

**MOBILE-AUGMENTED REALITY FRAMEWORK  
FOR STUDENT SELF-CENTRED LEARNING IN  
HIGHER LEARNING EDUCATION**



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**UMMS**  
UNIVERSITI MALAYSIA SABAH

**FACULTY OF COMPUTING AND  
INFORMATICS  
UNIVERSITI MALAYSIA SABAH  
2018**

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HIGHER LEARNING EDUCATION**

**AARON FREDERICK BULAGANG**



**THIS IS SUBMITTED IN FULFILLMENT FOR  
THE DEGREE OF MASTER OF SCIENCE**

**FACULTY OF COMPUTING AND  
INFORMATICS  
UNIVERSITI MALAYSIA SABAH  
2018**

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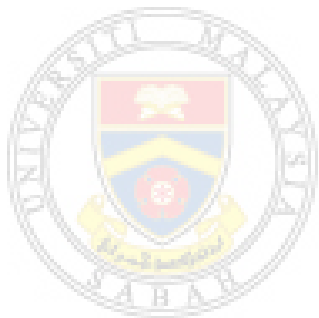
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## CERTIFICATION

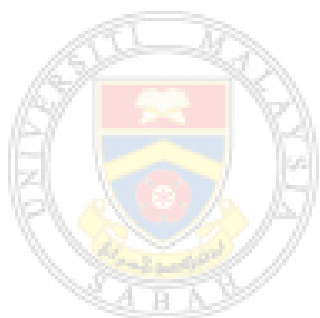
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Aaron Frederick Bulangang  
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## ABSTRACT

Mobile learning has contributed significantly in the field of higher learning education (HLE) in Malaysia since its emergence. Mobile learning is an educational system which uses portable or wireless devices for learning purposes. As technology evolved over the decades, mobile learning concept was introduced. It was originated and developed from e-learning. Augmented reality or well-known as AR combines real environment with virtual object that users can interact. Mobile-Augmented Reality can be applied in education with the use of mobile devices such as smartphones and tablets which support AR. Application of mobile-Augmented Reality in education helps to attract the interest of students during learning sessions. The existing problems with mobile learning application are the visualization and content presentation, which may not be appealing for students as it is mostly text-based. Moreover, the user interface of mobile learning may not be adaptable for an inexperienced user and the available frameworks for mobile-Augmented Reality is still limited. The aim of this research is to propose a framework for developing a mobile-Augmented Reality application in higher learning education to support the development for various courses offered at higher learning education in Malaysia. Thus, increasing the student motivation towards learning by using AR. The objective of this research is to develop an mAR application for Networking Fundamental course with visualization tool. The next step is to evaluate the relationships of Satisfaction, Motivation, Self-Efficacy and Features towards Effectiveness to find its significance through empirical testing. Then Designing a framework for developing an mobile-Augmented Reality application for learning. Methods that were used in this research are quantitative method using questionnaire that were distributed to the participants at five universities and analyzing the data using SPSS and SmartPLS to produce results to find significant relationship. From the result, it was found that mAR had two significant relationship between Self-Efficacy and Motivation towards Effectiveness. Which means that these are the two fields that future researchers and developers should focus to increase the learning outcome of students.

## **ABSTRAK**

### **RANGKA KERJA UNTUK PEMBANGUNAN APLIKASI PEMBELAJARAN MUDAH ALIH DENGAN MOBILE-AUGMENTED REALITY DALAM PENDIDIKAN PELAJARAN TINGGI**

