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# Improving Students' Motivation in Learning ICT Course With the Use of A Mobile Augmented Reality Learning Environment

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**Abstract.** Studies have shown that many Malaysian non-technical students have low motivation in learning ICT course due to a number of reasons, such as a lack of learning practice and effective learning applications. In view of such a problem, the researchers carried out a quasi-experimental study to examine the impact of a novel mobile augmented reality learning application (MARLA) on students' motivation in learning a topic of a university ICT course. The research was based on the pretest-posttest control group design, and the study sample consisted of 120 non-technical undergraduates majoring in social science, with a mean age of 19.5 years. They were divided into an experimental group and a control group. The dependent variable was students' motivation in learning, and the independent variables were learning method and gender. The experimental group used MARLA on their mobile devices to learn one of the topics of the ICT Competency course, namely Computer System; whereas the control group used a similar application on their desktop computers. The Intrinsic Motivation Inventory (IMI) was the research instrument used to measure students' motivation before and after learning sessions, which spanned 6 hours. Utilizing the SPSS (version 21), an analysis of covariance was performed, showing there was a main effect attributed to gender only, with male and female students attaining mean scores of 4.24 and 3.90 respectively for the motivation construct. This finding showed male students were more motivated than their opposite counterparts. In contrast, no such main effect attributed to learning method was observed, as evidenced from the mean scores of 4.08 and 4.07 of the experimental group and control group respectively for the measured construct, suggesting both methods were both equally effective. Additionally, there was an interaction effect between gender and learning method, with male students attaining different levels of motivation based on learning method. Arguably, such a mobile learning tool can be used to help non-technical undergraduates learn with greater motivation, but its success will rely on proper planning and implementation by considering students' demographic background.

## 1.0 Introduction

In recent decades, many new technologies, especially Information and Communications Technology (ICT), have been utilized in almost every facet of human endeavors. Such profound use is hardly surprising given that societies across the globe are becoming more aware of the importance of such technologies in helping them perform their duties more efficiently and effectively. Predictably, ICT has become indispensable to making workers become efficient. Hence, many nations have launched efforts to help improve ICT competency of students and workers. In view of such challenges, the Malaysian government, through its Ministry of Education (MOE), has continually revamped its



educational policy by introducing important changes to its primary, secondary, and tertiary educational curricula and academic programs to help produce a competitive, competent workforce [1], [2], [3].

For example, at the tertiary level, all Malaysian public universities have mandated non-technical and non-ICT fresh undergraduates to learn and pass the ICT Competency, which is one of the university compulsory course. The main purpose of learning this course is to ensure the students will be equipped with the knowledge and skills in using latest computer applications, which collectively serves as a productivity tool in their professions after graduation. Put simply, students need to acquire the right knowledge and skills in ICT as today's learning realm is characterized by the use of digital contents and delivery. Arguably, without such skills and knowledge, they can become less productive at best or ineffective at worst. Regrettably, students' learning performance in this course was quite mediocre, owing to logistical, pedagogical, experiential and motivational factors [4]. Among such factors, motivation stands out as one of the critical factors that needs immediate redress.

Arguably, the time allocated for the teaching of the subject matter in the majority of the universities nationwide is notoriously inadequate. Hence, lecturers have been forced to fully concentrate on giving lectures, thus having few opportunities for discussion [4]. Eventually, such a lecture-based approach can result in learning becoming stale and uninspiring. Obviously, lecturers are not to be blamed, but rather existing teaching constraints are responsible for the lack of motivation among students. Moreover, such learning approach has also prevented students to complete their work in the classroom, thus forcing them to take their assignments home. Nonetheless, completing their tasks at home is not practical as many students do not have the right platform to collaborate [4], [5]. Prolonging this learning scenario can make students become unmotivated or frustrated.

