THE EFFECT OF COLLABORATIVE MOBILE AUGMENTED REALITY
APPLICATION ON STUDENT'S LEARNING PERFORMANCE

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ABSTRACT

The objective of this study is to develop and test the effect of a mobile learning application, called Collaborative Mobile Augmented Reality Learning Application (CoMARLA), on student learning achievement and motivation in learning the Information Technology course. The development of CoMARLA is based on a framework guided by Moshman's constructivist learning principles and Keller's motivation principles. This study was based on a quantitative approach using a quasi-experimental method that employed a 2 by 2 factorial research design. The independent variable was the learning method and the dependant variables were students' learning achievement and motivation, with gender as the moderator variable. The sample of the study consisted of 120 social science undergraduates, with a mean age of 19.5 years, who were divided into an experimental and a control group. The experimental group received treatment with the use of CoMARLA on the mobile platform, while the control group received the same treatment with the use of similar application on the desktop platform. The research instruments used were a set of multiple-choice test and Intrinsic Motivation Inventory to measure students' learning achievements and motivation, respectively. A series of tests based on the independence t-test and Analysis of Covariance (ANCOVA) were performed on the data. The findings showed the students' learning achievements and motivation after treatment were significantly higher than they were before treatment. The same findings showed the experimental group's learning achievement and motivation after treatment were significantly higher than those of the control group. In addition, male participants' learning achievement was significantly higher than that of female participants. However, no significant difference in motivation between the two genders was observed. Overall, the findings suggest that such a novel mobile learning application can be used to help improve the learning achievement and motivation of social science undergraduates in learning Information Technology course.

KESAN PENGGUNAAN APLIKASI 'COLLABORATIVE MOBILE AUGMENTED REALITY' TERHADAP PENCAPAIAN PEMBELAJARAN PELAJAR

Abstrak

Objektif kajian ini adalah untuk membina dan menguji kesan penggunaan satu aplikasi pembelajaran yang dinamakan sebagai "Collaborative Mobile Augmented Reality (CoMARLA)" dalam pembelajaran subjek Teknologi Maklumat. Rangka kerja pembangunan CoMARLA adalah berpandukan kepada prinsip-prinsip pembelajaran konstruktivis Moshman dan motivasi Keller. Kajian ini menggunakan pendekatan kuantitatif dengan reka bentuk faktorial 2x2 kuasi-eksperimental ujian pra dan pos. Pembolehubah kajian adalah terdiri daripada pembolehubah bebas iaitu dua mod pembelajaran, pembolehubah bersandar iaitu pencapaian pelajar dan motivasi, dan jantina sebagai pembolehubah moderator. Sampel kajian melibatkan 120 orang pelajar sains sosial dengan purata umur 19.5 tahun yang telah dibahagikan kepada kumpulan eksperimen dan kumpulan kawalan. Kumpulan eksperimen menerima rawatan dengan aplikasi CoMARLA manakala kumpulan kawalan menggunakan kaedah konvensional dalam mempelajari topik Unit Sistem Komputer. Instrumen yang digunakan dalam kajian ini adalah set ujian aneka pilihan dan Inventori Motivasi Intrinsik. Data kajian dianalisis dengan sampel bebas ujian t dan Analisis Kovarians. Dapatan kajian menunjukkan terdapat perbezaan yang signifikan bagi pencapaian dan motivasi bagi pelajar yang mengikuti rawatan dengan aplikasi CoMARLA. Dapatan kajian juga menunjukkan pelajar dalam kumpulan yang menerima rawatan dengan aplikasi CoMARLA adalah signifikan lebih baik berbanding dengan pelajar dalam kumpulan kawalan. Seterusnya, hasil kajian tidak menunjukkan perbezaan yang signifikan bagi aspek motivasi antara kumpulan rawatan dan kumpulan kawalan. Namun begitu, wujud perbezaan yang signifikan bagi aspek motivasi antara jantina bagi kumpulan pelajar yang mengikuti pembelajaran dengan CoMARLA. Implikasi kajian ini dapat dirumuskan bahawa aplikasi CoMARLA berpotensi untuk digunakan secara meluas dalam pembelajaran bidang Teknologi Maklumat.