*Pembelajaran mudah alih telah digunakan dengan berkesan kepada pelajar pengajian tinggi di Malaysia sejak ia diimplementasikan. Pembelajaran mudah alih merupakan proses pembelajaran dengan menggunakan alat mudah alih seperti telefon pintar. Dengan perkembangan teknologi, konsep pembelajaran mudah alih diperkenalkan dengan e-learning. Augmented Reality atau Realiti Tambahan atau lebih dikenali sebagai AR menggabungkan persekitaran realiti dengan objek virtual di mana pengguna dapat berinteraksi dengan objek virtual. Menggunakan peralatan mudah alih seperti telefon pintar dan tablet, penggunaan aplikasi AR dapat disokong untuk pelajar menggunakan dalam pembelajaran. Penggunaan AR mudah alih (mAR) dalam pendidikan dapat menarik perhatian para pelajar dalam sesi pembelajaran. Masalah utama yang dihadapi dengan "M-learning" adalah visualisasi dan kandungan, di mana ia tidak dapat menarik perhatian pelajar kerana format penyampaian adalah lebih kepada teks. Seterusnya adalah antaramuka pengguna untuk "M-learning" tidak boleh diadaptasi oleh pengguna yang tidak berpengalaman mengguna telefon pintar dan rangka kerja bagi pembangunan aplikasi mAR masih terhad. Objektif penyelidikan ini adalah untuk mencadangkan sebuah rangka kerja bagi pembangunan aplikasi mAR untuk kursus yang ditawarkan dalam institut pengajian tinggi di Malaysia. Motivasi pelajar juga dapat ditingkatkan melalui pembelajaran dengan AR. Kaedah yang digunakan untuk penyelidikan ini adalah kaedah kuantitatif dengan menggunakan soal selidik yang diberi kepada pelajar semasa pengumpulan maklumat di lima universiti. Maklumat tersebut kemudian di analisis menggunakan SPSS dan SmartPLS untuk mengeluarkan keputusan bagi mencari hubungan yang penting. Hasil penyelidikan ini mendapati bahawa terdapat dua hubungan penting iaitu "Self-Efficacy" dan "Motivation" terhadap "Effectiveness". Ini bermakna penyelidik dan pembangun aplikasi harus memberi perhatian kepada dua hubungan tersebut untuk meningkatkan pembelajaran yang lebih efektif kepada pelajar.*

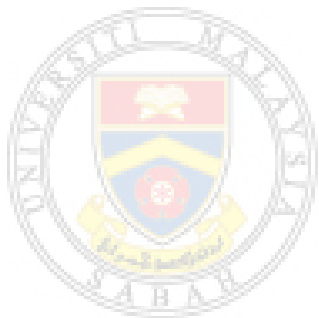


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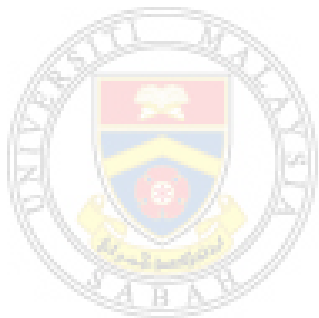
## LIST OF ABBREVIATIONS

3D	-	3-Dimension
AR	-	Augmented Reality
AVE	-	Average Variance Extracted
CR	-	Composite Reliability
E-Learning	-	Electronic-Learning
GPS	-	Global Positioning Satellite
M-Learning	-	Mobile-Learning
mAR	-	mobile-Augmented Reality
MSU	-	Management and Science University
OSI	-	Open System Interconnect
SmartPLS	-	Smart Partial Least Square
SPSS	-	Statistical Package for the Social Sciences
UI	-	User Interface
UiTM	-	Universiti Teknologi Mara
UMS	-	Universiti Malaysia Sabah
UPNM	-	Universiti Pertahanan Negara Malaysia
UTeM	-	Universiti Teknikal Melaka
VLE	-	Virtual Learning Environment

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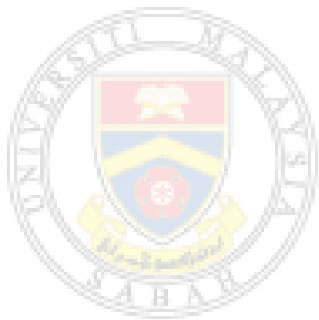
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# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

The use of Mobile-learning (M-learning) in higher learning education has contributed to the effectiveness of its implementation at various higher learning education in Malaysia. M-learning is defined as the use of mobile or wireless devices for the purpose of learning while on the move. The concept of M-learning starts from e-learning and distance learning revolution of the 18<sup>th</sup> and 19<sup>th</sup> century. Mobile devices allow students to extend their academic knowledge through emails, portals, e-library, internet-based information and group projects, thus, aiding them during the time they are studying. Mobile devices vary from laptop, smartphones and tablets which majority of student have access with affordable price while having an acceptable computing power for learning. However, the use of mobile device for educational purposes is still low if compared to entertainment activities on smartphone such as social media, consuming videos, music or playing games (Clayton et al., 2016). Which is why AR is part of this research, to gain more interest from students towards learning through their mobile devices. AR is a combination of technologies that enable real-time mixing of computer-generated content with live video display. AR helps in better visualizing 3D objects through the screen of mobile device and enable user to interact with touch screen capabilities. M-learning will have strongly impact on Malaysian higher education as more student nowadays have access to smartphone and rely on it to communicate with their lecturers and other students. It is evidenced with the increase in research activities and initiatives in the area of M-learning, particularly in the public and private higher learning education. Thus, the need for a proper framework to guide developers in creating an application that will help students. This research will focus

on three problems of M-learning: visualization, user interface and framework. This framework includes the learning theory and also interactivity and evaluation of constructivism theory. In this research, students from various higher learning education in Malaysia will be participating the data collection phase. The expected outcome of this research is to build a proven framework to develop a M-learning application with AR that can be used by multiple higher learning education in Malaysia.