Interestingly, according to Bandura [6], one of the leading scholars in social learning, motivation will have a greater effect on people's actions than on their learning. He also asserts that vicarious experiences could also affect people's motivation. For example, people observing a person's act of accomplishing a feat will be motivated to follow suit. In other words, people's motivation can be enhanced through the vicarious experiences of observing others. Thus, it is essentially that teachers ensure that there are opportunities for students to observe effective models that help reinforce such vicarious experiences. Teachers should also encourage students to engage in activities that can help enhance their self-efficacies that lead to improved learning.

Hence, identifying the means to motivate students in learning is important. Without motivation, students will only engage in superficial learning, not deep learning, thus depriving them the essence of learning. In this respect, teachers and instructors must fully understand the vital role of motivation in learning. With high motivation, students will be able to carry out their work diligently and strive persistently to achieve learning goals [7]. In addition, motivation can help expedite the process of acquiring relevant skills, as students will remain focused and committed. Naturally, motivation can help improve learning performance, as students will be more energetic and resilient. Research has shown that students with high motivation tend to be successful in learning compared to students with low motivation [8]. Apparently, the latter was less committed and less focused during the learning process, ultimately resulting in a poor learning engagement that leads to low academic performance. In fact, motivation helps students to be consciously aware of their responsibility to put in every effort in their learning activities. Therefore, teachers are compelled to create a learning environment that can nurture students' motivation so that learning will take place with great efficacy.

Clearly, the creation of such learning environment relies on both pedagogical and technological factors, which need to be carefully planned, developed, and implemented. Together, these two main factors, such as appropriate feedback and scaffolds, can help inspire students to partake in learning activities, which reinforce their desire to achieve learning goals [9]. In fact, DePasque and Tricoli [10] state that students' intrinsic motivation can be vigorously expressed in learning environments by prompt feedback, which strengthens reasoning during learning. More importantly, such learning environments should encourage collaborative participation among learners such that they can become more motivated, energetic, and engaged, which leads to better cognition [11], [12]. Apparently, such learning environments are lacking in Malaysian universities. Hence, a new and an affordable learning

platform is entailed to provide students the learning space in which students can access relevant learning materials and contents and communication tools to help them work collaboratively. In this regard, collaborative learning has become commonplace in many developed nations given its many learning benefits, such as enhanced reasoning, better social interaction, and increased motivation [13]. To address some of the above problems, several researchers in Malaysia have carried out several studies to examine contributing factors and to provide relevant solutions, which typically involved the use of ICT [14], [15], [16], [17]. Such emphasis on the use of ICT-based solutions is hardly surprising given the availability of powerful, affordable hardware and software for the developments of such learning tools. In recent decades, new developments and improvements in ICT have spurred the use of digital multimedia [18], animation [19], virtual reality [20], [21], and augmented reality [22], among others, in a diverse range of academic contexts, producing many interesting, promising results.

Of late, a variant of virtual reality technology, namely the mobile augmented reality (MAR) technology, has been making inroads in the training and learning domain. Seemingly, the appeal of MAR to educators lies in its mobility as learning applications can be accessed using the ubiquitous mobile devices, namely hand phones. Virtually, learners can access learning materials and contents anywhere, anytime on their mobile devices. Certainly, the mobility of this technology will transform the way in which learners learn in this information-rich era. In fact, in many developed nations, MAR learning applications have been integrated into formal classroom activities [16], [17], [18], in which students' learning performance and motivation have improved significantly [19]. However, such deployment of this technology in Malaysia is a recent event, thus necessitating more efforts to bring this technology into the Malaysian mainstream learning context. More importantly, the use of MAR learning tools has to be guided by sound theoretical principles to ensure their successful deployment and utilization [20].

In view of low motivation among students, the research on the use of such technology in the Malaysian educational context needs to be addressed to help improve the learning of ICT Competency course among fresh non-technical undergraduates. If such poor motivation is allowed to persist, students will surely face impending serious implications in their careers later, as technology is pervasive in the working realm. However, integrating technology into learning activities has many challenges or obstacles, which have to be dealt with extreme caution. There is a myriad of factors influencing such integration, such as gender, age, academic background, and ethnicity, which can be detrimental to the successful use of technology in education. For example, a study by [21], which involved a desktop virtual environment, found that male students performed relatively better than female students and, in general, the former were more motivated than the latter in using such a novel learning tool. Hence, these differential attainments may pose a challenge to using other technologies based on a new learning platform, notably the mobile learning platform using MAR technology.

