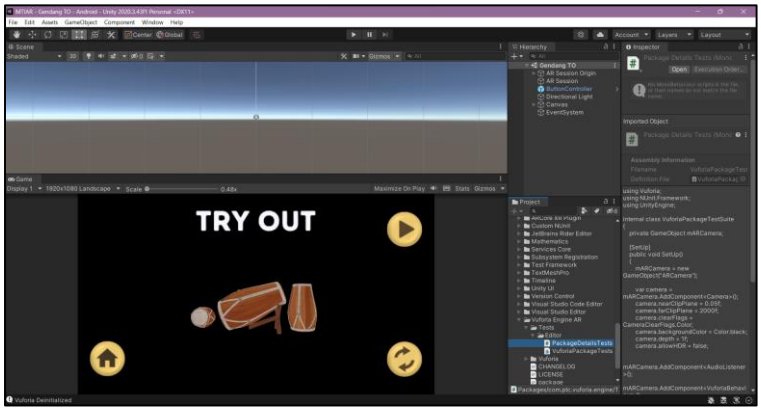


Figure 7: Development of MTIAR in Unity Editor

3.5 Testing

In the last phase of the MMCD methodology, two types of testing will be performed, including functional testing and user acceptance testing. If bugs are discovered in this phase, the project will return to the previous phase to update the integrated functions to fix the bugs.

4. Result and Discussion

The development of the application is completed. User testing was carried out to evaluate the usability and the functionality of the application. The testing is conducted towards 30 target users from both genders and all ages.

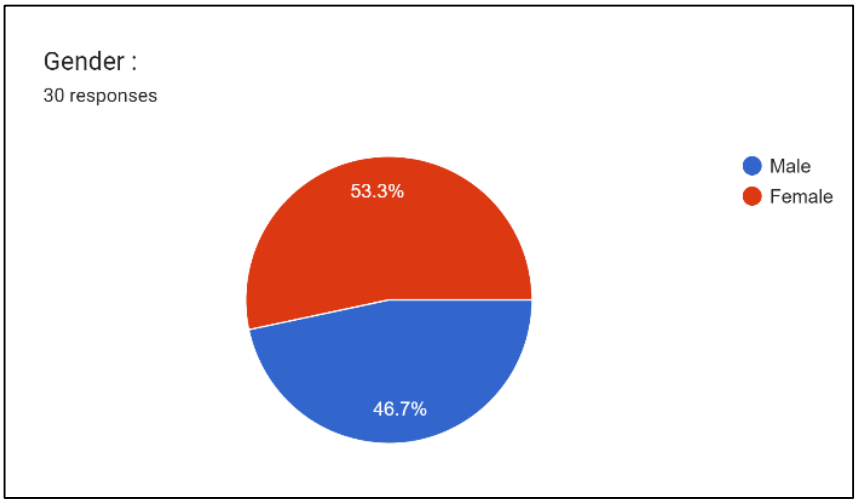


Figure 8 (a): The gender demographic results of user

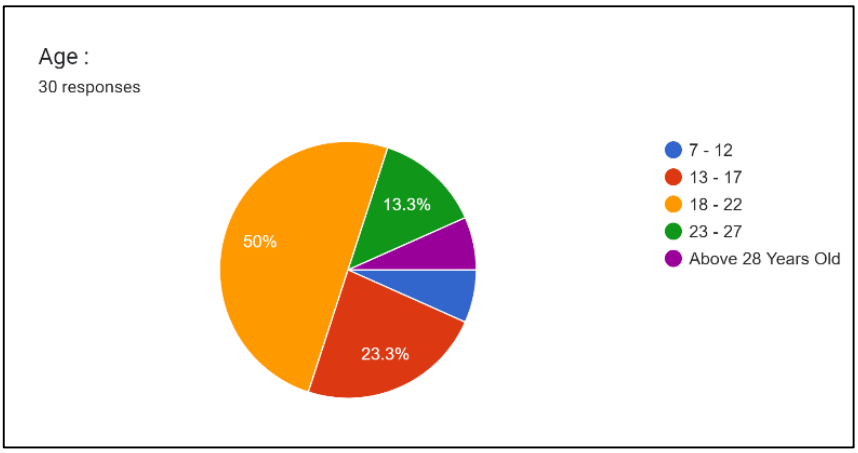


Figure 8 (b): The age demographic results of user testing.