## **1.2 Research Background**

The concept of M-Learning begins from e-learning and distance learning revolution on 18th and 19th Century. Mobile revolution of the late 1990s has changed the distance student from a citizen who chooses not to go to campus, instead moving at a distance from the campus. The term mobile is the same as mobile phones where it is a device that has ubiquitous features that can carry to any places and with internet connection. Consistently, with the development of mobile technology, mobile phone has improved tremendously and it is considered as a new organ in the evolutionary of time line since directly integrates with the brain.

This research explores the problems of M-learning at the institute of higher learning in Malaysia. Education in Malaysia has gone through a dramatic changes and development which lead to transformation of Malaysia into an education hub especially in South East region (Grapragasem et al., 2014). In addition, Grapragasem et al. (2014) stated that Malaysian government had taken considerable move in developing education industry as education is essential in contributing into national GDP and also development in human capital. This research is also in support for University Industry 4.0 where AR is one of the nine pillars of the Industrial Revolution 4.0 to use the skill of academicians to change the industry with new and emerging technologies (Lavanya et al., 2017).

The latest technology advancement had significantly influenced the usability of mobile devices as a communication tool in the current world (Tajuddin et al., 2013). There was a prediction shows that the latest learning trend is the mobile-

based education stated by Gary et al. (2011). Smart phone, personal digital assistant (PDA), tablet PC are built-in with applications that enable connectivity (Tajuddin et al., 2013).

Mobile devices innovation enables students to access educational email, portal, library assistant, internet-based information and teamwork projects according to Lee (2011). Mobile devices aid in access to information in the class without time-limit or boundaries (Akour, 2009). Samsiah and Azidah (2012) claimed that M-learning is developed from electronic learning so it is essential to suit the learning style into new generation's capabilities and experience.

M-learning use mobile or wireless devices for the purpose of learning mobility. The devices used for M-learning are cell phones, smart phones, palmtops, and handheld computers; tablet PCs, laptops, and personal media players which fall within this scope (Park, 2014). M-learning through AR is an effective way to enhance learning experience among user interface through the concept of visualization. The AR features are visualized learning content that enable user to possess focus and interesting to learn during the learning process (Yusoff and Sunar 2014). AR allows the user to see the real world, with virtual object superimposed upon or composite with the real world.

M-learning system through AR, can appeal to students at a more personnel level, and promoting both engagement and motivation among its user. AR was applied in education to make the learning process more interactive and reliable. The features of M-learning through AR are mostly interactive, blended with real environment, ubiquitous and portable. Currently, the AR application on mobile is divided into two types; indoor and outdoor environments. AR was designed for educational purpose based on some aspects that are proposed by where there are three AR aspects for educational purposes.

Some of the benefit of utilizing AR in M-learning are:

- i. AR enhances the learning experiences by using 3D synthetic objects for students view the object in front of their eye through mobile interfaces; the 3D object manipulation making the interaction claimed by Barih and Abbas (2015).
- ii. Student can use Smartphone or tablet in AR to interact with the object; it can gain knowledge in handling the new devices among student according to Nincarean et al. (2013).
- iii. Designing of AR in educational purpose offer affordances of presence, immediacy and immersion by providing mediated space that give student a sense of being in a place with others stated (Wu 2009).

Mobile phones had been used widely by users of all generations from old to young, they use their phones to play games, search for information, social media, to read the news. With AR, the learning experience can be enhance with the use of smartphone with added information and new ways to interact during the learning process that can be a learning tool for all ages, but in order to do so, it must be effective, developed and implemented properly said Ally. (2013).