In assessing students' motivation, a number of instruments have been developed to measure the motivation constructs. For example, the Intrinsic Motivation Inventory (IMI), which was originally developed by Edward Deci and Richard Ryan, has been translated into several major languages, such as Malay Language [22], which has been successfully verified and validated. This instrument contains 29 items that help measure participants' interest and enjoyment, perceived competence, effort and importance, pressure and tension, value and usefulness, and perceived choice while performing a given activity. Each item contains a statement entailing a participant to rate using a scale of "1" to "7", with "1" being "not true at all" and "7" being "very true". The computed reliability coefficient of Cronbach Alpha of this instrument was 0.84.

Taking into account of the discussed learning issues, two research objectives were formulated to guide the study as follows:

- a) To develop a collaborative mobile augmented reality learning application (MARLA) that can help motivate students to learn a topic of ICT Competency course collaboratively.
- b) To investigate the impacts of learning method and gender on students' motivation in learning a topic of ICT Competency course.

To help achieve the above research objectives, two research questions were formulated accordingly as follows:

- a) Does learning in different methods lead to a significant difference in learning motivation?
- b) Does the gender factor have a significant impact on learning motivation?

## **2.0 Research Methods**

This study was based on the quasi-experimental research approach using the pretest-posttest control group research design. The following subsections provide the details of the research method of the study used.

### **2.1 Participants**

A study sample made up of 120 first-semester social science undergraduates, with a mean age of 19.5 years, was recruited from two intact classes. To ensure a proportional representation of both genders, stratified random sampling was used to divide the participants into two groups, namely the experimental group (23 males, 37 females,  $N = 60$ ) and the control group (22 males, 38 females,  $N = 60$ ).

### **2.2 Research Instrument and Instructional Materials**

A set of instructions, detailing the purpose of learning and expected learning outcomes, was displayed on the screen of their devices. In addition, the participants were furnished with learning materials related to the topic of learning. For the experimental group, the participants were allowed to use the learning application on their mobile phones. For the control group, the participants used a similar application on the desktop computer. The research instrument used was the Intrinsic Motivation Inventory (IMI).

### **2.3 The Development of the Mobile Augmented Reality Learning Application (MARLA)**

The researchers used the constructivist principles, as propounded by Moshman's (cited in Dalgarno) [23], in developing MARLA. According to Moshman, the interpretation of constructivism rests on three principles, namely endogenous, exogenous, and dialectical principles. Endogenous constructivism stresses the importance of learner exploration during learning. Exogenous constructivism underscores the imperative of direct instruction, but with a strong emphasis of learners actively constructing their own knowledge representation. Dialectical constructivism plays the important role to facilitate the interaction among learners, their peers, and lecturers. Based on this interpretation, teachers and instructors are responsible to create a constructivist-learning environment using appropriate learning contents, features, materials, and facilities.

For instance, in MARLA, materials that draw on the endogenous standpoint are the multimedia contents, such as 3D objects, audio narration, and demonstration videos. To invoke exogenous learning, instructional sheets, guidelines, and cognitive tools are available to help knowledge construction. Finally, materials that tap on the dialectical view consist of collaboration and support tools, such as Facebook and Google doc. These tools serve as the communication platform of MARLA learning tools, of which learners could partake in discussion sessions to solve a given task. With such a platform, learners could immerse in an iterative communication loop as proposed by Obikwelu and Read [24]. Figure 1 shows the framework that helped guide the development of MAR learning applications.