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3D	Three Dimensional
ANCOVA	Analysis of Covariance
AR	Augmented Reality
CoMARLA	Collaborative Mobile Augmented Learning Application
ICT	Information and communications technology
MANCOVA	Multiple Analysis of Covariance
MAR	Mobile Augmented Reality
MKO	More Knowledgeable Other
UPSI	Universiti Pendidikan Sultan Idris
UTAUT	User Acceptance and Use of Technology
ZPD	Zone of Proximal Development
GLM	General Linear Model
MSC	Multimedia Super Corridor
MOE	Ministry of Education
MP3	MPEG-1 Audio Layer-3

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CHAPTER 1

INTRODUCTION

1.1 The Background of the Study

At the dawn of the new millennium, the world has been witnessing a myriad of transformations or changes, affecting every sphere of the human's life across the globe. Naturally, these changes have reshaped the educational, political, and social landscapes, exposing humans to new challenges. One thing is for sure, the human's life is now more dependent on Information and Communications Technology (ICT), especially computer technology, which helps nations to move forward with greater

ease and efficiency. Undisputedly, the use of ICT has literally swamped the human's life – in fact, it has become totally indispensable (Thomas & Watters, 2015). For example, design engineers will rely on specialized equipment, notably ICT-based hardware and software, to analyse the mechanical properties and dynamics of components in their designs. Likewise, environmental scientists will use an array of ICT systems to gather and analyse a huge amount of environmental data before making precise predictions or forecasts. More importantly, those involved in teaching, such as lecturers, instructors, and teachers, have become more and more dependent on novel, innovative learning tools and materials (which are invariably based on digital technology) to improve their tasks (Zylka *et al*., 2015). Given the imperative to stay abreast with this kind of technologies, it is not surprising that many nations have begun putting in every resource available to improve the ICT *Competency* of their populace, as only through such competency can the nations move forward in this challenging time. In some nations, the efforts to educate the masses with an ICT start at the preschool level, such as Greece and China (Liu *et al*., 2014).

In recognition of the need to educate and equip its general masses with this technology, Malaysia has introduced and implemented a series of initiatives to make Malaysians ICT literates. Among those, the *Multimedia Super Corridor* (MSC) represents the pinnacle of Malaysia's efforts to help produce a vast pool of knowledge workers to spur its economic growth. More importantly, the MSC program was launched to catapult Malaysia to an industrialised nation by 2020, the year that will see Malaysia as a high-income nation. Undisputedly, Malaysia is hard-pressed to achieve this ambitious goal as the number of engineers, scientists, computer experts,

and IT specialists will be extremely huge, thus entailing a concerted effort to produce such a workforce. As it stands now, Malaysia is still short of meeting the required number of ICT professionals as evidenced by the high recruitment of foreign ICT experts, programmers, and analysts, especially from India (Gopinathan & Raman, 2015).

Taking cognizance of such predicament, the Malaysian government, through its Ministry of Education (MOE), has revamped its educational policy by introducing important changes to its primary, secondary, and tertiary educational curricula and academic programs (Hanapi & Nordin, 2014). For example, all primary school pupils will now have to learned the basic of ICT, starting from Year Four to Year Six, totalling three years of learning the subject matter (Barghi *et al.*, 2017). For the secondary schools, the subject *ICT Literacy* serves an elective subject by which the secondary school students can learn at the lower secondary level, namely at the Form 2 and Form 3 levels involving 14-year-old and 15-year-old pupils, respectively. In addition, students can also learn *Programming* and *Multimedia Production* subjects at the middle, secondary level, namely at Form 4 and Form 5 consisting of 16-year-old and 17-year-old pupils, respectively (Kassim *et al*., 2014). At the tertiary level, many Malaysian public universities mandate their "non-technical" and "non-ICT" fresh undergraduates to take of the university compulsory course, notably *ICT Competency* (Arokiasamy *et al.*, 2014). Only when students are equipped with the knowledge and skills in ICT can they learn more efficaciously as today's learning realm is characterized by the use of digital contents and delivery. Devoid of such ability can render students ineffective or demotivated in their pursuit of academic excellence, be it as the primary or tertiary levels (Hussein & Kabai, 2015).

In carrying out the above reforms, many problems have emerged besetting the smooth transitions from old teaching and learning practices to new ones. Such problems encompass a wide range of technical, logistical, managerial, and financial issues. Such issues have become a focal point in many studies in Malaysia of late. In terms of academic achievement, studies have shown that the secondary school pupils' learning performance in the *ICT Literacy* subject is just average, especially among those from sub-urban and rural communities compared to those living in big cities and affluent neighbourhood (Sua, 2012). Undeniably, the latter represents students who are economically disadvantaged, depriving them the necessary supports to help learn effectively (To, 2016).