### **1.3 Problem Statement**

Problem faced in mobile learning are:

- **Difficulties in Visualizing Learning Materials**

Difficulties in visualizing learning materials is one of the problems that motivated the research for developing a M-learning application is that students have difficulties in understanding what they are learning. In Saidin (2015), a research about student understanding toward a science subject found that 74% students were unable to answer the test given. Current M-learning system are lacking of interactivity in term of learning content causes student's lack of focus and memorable (Yusoff et al., 2014). This maybe due

to the lack of interactivity such as 3D object, interaction and more features within the application.

- **Current M-learning User Interface Are Complicated**

Complicated user interface can demotivate the user from using the application because user interface is important for user to interact with in every mobile application, it determines the level of usability of the application itself, a good user interface allows the user to use the application with ease even though they are not familiar with it. Non-technical student may have disadvantage in using the application as it required them an additional learning curve stated Corbeil and Valdes-Corbeil (2007). Due to the limited screen size of a smartphone if compared to a tablet or a laptop, the content of the M-learning application must be focused to be effective. For example, an e-learning application cannot simply be adapted to M-learning; developer must utilize the smartphone screen without leaving important material. In order for the application to be accepted by wider audience, it has to be robust and in high quality by Ali et al., (2014). If the application is not optimized to fit the smartphone screen, it may be difficult for the user to navigate through the application.

- **Limited Framework for Developing mobile-Augmented Reality Application**

Framework for developing a mAR based application for higher learning is still limited at this point at time. Although there are several M-learning framework, a specific framework for mAR application still lacks which makes it difficult for developer to focus in what aspects should they develop. As discussed by Masrom et al. (2016) states that a framework is important to design a M-learning application especially for developers for them to use as a guide to develop an effective M-learning application. The application must then be evaluated by students and educator to verify the application is effective especially towards students. One of the gap identified by Cochrane (2012) in M-learning is that there is no clear pedagogical theory when designing a M-learning and the evaluation for M-learning is still limited.

#### **1.4 Research Questions**

- i. Does the user interface of mAR application ease the student in navigating through the application?
- ii. Does mAR application help student in visualizing their studying materials?
- iii. Does the current framework help in assisting developer in developing the application?

#### **1.5 Research Objective**

Three objective were identified to solve the problem statement are as follows:

- i. To develop an mAR application for Networking Fundamental course as a visualization learning tools using Unity, Blender and Vuforia.
- ii. To evaluate the relationship of Satisfaction, Self-Efficacy, Motivation and Features towards Effectiveness using empirical testing
- iii. To design a framework for developing an mobile-Augmented Reality application based on evaluated attribute result through PLS SEM method.

#### **1.6 Research Scope**

##### **1.6.1 Development**

The development of the NetmAR (Network Fundmanteal mobile-Augmented Reality) application was developed using blender for 3D modelling, Vuforia for AR features and Unity to design the user interface and compilation. The application was developed specifically for Android platform as it has the higher user among student.

##### **1.6.2 Participants**

The participants are from higher education institutions in Malaysia, Five universities that offer Computer Science course with Networking subject were chosen. 30 students who already taken or is currently taken Network Fundamental subject were selected as participants to take part in pre-test,

learning session, post-test, and answering a questionnaire. They will be grouped in three following the control groups which are Traditional, Non-mAR and mAR groups.

### **1.6.3 Data Collection**

During the data collection, using the questionnaire, students are asked about their Satisfaction, Self-Efficacy, Motivation and Features towards Effectiveness based on their group. The data is then entered into SPSS for normalization, and further analysed using SmartPLS3 to find relationship that are significant to produce a framework based on the result retrieve in SmartPLS3 analysis to develop an mAR application.

## **1.7 Organization of the Report**

Chapter 1 is the introduction of the research where the chapter will explain briefly about the introduction, research background, problem statement, research questions and research objectives of the research.

Chapter 2 contains the literature review of the research. This chapter explains the existing research that has been done on M-learning as well as mAR application for higher learning education on the problems faced by researchers, solution to the problem and future works. The existing research discussed about the usage of mobile device in higher learning education, problem with student understanding the subject due to lack of visualization, difficult user interface that may deter student to use the application for long term and the lack of mAR framework for developing application for higher learning education.

Chapter 3 will discuss about the methodology to be use in this research, this research has five phases which includes, Identify conceptual features, Identify technical requirement, Prototype development, Pilot testing, Final testing and Data collection. Two application were developed, one without the use of mAR, and the other with the use of mAR. Five universities were selected for the final testing and data collection where 30 students from each university are selected to participate.