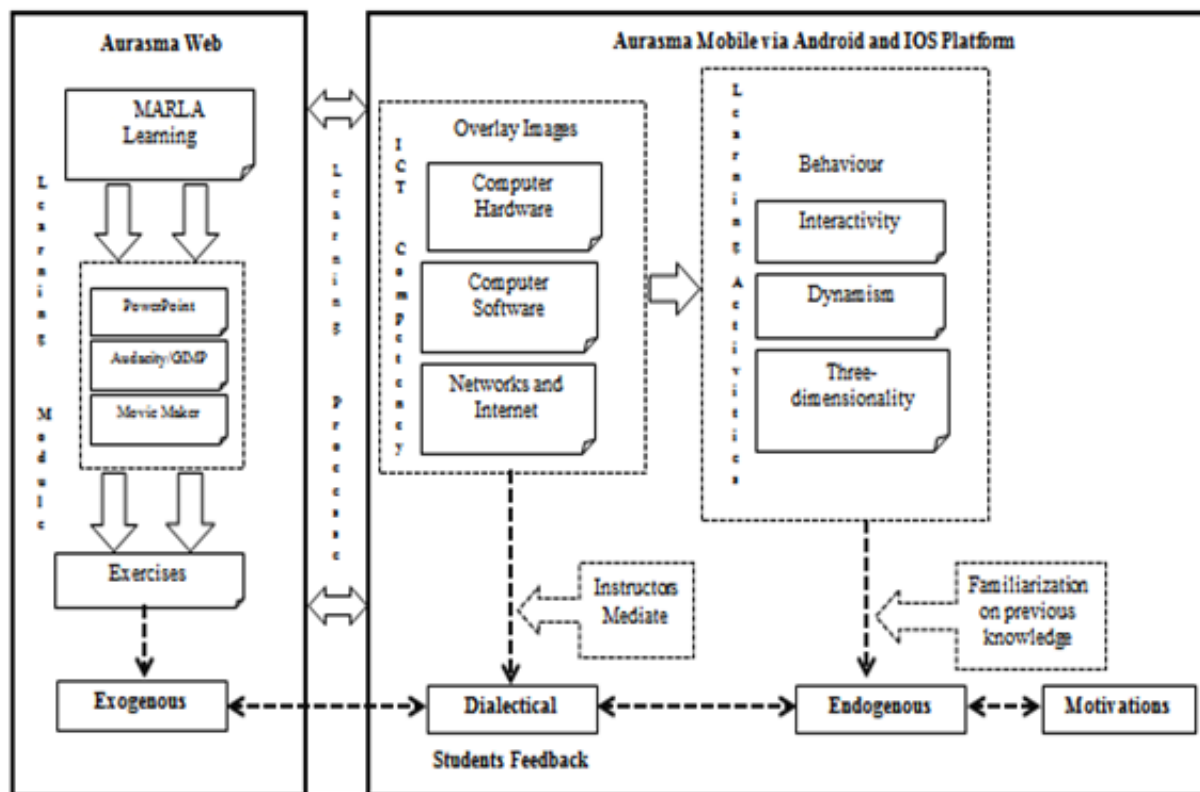


Figure 1: The theoretical framework for the development of MARLA

The development of MARLA was carried out by using the web-based augmented reality (AR) development system, Aurasma Studio, which also hosts a diverse array of AR contents online. When accessing Aurasma's website, users can use the various features available to develop AR contents using various templates. The developed AR contents can be uploaded to the system's server as cloud contents, which can be downloaded to users' devices. Users can access, share, and distribute such AR contents using some of the novel features available, such as popular hashtags based on trends or templates. Having this quick and precise search of relevant contents helps students in their learning process as it can proceed without any delays or interruptions. Interestingly, any devices that have internet connectivity, such as mobile phones, can access such AR contents, thus expanding the learning envelope that makes learning become more pervasive and encompassing,

## 2.4 Procedure

The experimental research involved three stages, which were carried out in sequence. First, the participants were pre-tested for learning motivation using the Intrinsic Motivation Inventory (IMI). Then, the participants were divided into the control group and the experimental group, which were exposed to conventional and MARLA learning, respectively. Finally, on the last learning session, the participants were post-tested for the same measure using the same research instrument used in pre-testing.

