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Research Paper

POCKET MALAYSIA: Learning About States in Malaysia Using Augmented Reality

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Abstract: In era 4.0, teaching and learning are still in traditional method, which is using textbook. Hence, students become bored and easily to fall asleep during class. Therefore, researcher wish to develop an attractive and friendly-user augmented reality application as a learning aid for students. Pocket Malaysia uses AR system to learn about states in Malaysia. Student can learn in fun way through multimedia usage. There are several objectives to implement this research. Those are to identify which topic in Form One Geography Textbook is suitable to be implement in augmented reality concept, develop an augmented reality application that can help students recognize the name of states in Malaysia, location of states in Malaysia map and other details regarding each state in Malaysia through an interactive way and, evaluate usability of the application. This research uses quantitative method. The research approach is survey. About 15 students that are studying Geography subject in Universiti Pendidikan Sultan Idris (UPSI) are involve as sample through quota sampling. Overall, Pocket Malaysia is a good starting point for Geography subject in secondary school. This is because not many AR applications today are focusing on Geography subject. Based on the survey, many agree that it is easy to use although there is unclear instruction in scan section. The GUI also is quite pleasant along with the font size and colour selection. In general, it is successfully developed as it gave out the expected outcome. The weakness of this application should be improved in the future.

Keywords: Augmented Reality, Educational Technology, Geography, Industry 4.0, Teaching and Learning.

1. Introduction

In era 4.0, the usage of gadget like mobile phone is a common thing. In the early year of 2000, only working adults used mobile phone. However, this has changed now as teenagers and kids as well use mobile phone in their daily life. As stated by Vinothini et al. [1], children nowadays has developed a habit on using mobile devices as they are well-exposed them. The so-called mobile phone term also has changed to smart phone. This is due to the mobile phone function itself that has evolved from only able to send text messages and make phone call, to advance functions such as taking picture and surfing the internet. Hence, the usage of mobile phone in teaching and facilitation (PdPc) nowadays is not something peculiar as mobile phone brings advantages. Based on O'Connor & Andrews [2] researched, they found out that the usage of mobile technology benefited nursing student in better access to educational material, improvements in knowledge and confidence, and reduced levels of anxiety around learning in practice.

In Higher Education Minister Mandate back in 2018, to realize Higher Education 4.0, it stated that researcherneeded to transform learning and teaching approach from traditional to Learning and Teaching 4.0 or PdP 4.0 [3]. One of the transformations demands for PdP 4.0 is 21st Century Pedagogy. It stated that this approach should include heutagogy (self-determined learning), paragogy (peer-oriented learning), and cybergogy (learning based on virtual environment). In this case, a need to use augmented reality application is rational as it is one of ways to implement cybergogy approach in teaching and learning process.

Student nowadays are advance in getting information as they can easily access the internet. This is because internet can be purchase at low cost in Malaysia. Therefore, teachers and books are not the only sources to get information regarding their studies. It is true that getting limitless of information is good but without the passion to study, it is useless as student only learn to pass the school exam. Thus, researcher hope to create an application that can attract their attention so that they can learn without having the pressure to learn.

Generally, teaching and learning are still in traditional method, which is using textbook. Hence, students become bored and easily to fall asleep during class. According to Kurniawan et al. [4], students were having difficulties in visualizing human anatomy from 2D to 3D as the current method of learning human anatomy were using text books and plastic. Therefore, researcher wish to develop an attractive and friendly-user augmented reality application as a learning aid for students. This application will cover on Malaysian map topic in form one Geography subject. Information about the states will appear when a user point out the camera to the selected image of states on the Malaysia map.

Pocket Malaysia uses AR system to learn about states in Malaysia. It interacts with the marker to display information about the states in Malaysia when camera is pointing out towards the marker. It is a mobile application. It uses mobile phone camera to scan the map that is created as the marker. Image and information about the selected states then will be display on the screen. As a result, student can learn in fun way through multimedia usage. Mahat et al. [5] stated that the effectively used of ICT in teaching and learning can create an interesting learning environment and achieve the objectives of teaching and learning.

There objectives for this research is to develop an augmented reality application that can help students recognize the name of states in Malaysia, location of states in Malaysia map and other details regarding each state in Malaysia through an interactive way.

2. Literature Review

In this chapter, researcher will discuss about previous studies that had been carried out by other researchers. These studies will provide about augmented reality technology, learning theory, teaching and learning method used by Geography teacher, software development tool for augmented reality, augmented reality marker, evaluating augmented reality and comparison between software models.

2.1. Augmented Reality

Augmented reality provides an enriched view onto the physical world, adding layers with contextually useful information, delivered visually or by stimulating other senses using wearable and hand-held devices [6]. According to Farshid et al. [7], augmented reality (AR) is the combination of the real world with digital information. It makes the real time environment merged with the digital content that is being generated by computer software simultaneously. AR can take in various forms but the most

common form is being an application in a smartphone. AR layers can consist of sensory such as sound, video, graphics, or haptics, or only data based.