Based on Figure 8(a) and 8(b) the demographic of the target users of the developed application is shown. 53.3% of the target users are female and the remaining 46.7% of the target users of the developed application are male. In the age demographic, 50% of the target users were in the range 18 to 22 years old. The second largest age range are users from the age of 13 to 17 years old at 23.3%. The third age range of the target users are 23 to 27 years old at 13.3%. The smallest age range are users who are 7 to 12 years old or above 28 years old at 6.7%.

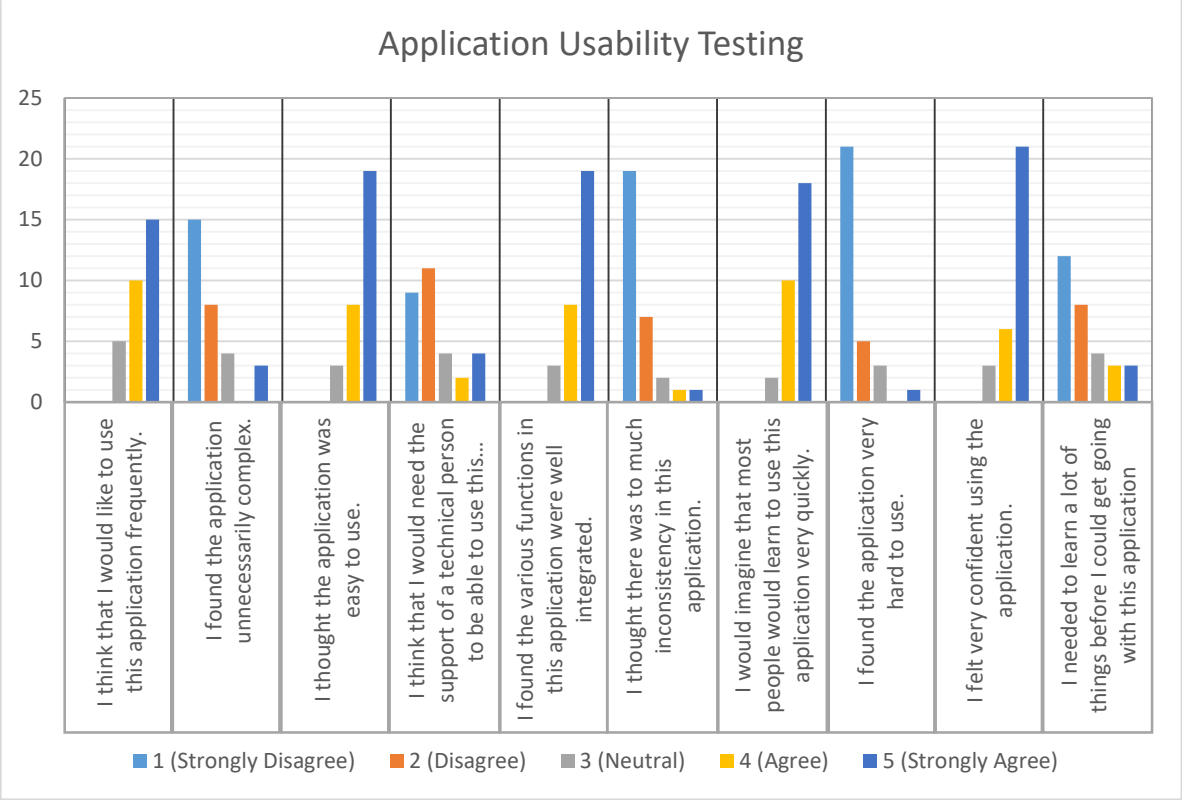


Figure 9: The results of usability testing of MTIAR

Based on Figure 9, the results of usability testing of MTIAR shows that 50% of the target users strongly agree that this application will be used frequently. This means that half of the target users would be interested of using the application more than once. Other than that, 50% of the target users strongly disagrees that the application is unnecessarily complex. This means that the other half of the users requires more time to navigate throughout the application.

Next, over 63.3% of the target users strongly agrees that the application was easy to use. 66.7% of the target users disagree that they need the support of a technical person to be able to use this application. Based on that statement, it can be confirmed that most of the users do not require the developer to teach them how to use the application. Besides that, over 63.3% of the target users strongly agrees that the functions of the application were well integrated and 63.3% also disagreed that there were inconsistencies found in the application. This means that most of the users do not find any fault in the application besides only a few errors in terms of run time.