## 3.0 Results

The researchers used the SPSS (version 21) to analyze the data to yield both the inferential and descriptive statistics. In particular, the univariate Analysis of Covariance (ANCOVA) was carried out to test if there were any significant differences in motivation attributed to learning method and gender. Before learning, the experimental group's mean score of motivation was 3.64 (SD = .64), and the

control group's mean score was 3.90 (SD = .21). After learning, the experimental group's mean score of motivation was 4.08 (SD = .54), whilst the control group's mean score was 4.07 (SD = .20). Table 1 summarizes the participants' motivation based on learning method and gender.

Table 1: Motivation based on learning method and gender

Group	Gender	Motivation			
		Before		After	
		Mean	SD	Mean	SD
Exp	Male	4.00	.34	4.35	.25
	Female	3.06	.60	3.85	.60
	Total	3.64	.64	4.08	.54
Control	Male	3.84	.21	4.13	.19
	Female	4.00	.18	3.96	.18
	Total	3.90	.21	4.07	.20

To determine whether there were any main and interaction effects attributed to the learning method and gender, an analysis of covariance was performed. Table 2 summarizes the result of the analysis. The analysis of the (2 x 2) ANCOVA, with a learning method (2 levels: mobile and desktop) and gender (2 levels: female and male) as between-subjects factors, revealed that the main effect of learning method was not significant,  $F(1,115) = .03$ ,  $p > .05$ . This indicated that both learning methods were equally effective in improving the participants' motivation. In contrast, the main effect of gender was significant,  $F(1,115) = 33.95$ ,  $p < .001$ . This finding showed that between male and female participants, the former were highly motivated than the latter. Interestingly, there was an interaction effect between the learning method and gender,  $F(1,115) = 8.77$ ,  $p < .05$ , which is clearly shown in Figure 2. The two slopes are not parallel, indicating an interaction effect between the two independent variables.

Table 2: Tests of between-subjects effects

Source	The sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.41	4	1.85	17.78	.000
Intercept	14.36	1	14.36	137.8	.000
Pre-Motivation	.08	1	.08	.73	.396
Group	.003	1	.003	.03	.859
Gender	3.54	1	3.53	33.95	.000**
Group*Gender	.91	1	.91	8.77	.004*
Error	11.98	115	.10		
Total	2011.25	120			
Corrected Total	19.39	119			

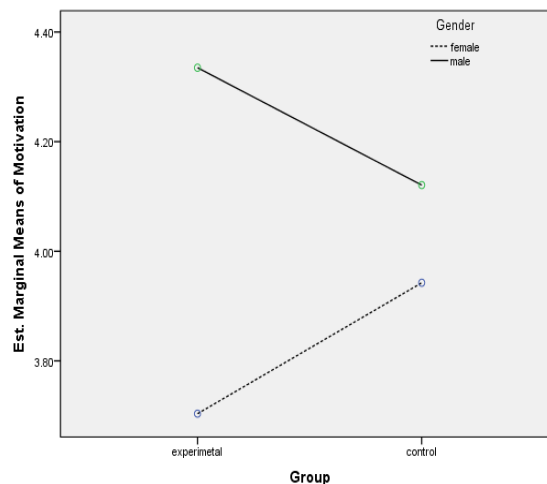


Figure 2: Motivation by learning method and gender

#### 4.0 Discussion

A number of interesting and promising findings were revealed by the data analysis. Firstly, the findings showed that there was no main effect attributed to learning method, indicating that both learning methods were able to improve the participants' motivation – they were both equally effective. Secondly, a main effect attributed to gender was found, showing that, in general, male attained relatively higher motivation than their opposite counterparts. Thirdly, and interestingly, there was an interaction effect between learning method and gender, indicating that there were different attainments of motivation based on the learning method used according to the category or to the level of gender (see Figure 1). Clearly, the figure shows that male participants tended to attain different levels of motivation based on the learning method that they used. Specifically, male participants gained higher motivation when they learned using MARLA than those male participants who used similar application on desktop computers. In contrast, no such significant differential levels of motivation were observed among female participants. As such, these particular findings will have some implications for the current teaching practices.