2.2. Learning Theory

The role of Technology of Information and Communication is essential in the education sector [8]. This is because they can enhance the student's learning as well as the teaching methods used by teachers. Hence, constructivism learning theory seems suits to implement with AR application. Constructivism learning theory is a learning theory where the environment of learning is focussing on the student. According to The University of Sydney (n.d.), constructivism refers to a learning theory found in psychology, which explains how people might acquire knowledge and learn.

Example of constructivism learning theory can be seen applied in the research presented by Shao & Gwo [9]. They proposed AR-based learning as a flipped learning as employing proper educational technologies or learning strategies to improve students' performance. The learning theory applied when students need to log into the flipped learning system to study the pre-class learning content. The study shows that the students' learning achievements, learning motivation, critical thinking tendency, and group self-efficacy were significantly improved with help of AR. Figure 1 shows student interact with flipped learning lesson containing AR technology.

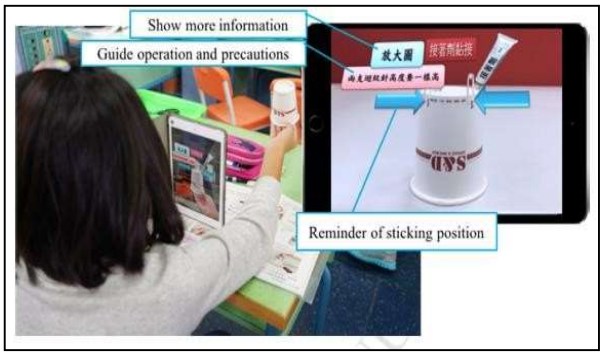

Figure 1. The Lesson in Flipped Learning

2.3. Teaching and Learning Method Used by Geography Teacher

The role of teachers in teaching and learning process is also important besides the syllabus itself [10]. Therefore, Geography teachers should enhance the effectiveness and the quality of pedagogical practices, in order to make Geography interesting for students. A research had been conducted to examine the productive pedagogical practices among Geography teachers in Malaysian context. Observation on the teaching and learning processes of nine Geography teachers in selected secondary schools had been done in this research. The results showed that the competency level was under par excellent from the established criteria of the productive pedagogies practices.

2.4. Software Development Tool for Augmented Reality

There are many tools that can be used to develop AR application. One of the tools for software development is Visual Environment for Designing Interactive Learning Scenarios (VEDILS). VEDILS, is a visual tool for designing, customising and deploying learning technologies [11]. It provides users with a development environment that is easy to handle. The framework of VEDILS containing the development tool and a method for designing and deploying learning activities. To test the suitability of the tool for user who lack in programming skills, the researchers conducted a workshop for 47 third-level educators on how to create their own mobile augmented reality application. As a result, VEDILS framework and researchering tools is suitable for supporting users without programming skills, as all of the teachers were able to develop their own application.

Other software development tool used by researchers is Android Studio [4]. Android Studio uses JAVA programming language. It is designed for the development of android applications and is compatible with various AR engines. AR engines used by the researchers were the AndAR with the

Unity and Vuforia AR frameworks that are made for the mobile platform.

There are also researchers that used Vuforia as their software development tool. Jamaliab et al. [12], used Vuforia as it is a software platform, designed for high quantity operation of AR on mobile devices. In addition, it also provides the tools to create all categories of AR experience. The reasearchers chose this software development tool because it is widely used for various types of product delivery in commercials, education, sports, and in other fields.

2.5. Augmented Reality Marker

Development for AR application consists of marker-based tracking and marker-less tracking [11]. Marker-based tracking as in Figure 2 uses labels composing of coloured or black and white pattern. Meanwhile, marker-less tracking as in Figure 3 uses the mobile device's GPS or image recognition systems to identify a location. These markers make use of sensors to determine the location, orientation and direction of the mobile device. Example of sensors are accelerometers and gyroscopes. Before the virtual information such as sounds, 2D images, 3D models, etc. is placed on the live image, the AR application needs to look for a predefined pattern in order to identify a match and a reference position.

Figure 2. AR Marker-Based Tracking

Figure 3. AR Marker-Less Tracking

2.6. Evaluating Augmented Reality

Kurniawan et al. [4], evaluated their AR software by survey. There were 30 medical students involved in the research. To execute the survey, they had delivered video application, tested the application, and distributed the questionnaires to the users after the users used it. To analyse user's satisfaction towards the application, the researchers used attitude questionnaire. The questionnaire consisted of several aspects such as teaching material, interface design, multimedia features, interactive function, and practicability. Researchers chose to use attitude questionnaire because the approach was effective and it saved time in evaluating the satisfaction of users.

2.7. Comparison between Software Development Methodologies

Table 1 shows the differences between the three development methodologies that is Agile Model, Prototype Model and Rapid Application Development (RAD) Model.