Furthermore, 60% of the target users strongly agree that most people would learn to use the application very quickly and over 70% of them strongly disagrees that the application was hard to use. Interestingly, 70% of the target users were confident while using the application. Lastly, 40% of the target users strongly disagrees that they needed to learn a lot of things before they could get going with this application. Therefore, based on the results the application has passed the user acceptance test.

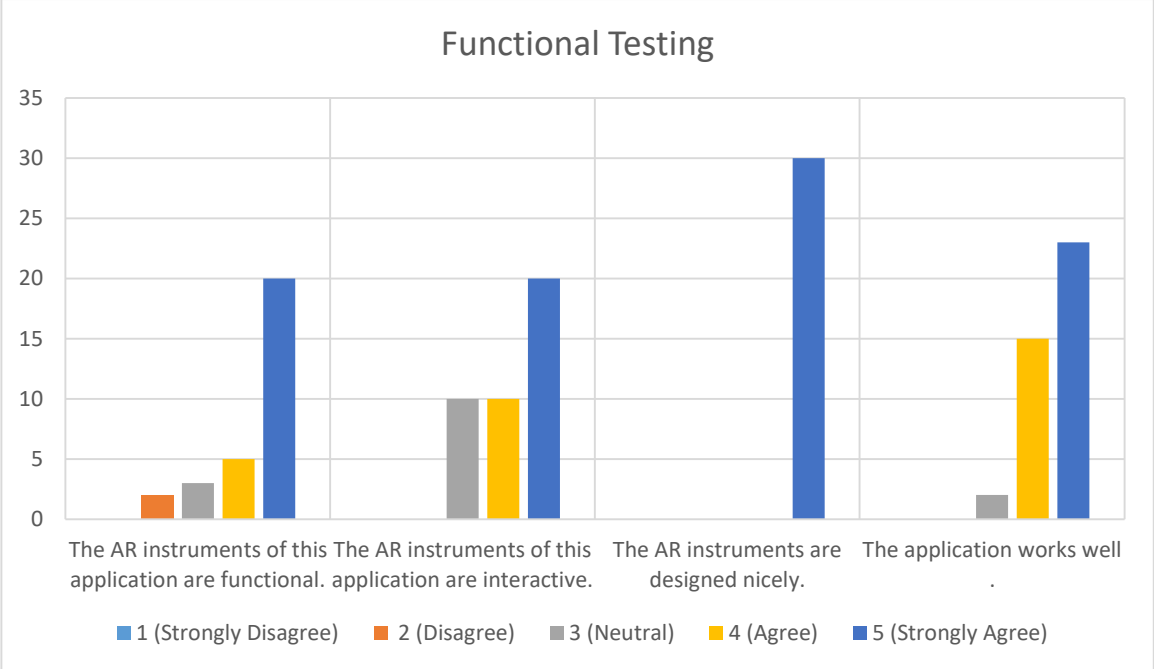


Figure 10: The results of functional testing of MTIAR

Based on Figure 10, 66.67% of the target users agrees that the AR instruments of the application are functional. Next, 66.67% of the target users agree that that the AR instruments are interactive. 100% of the target users agree that the AR instruments are designed nicely. Lastly, 76.67% of the target users agree that the application works well. This tells us that the application has surpassed the functional testing because most users agree that the application is working well despite a few errors in the application.

5. Conclusion

This project is proposed to develop an interactive mobile application named 'Malaysia's Traditional Instruments with AR'. Malaysia's Traditional instrument with AR is intended to introduce traditional instruments mainly involved in a Zapin performance using AR technology as an alternative to promote the musical instruments to a wider audience.

Table 1 explains the advantages and limitations of the proposed application. The existing applications that are available on Google Play does not implement the use of AR technology and lacks a few multimedia elements that could help attract users' interest to learn more about traditional instruments. Thus, the proposed application will be a good alternative by implementing AR technology in learning about traditional instruments.

To conclude, this project has been completed. It has achieved all three objectives which is to design a Malaysia's Traditional Instruments with AR mobile application using AR design principle, to develop an interactive mobile application using augmented reality that introduces the traditional instruments in Malaysia by using marker-less AR and conducting the functional testing and user acceptance testing.

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