Arguably, the use of such MAR learning application can help create an effective learning environment in which students can work together more intensely compared to working in a computer laboratory. In the former setting, students can use their mobile devices with greater flexibility and mobility to communicate and discuss with their peers and instructor or mentor. With such greater mobility, they can engage in an exciting learning experience as access to relevant learning materials or contents is always available anywhere, anytime — in short, time and geographical barriers are virtually eliminated. In addition, such a mobile learning application can be readily used in independent or informal learning contexts, in which students will be able to practice and rehearse learning activities outside the formal learning hours. Moreover, such mobile learning application, which supports a wide range of multimedia contents, can help deal with the different learning demands of students who come from diverse educational backgrounds [25]. Presumably, with this capability, the learning application will have a strong appeal to attract students to partake in learning activities with a higher level of enthusiasm and motivation, which can lead to better learning experience. Hence, such mobile learning application can become a potent learning tool to help students learn in informal learning.

As learned, male students tend to become highly motivated in learning in environments that use novel, innovative tools or applications. By contrast, such orientation may not transpire for female students, suggesting that they may have some reservations to use such tools initially. In all likelihood,



they may use such tools with some cautions, or they may not be too excessively excited compared to male students. Therefore, this particular finding reinforces the needs to pay greater attention to female students when employing new, unfamiliar learning tools. More importantly, they should be given sufficient time to familiarize with the tools and, if required, should be provided with special training. The above finding is consistent with previous findings that indicate male students gaining greater advantages in various learning situations that employed a wide range of technological tools. Nevertheless, such findings are open for debates, but many scholars concur that such male superiority is due to experiential factors, not biological factors. Thus, with more opportunities for experiencing novel technologies, such gender impurity may quickly disappear.

Furthermore, this particular finding may have some serious implications on the teaching practice, affecting the morale of students and instructors alike. Clearly, all sorts of technologies, especially ICT, have virtually reached every corner of the world, affecting almost every facet of the people's lives. Particularly, the younger generation is so accustomed to using new, innovative technological devices to the extent that they may develop high expectations for technology-driven learning or training, anticipating eagerly that their learning will involve some sort of exciting, new learning tools or applications. If such high expectation is unmet, their morale or motivation to learn will suffer, thus depriving them of meaningful learning experiences.

For lecturers and instructors, they will encounter many challenges in adopting such a mobile learning tool in their classes. As demonstrated in this study, female students may not be highly motivated in using new, innovative learning method initially. Probably, they may view or perceive new learning applications as something that are ordinary – nothing to get excited about. With such a perception, they may miss the opportunity to explore the attractive features of the learning tools. Given their heavy psychological inertia at the beginning, they may not catch up with male students in the computer-mediated learning activities, which could lead to poor learning motivation and performance. Thus, it becomes the imperative of the instructors to correct such a misplaced perception such that female students too can capitalize on new, innovative learning applications. In this regard, the responsibility is on the lecturers and instructors to guide and motivate students, especially female students, to use such learning tools.

## **5.0 Conclusion**

In conclusion, the findings of this study help shed some light on the potential benefits and challenges of using mobile augmented reality learning tools in the learning process to help improve students' motivations. In this study, the mobile learning method had been demonstrated to be equally effective as the desktop learning method in motivating students to learn. This particular finding suggests that mobile augmented learning tool can be used as a learning application to help students learn anywhere, anytime, by capitalizing the mobility of mobile devices. Nevertheless, the effective use of such a novel tool may be mediated by several factors, such as gender. For example, a particular type of students will probably require intense coaching or training than the others to familiarize with the tool. More significantly, relevant, contemporary theoretical framework is entailed helping develop such an effective learning application. And to cap it all, more studies are required to examine whether improved motivation will translate into improved learning performance.