Table 1. Comparison between Software Development Methodologies

NO.	MODEL	ADVANTAGES	DISADVANTAGES
1.	Agile Model	• A realistic approach to software development. • Minimum resource requirements. • Any change in the feature can be accommodated in the current release of the product.	• Not suitable for handling complex dependencies. • Less documentation. • Sometimes the requirement is not very clear. So, it is difficult to predict the expected result.
2.	Prototype Model	• Involvement of users are active during development. • Users get a better understanding of the system development as a working model is provided. • Defects can be detected much earlier. • Better solutions can be generated as users provide fast feedback. • Able to identify the missing function easily. • Able to identify confusing or difficult function.	• The complexity of the system may expand beyond the original plans. • Too much dependency on the prototype may lead to the risk of insufficient requirement analysis. • Too much effort in building prototypes will be invested if it is not monitored properly. • Users may get confused between prototypes and actual systems.
3.	RAD Model	• Reduced time for developing. • Reusability of components is higher. • Able to make earlier review. • Encourage feedback from customer.	• Skilled developers or designers is highly required. • High dependency on modelling skills. • Suitable for systems that are component based and scalable.

The software development methodology that will be used for developing the product is prototype model.

3. Methodology

3.1. Research Design

This research uses quantitative method. The research approach is survey. About 15 students that are studying Geography subject in Universiti Pendidikan Sultan Idris (UPSI) are involve as sample through quota sampling. The instrument tool used for data collection was structured questionnaire with Likert Scale. Respondents will be given the Pocket Malaysia application to try first. After that, they need to answer the questionnaire about product's usability. The data then analysed by descriptive statistics technique.

3.2. Software Development Methodology

The chosen software development methodology is Prototype Model as in Figure 4. Prototype is described as a working model of software with some limited functionality (Tutorials Point, n.d.). It is developed according to the currently known requirements. Thus, it helps in understanding customer requirements at an early stage of development (Tutorials Point, n.d.). By using this method, users are allowed to evaluate developer proposals and try them out before implementation. As a result, both parties will be benefitted as prototyping helps in getting valuable feedback from the customer. Meanwhile for the software designers and developers, it helps them to understand about what exactly is expected from the product under their development.

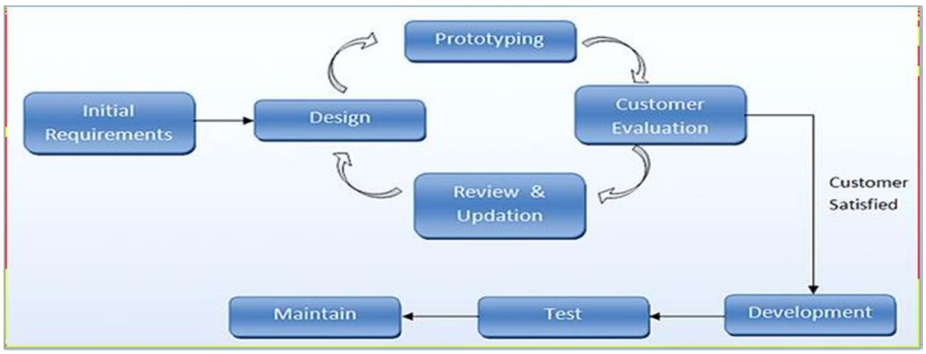

Figure 4. Prototype Model

There are two types of approach in using Prototype Model are rapid throwaway prototyping and evolutionary prototyping. The researcher used evolutionary prototyping approach. This type of approach allowed software designer and developer to make improvement on the existed developing prototype.

3.3. Justification Methodology Selected

Prototype model is chosen as the software development methodology because of some reasons. Based on research made by Rather & Bhatnagar [13], the use of certain models by developers are according to the size of the software that is going to be developed, low cost, risk, high quality, and small cycle of time in order to optimize the productivity and quality of software product. The reasons of choosing prototype model are described in Table 2 according to Rather & Bhatnagar [13] analysis.

Table 2. Analysis of Choosing Prototype Model

Model / Merits	Prototype
Success rate	Good
Flexibility	Highly flexible
Implementation time	Less
Expertise required	Medium
Simplicity	Simple
User involvement	High

3.4. Prototype Model

There are eight stages in this model. They are initial requirements, design, prototyping, customer evaluation, review and updation, development, test and maintenance. However, iteration may occur if the client is not satisfied with the first prototype during customer evaluation phase. Iteration of review and updation, design and prototyping phase will keep going until client is satisfied with the protoype.

3.4.1. Initial Requirements

Requirements are gathered by interviewing client or analysing reliable sources to get the contents needed in the application. Researcher also analysed the existed AR application with different topic to find the suitable design interfaces and functions.

Initial requirement phase is a phase where researcher searching for the required information. In this stage, researcher collected requirement by go through the Dokumen Standard Kurikulum Pentaksiran (DSKP) Geografi Tingkatan Satu and Form One Geography textbook to know more about the learning content. Researcher also observed several AR applications with different topic to find the suitable graphic user interface and functions to be implement in the product.