Another problem seems to stem from the schools' policy with regard to the

prioritization of subjects. Being an elective subject, *ICT Literacy* is deemed less important by many school administrators, which has resulted in less financial and logistical support. As a consequence, the subject matter is being taught in less favourable condition, as typified by poorly maintained computer laboratories and inadequate teaching and learning aids (Thomas & Watters, 2015). Without the necessary redress, the situation has made the teaching and learning process stale, lacking the vitality to make students motivated and engaged in learning the subject matter (Fini *et al.*, 2010). Ultimately, their learning efficacy suffers, with many of the students failing to attain high grades in their assessments. The importance of motivation in learning should never be downplayed as many studies have endow its positive impact on learning efficacy (Yilmaz, 2017). In general, students with high motivation tend to invest in more effort to achieve the learning goals, and they will be

more persistent, and not easily defeated, when face challenging tasks (Bindewald & Atallah, 2017).

Another disturbing trend is that male students tend to outperform their female counterparts in learning the subject matter (Michalak *et al.*, 2017). These finding run parallel with other findings of research focussing on the learning achievements of technical and science-related subjects among secondary school pupils or middle-graders (Markovits & Benenson, 2010). The former's superiority may be attributed to their advanced computing experience, particularly in video games or computer games, thus giving them a comfortable lead (Kinsler, 2013; Tomai *et al.*, 2014). Consequently, boys will also develop a strong inclination to learn any subjects that require extensive use of computers. In all likelihood, male students will also develop strong motivation in learning this subject compared to female students (Hedges & Nowell, 1995).

Currently, in majority of the schools nationwide, the time allocated for the teaching of the subject matter is notoriously paltry. Thus, many teachers are compelled to rush to assure they could complete the school curriculum on time (Alhija, 2016). In such learning scenario, students will be short-changed of quality and meaningful learning experience. Obviously, this is not the fault of teachers, but rather the existing teaching constraints that preclude such learning opportunities (Rodríguez *et al.*, 2016). This type of situation also prevents students to work in the classroom, and they are forced to take home their assignments, but completing such

tasks is quite impossible as many students do not have the right platform to collaborate (Nincarean *et al*., 2013; Ngang *et al*., 2014; Stanisavljević-Petrović *et al*., 2015).

A vast majority of schools in Malaysia is not equipped with the right teaching and learning platform to help students complete their assignments, tasks, or reports. Thus, a new and an affordable learning platform is entailed to provide students the learning space in which learning materials and communication tools can be used for their learning benefits (Ghani *et al.*, 2014). In fact, collaborative learning has become commonplace in many developed nations given its many learning benefits, such as enhanced reasoning, better social interaction, and increased motivation.

Fascination with technology has always been a driving force for people to improve their productivity. Especially in teaching, technology has always been at the forefront in many learning reforms or transformations. Its importance to facilitate and support the teaching and learning process has become more and more critical in today's learning realm as the focus of education nowadays to provide sufficient and meaningful learning opportunities to every student. In this regard, many new learning concepts, such a technology-enhanced learning, computer-mediated learning, web-based learning, e-learning, multimedia learning, and m-learning, among others, have been introduced with some degree of success (Blömeke *et al.*, 2012). In addition, teaching materials and contents take the form of digital multimedia elements (i.e.,

text, graphics, video, audio, and animation) to enrich the learning process (Johnson *et al.*, 2014).

Likewise, interactive and immersive learning environments using innovative technologies, such as virtual reality (VR) and augmented reality (AR), are being used to help students learn complex and abstract learning concepts with ease (Billinghurst *et al.*, 2001; Craig, 2013; Wang *et al.*, 2013). These technologies were once used almost exclusively in the military and research domains, but now they have been made in road in the educational realm. All these accomplishments owe to the continually improving desktop computing technology, engendering effective, and yet, affordable learning solutions to schools and colleges. Studies on the impact of learning applications based on VR and AR have found to be quite efficacious in various disciplines, notably engineering, science, and technology (Cheng & Tsai, 2012; Johnson *et al.*, 2010).

Of late, a variant of AR technology – mobile augmented reality (MAR) technology – is making its presence equally important for training and learning purposes. The appeal of MAR to educators lies in its mobility as learning applications can be accessed using the ubiquitous mobile devices, namely hand phones. Learners can now gain access to learning materials and contents anywhere, anytime on their "palms". Arguably, the mobility of this technology will transform the way in which learners learn in this new millennium. In developed nations, MAR learning applications are being used in many learning contexts (Chang *et al.*, 2010; Li, 2010;