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After analysed, researcher got the ideas to develop augmented reality application based on the chapter Lakaran Peta Malaysia. This is because researcher want to produce AR marker based on the shape of the states in Malaysia map. Researcher also found out that there are information from other topics that could be put together with information from the chosen chapter.

3.4.2. Design

In this third stage, the researcher will design the interfaces for the software as well as the Object Oriented Program (OOP) diagram.

After thoroughly analysed the textbook and DSKP of Geography subject for form one student, graphic user interface (GUI) for the application was designed. The GUI consists of main menu interface and scan interface. For the AR marker, researcher searched for the free authority of Malaysia map in Portable Network Graphic (PNG) format on the internet. The reason is the image save in PNG has good resolution. Figure 5. shows Malaysia map used for designing AR marker.

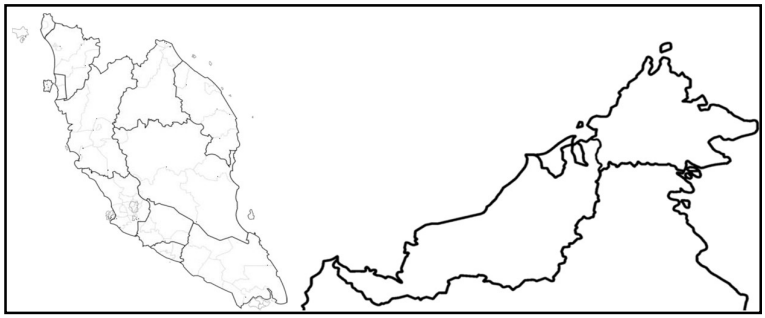

Figure 5. Malaysia Map Used for Designing AR Marker

3.4.3. Prototyping

In the first prototype phase, AR marker was produced using Adobe Photoshop. Each state in Malaysia map was cut according to the black line over the state. The white space in each state then was given colour to make it looked prettier. The background of the state was made transparent and it was saved in Joint Photographic Experts Group (JPG) format. This is due to the Vuforia, a file database system only accept file with JPG format or PNG format with maximum file of 2 Mb. The completed AR markers then saved in Vuforia as the target marker. Figure 6. shows view of get development key button in license manager section.

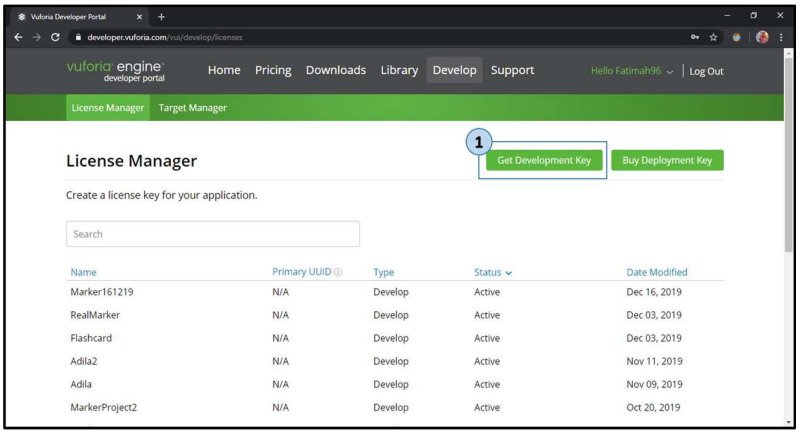

Figure 6. View of Get Development Key button in License Manager Section

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To save target marker in Vuforia, researcher need to create a license first. To do this, click on the Get Development Key button as in Figure 6. Then, create a license name and tick the box at the bottom of the page. Then, click on the Submit button to complete the process as in Figure 7.

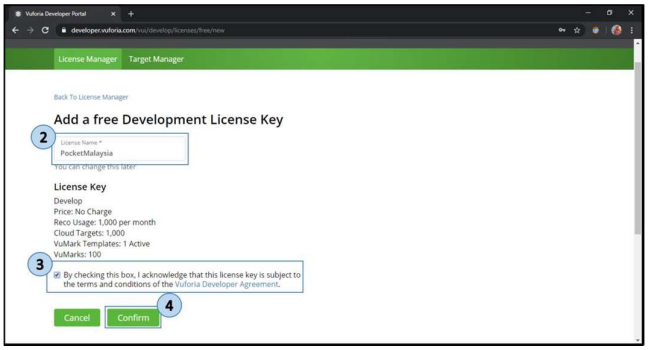

Figure 7. Steps on Creating License Name in Vuforia

After that, researcher need to create a database. To do this, researcher went to the target manager section. Researcher create new database by clicking on the add database button. Create database section is displayed on the screen. Researcher then create a name for the database, ticked on box for Device and clicked on the Create button. The steps can be seen in Figure 8.

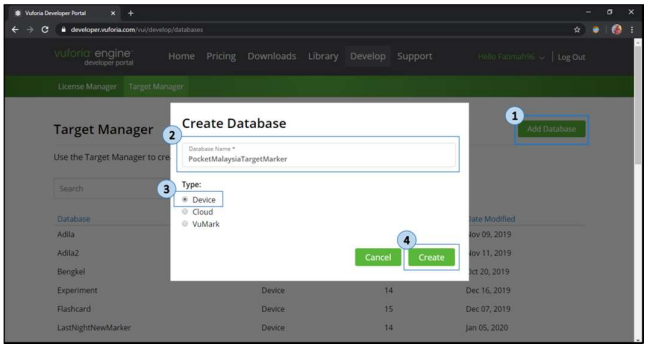

Figure 8. Steps on Creating Database in Vuforia

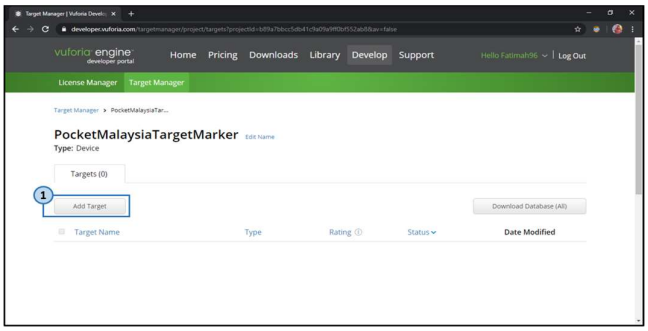

Figure 9. View of Add Target Button in Target Manager Section

After creating a database, researcher is able to save AR marker in Vuforia. To do this, click on the add target button as in Figure 9.

Then, add target section is displayed as in Figure 10. Researcher need to find the image that has been cut earlier using browse button. After found the image, researcher need to set the width. Name of the image will be set automatically based on the previous name it was saved. However, the name can be edit in the name box. Lastly, researcher clicked on the add button to add the image into the created database.

The image that has been saved will be displayed as in Figure 11. To download the database, click on the the download database button. The database will be saved into the computer. After that, the application was developed using unity. Researcher begin the development of the application with developing of displaying AR objects in Scan scene. To display AR objects, researcher begun with create AR camera. The steps to create the camera can be seen in Figure 12.

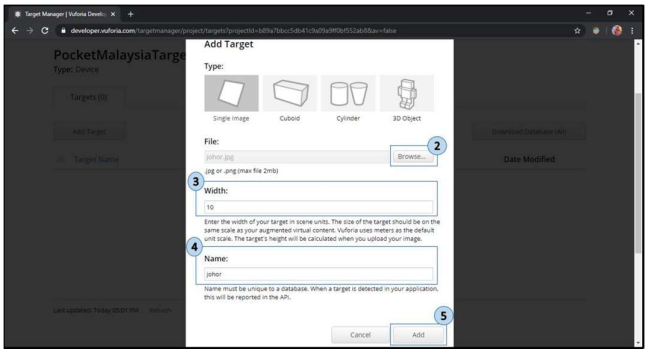

Figure 10. View of Add Target Section

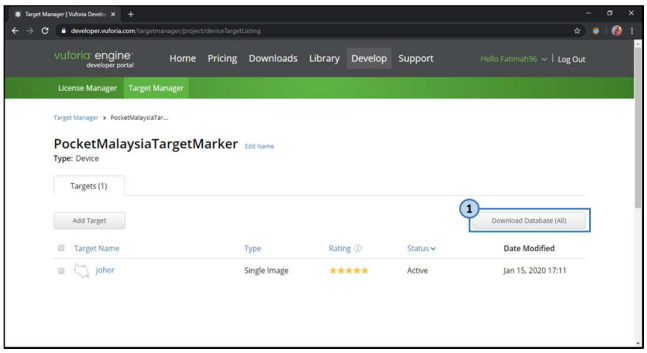

Figure 11. View of Target Marker and the Download Database Button in Database

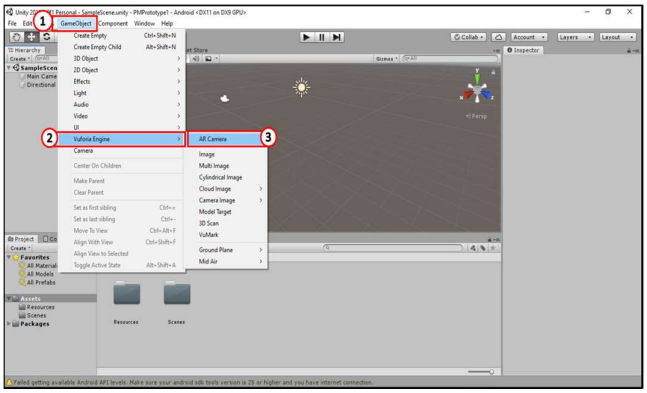

Figure 12. Steps on Creating AR Camera

After creating the AR camera, the main camera can be deleted. Researcher then imported the database that had been downloaded from Vuforia into Unity. To do this, researcher clicked on the assets button. Then, researcher clicked on import package and custom package to import the database. Figure 13 shows the process to import database into the unity.

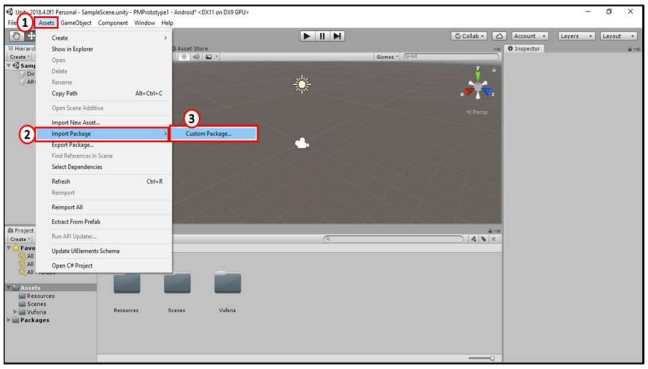

Figure 13. Steps on Importing Database into Unity

After importing database, researcher created the base to hold the AR marker. The base called as Image Target in unity. To do the base, researcher clicked on game object button. Then, researcher clicked on Vuforia Engine and image. The steps as in Figure 14.

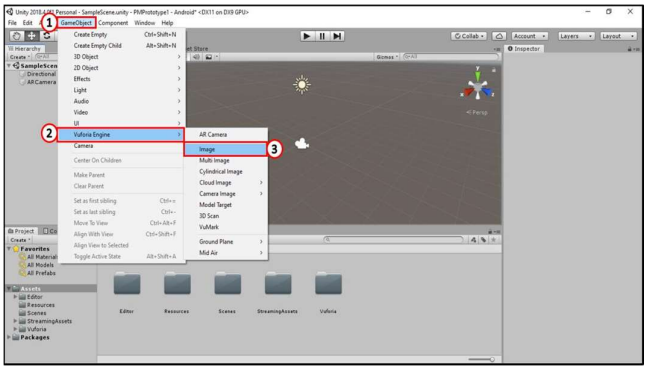

Figure 14. Steps on Creating Image

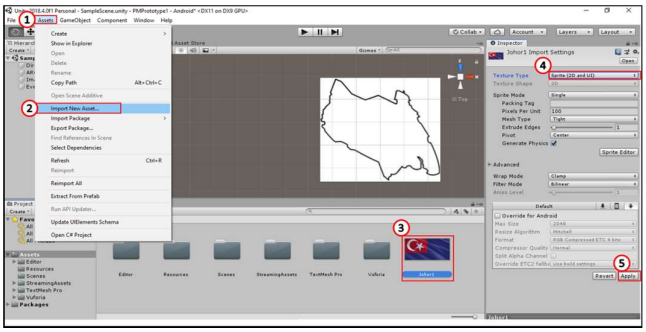

Figure 15. Steps on Importing Assets into Unity and Changing Image Texture

Researcher then added 2D object such as flag image as the AR objects. Firstly, researcher needed to import the image of Johor flag. To do this, researcher clicked on Assets and selected Import Asset to import the image into Unity. After importing the image, the type of texture of the image needed to

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change to Sprite. To do this, researcher must clicked on the flag image. Then, changed the image texture in Texture Type and clicked on the Apply button to finish the process. The steps as in Figure 15.

After that, researcher need to create Image under Image Target to contain the flag image. To do this, researcher right-clicked on image target, selected ui and selected image. Next, researcher clicked on image and drag the flag image into the source image box. The steps can be seen in Figure 16.

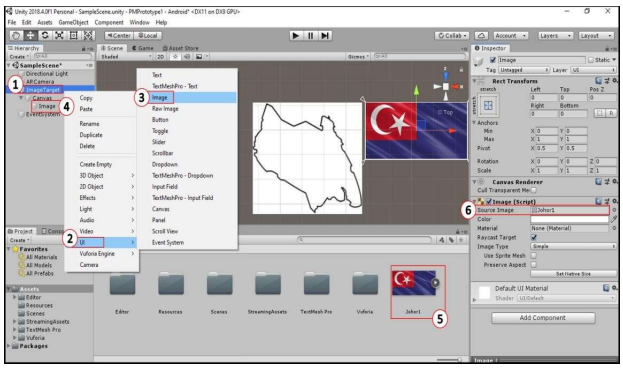

Figure 16. Steps on Creating Image and Inserting Flag Image in Image

3.4.4. Customer Evaluation

The system then presented to the client. Client will recognise its strength and weaknesses as well as adding or removing any unwanted requirements in the prototype. These comments and suggestion will be collected to improve the prototype. This prototype will keep modifying until the client satisfied with the prototype.

The first prototype was presented to supervisor. In this phase, the supervisor acted as the client. The feedbacks received were the size of AR marker for Perlis, Pulau Pinang and Melaka state were too small. The supervisor advised to make them a little bit bigger. Besides that, the first prototype fail to detect some markers. This is due to the size of marker itself which is small made it cannot be detected by the camera. The other reason was the black line surrounding over the marker is thin and blur when printed on the A4 paper made the prototype taking longer time to detect. Thus, supervisor advised to make the line surrounding over the markers thicker. Supervisor also suggested adding simple note regarding to each state in Malaysia and information about the application.

3.4.5. Review and Updation

In this stage, the new requirements are gathered and analysed to improve the existed prototype. The requirements of the application were refined based on the feedbacks given from the supervisor during the user evaluation phase.

3.4.6. Design

The GUI of the prototype were not changing and researcher still using the same Malaysia map as the AR marker.

3.4.7. Prototyping for Second Prototype

The first prototype was improvised. The AR marker as shown in Figure 17 was fixed using Adobe Photoshop. The line surrounding over the markers were made thicker and the size of the markers were made tofit the A4 paper vertically. Thus, making the size of Perlis, Pulau Pinang and Melaka a little bit bigger than before. Researcher made all markers become white except for the line surrounding over the markers which is still black in colour. This is because researcher found out that markers in black and white colour were getting higher rating from Vuforia, which makes the camera detect the marker easily than markers in colour. All markers got four or five rating from Vuforia except for Perlis marker that got only one rating even though the marker was improvised. Besides that, additional information about the states also was added to the Scan scene as well as developing new interface called as notes interface and help interface. As a result, second prototype was completed

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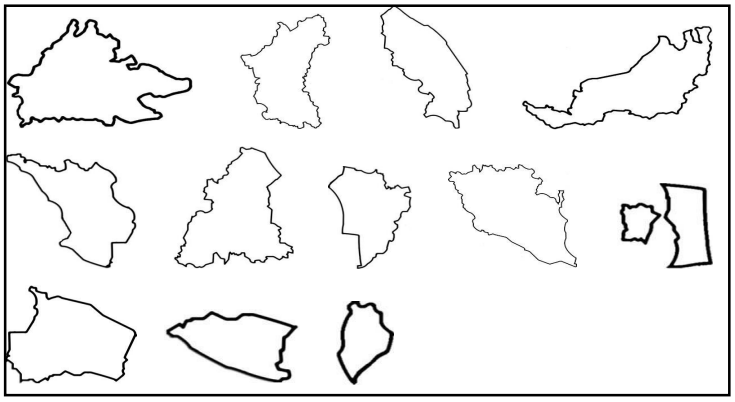


Figure 17. AR Marker that Been Improvised

3.4.8. Costumer Evaluation

The supervisor satisfied with the second prototype. All navigation buttons are functioning and the flow of all interfaces were correctly navigated. The information also displayed on the phone screen when marker was scanning by the camera. However, Perlis, Melaka and Negeri Sembilan marker cannot be detected. This is maybe due to its size as when researcher scanned the marker in the laptop which has bigger size than the print one, the camera managed to detect the marker even though it took times to adjust the position of the camera from the marker.

3.4.9. Development

As the supervisor satisfied with the second prototype, it was acknowledge as the complete application. The application then was published into APK file to be installed in Android mobile phone. The GUI of the complete application can be seen as in Table 3.

3.4.10. Testing

Researcher tested the functionality of the application. The reasons were to examine whether the application can run its programme after user touching on the application icon, to make sure that the navigation buttons in the application were functioning, to check whether the correct interface is display or not, to check whether the camera can detect the AR marker, to make sure the information were display after scanning the AR marker, and to make sure the application can stop running when user selects Quit button. Besides that, researcher also tested the usability of the application with Geography students of UPSI. The purpose of this testing were to gain data about the user interfaces, learning contents, usage of font and its colour and user understanding on how to use the application. They need to answer a questionnaire based on Likert Scale consists of strongly disagree, disagree, undecided, agree and strongly disagree.

3.4.11. Maintenance

Maintenance will happen when the application released to the public.

4. Result

4.1. Result Finding for Respondent Background by Gender and Semester

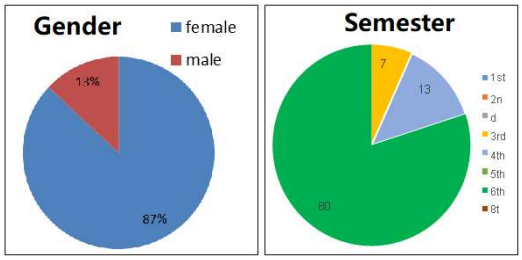
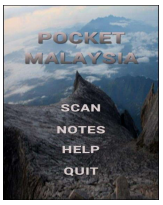
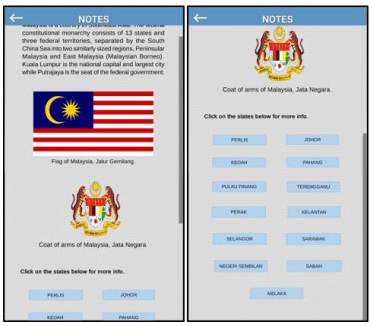


Figure 18. Respondent Background Based on Gender and Semester

Table 3. The GUI of Pocket Malaysia Application

Name of Interface	User Interface	Description
Main Menu		This is Main Menu interface of Pocket Malaysia application. There are four buttons in this interface. They are Scan, Notes, Help and Quit buton.
Scan: Scan interface before scanning marker:		This is Scan interface. There is only one button in this interface, which is Go Back button. To scan the AR marker, user can place the AR marker in front of the camera.
Scan: Scan interface after scanning marker.		This is an example of Scan interface after scanning Perak AR marker. After camera scanning the marker, the image of flag and information about the marker will be display on the screen.
Notes: Notes interface about Malaysia		This is the first interface in Notes. User can view information about Malaysia in this interface. This interface also contains buttons of 13 states in Malaysia. To see the buttons, user need to scroll down the screen.
Example of Notes interface about Perak		This is an example of Notes interface about Perak. In this interface, user can display the information of Perak. The Go Back button in this interface will take user back to the previous Notes interface.
HELP		In this interface, there is guidance for user on how to scan the AR marker and how to display notes in the Notes interface.

Based on Figure 18, the number of female respondent is higher than male respondent with 87% were female while 13% were male. All respondent are students in UPSI who is taking Geography course**.** It can be seen from Figure 18 that most respondent were student from seventh semester with 80% following by student from fifth semester with 13% and student from fourth semester with 7%.

4.2. Result for Usability of Application

To evaluate the usability of the application, all respondents were compulsory to answer all eight questions in the questionnaire.

- 53.3% of eight respondents agree that the interface is interesting
- 40% agree and 33.3% strongly agree that the interface of scan part after scanning the map is interesting. 66.7% agree and four respondents with 26.7% strongly agree that the font size and colour used in the application is suitable.
- 60% agree and 26.7% strongly agree that the 2D objects displayed on the screen phone are clear and understandable. Table 8. shows result finding for the words in the application are easy to read.
- 60% and 26.7% are agree and strongly agree that the words displayed in the application are easy to read.
- 46.7% chose agree and 46.7% strongly agree that the function of navigation buttons in the application can be used well
- 66.7% understand the flow of the application from one page to another page easily following by
- 53.3% agree that the learning contents in the application are satisfied enough.

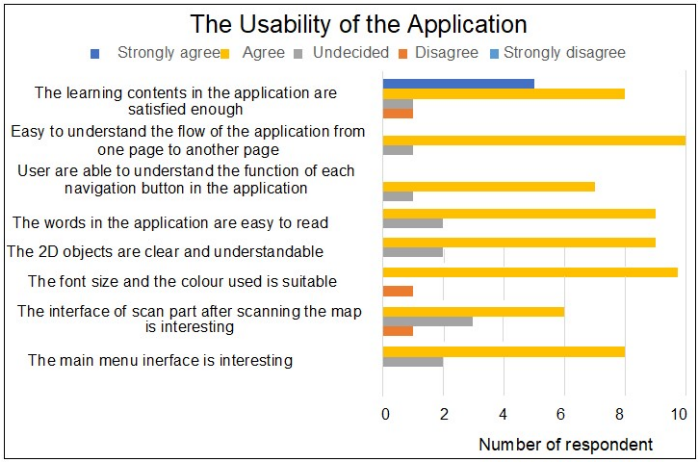


Figure 20. The Usability of the Application

5. Conclusions

From the survey, it can be seen that the application is easy to use. This is because most of the respondents agree that it is easy to understand the flow of the application from one page to another page and they were able to understand the function ofeach navigation buttons in the application. Research objectives of this project has been achieved. To develop Pocket Malaysia application, researcher analysed the topics that are in Form One Geography textbook and its DSKP first. This is to make sure that the application that is going to develop is relevant with education nowadays and it is suitable to be applied with the AR technology. Based on the analysis, researcher then developed an AR application called as Pocket Malaysia with contents of Form One Geography. During development, researcher used Prototype model to develop the application. Pocket Malaysia then is tested with 15 students Geography course in UPSI. The testing is about usability of the application.

The information from text and flag image to visualize contents on the map need to be changed. For example, when user scans the AR marker, a visual of rivers and mountains in the state can be seen from

the phone screen along with their names. By doing this, user can learn about the location of rivers and mountains instead of their names only.

Overall, Pocket Malaysia is a good starting point for Geography subject in secondary school. This is because not many AR applications today are focusing on Geography subject. Researcher tend to hear more on solar system, human anatomy and biology. Furthermore, this application based on Form One Geography subject in Malaysia. Based on my observation reading the textbook, students are exposed with many examples of Geography landscape in Malaysia. This is indeed a good way to let students know about their own country besides teaching them matters related to Geography itself. Hence, making researcher developed an application based on augmented reality technology so that learning can be more exciting and meaningful, not only for student but for teacher too.

In addition, the application itself is not hard to use. Based on the survey, many agree that it is easy to use although there is unclear instruction in scan section. The GUI also is quite pleasant along with the font size and colour selection. In general, it is successfully developed as it gave out the expected outcome. The weakness of this application should be improved in the future.

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