## References

- [1] Sua, T. Y. (2012). Democratization of secondary education in Malaysia: Emerging problems and challenges of educational reform. *International Journal of Educational Development*, 32(1), 53-64.
- [2] Cheah, P. K., & Merican, A. M. (2012). Education Policy: A Case Study of Digitizing Education in Malaysia. *Procedia-Social and Behavioral Sciences*, 69, 1714-1718.
- [3] Arokiasamy, A. R. A., bin Abdullah, A. G. K., & Ismail, A. (2015). Correlation between Cultural Perceptions, Leadership Style and ICT Usage by School Principals in Malaysia. *Procedia-Social and Behavioral Sciences*, 176, 319-332.
- [4] Nincarean, D., Alia, M. B., Halim, N. D. A., & Rahman, M. H. A. (2013). Mobile augmented reality: The potential for education. *Procedia-Social and Behavioral Sciences*, 103, 657-664.
- [5] Stanisavljević-Petrović, Z., Stanković, Z., & Jevtić, B. (2015). Implementation of Educational Software in Classrooms—Pupils' Perspective. *Procedia-Social and Behavioral Sciences*, 186, 549-559.
- [6] Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological review*, 84(2), 191.
- [7] Brown, H. D., & Principles, T. B. (2001). An interactive approach to language pedagogy.
- [8] Lai, E. R. (2011). *Motivation: A literature review*. New York: Pearson.
- [9] Rehman, A., & Haider, K. (2013). The Impact of Motivation on Learning of Secondary School Students in Karachi: An Analytical Study. *Educ. Res. Int*, 2(2), 139-147.
- [10] DePasque, S., & Tricomi, E. (2015). Effects of intrinsic motivation on feedback processing during learning. *NeuroImage*, 119, 175-186.
- [11] Martín-Gutiérrez, J., Fabiani, P., Benesova, W., Meneses, M. D., & Mora, C. E. (2014). Augmented reality to promote collaborative and autonomous learning in higher education. *Computers in Human Behavior*
- [12] Chen, C. H., & Law, V. (2015). Scaffolding individual and collaborative game-based learning in learning performance and intrinsic motivation. *Computers in Human Behavior*.
- [13] Akçayır, M., Akçayır, G., Pektaş, H. M., & Ocak, M. A. (2016). Augmented reality in science laboratories: The effects of augmented reality on university students' laboratory skills and attitudes toward science laboratories. *Computers in Human Behavior*, 57, 334-342.
- [14] Hafizul F. H., & Samsudin, K. (2012). Mobile Learning Environment System (MLES): The case of android-based learning application on undergraduates' learning. *International Journal of Advanced Computer Science and Applications*, 3(3), 63-66.
- [15] Hassan, H., Said, C.S., Johan, R., Fabil, N., Hanif, A.S., Mailok, R., & Hashim, M. (2008). *Pembinaan Perisian Multimedia Pintar Teknologi Maklumat KBSM*. Project Report. UPSI, Tanjong Malim.
- [16] Mohamad, A.J., Lakulu, M., & Samsudin, K. (2016). The development of a mobile application for kindergarten early reading: Challenges and opportunities. *Journal of engineering and applied sciences*, 11(3), 380-383.
- [17] Samsudin, K., Nazre, A.R., Jamilah, H., Sairabanu, O.K., & Norasikin, F. (2010). Effects of training method and gender on learning 2D/3D geometry. *Journal of Computers in Mathematics and Science Teaching*, 29(2), 1-14.
- [18] Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). *Horizon report 2014 - Higher education edition*. Austin, TX: The New Media Consortium.
- [19] Hafizul F. H., Samsudin, K., Norhisham, M. N., Ashardi, A., & Che Soh, K. (2012). The Making of IT Teachers: Lesson Learned from Animation-Enhanced Training. *The GSTF International Journal on Computing*, 2(1), 41-45.
- [20] Craig, A. B. (2013). *Understanding augmented reality: Concepts and applications*. Amsterdam: Morgan Kaufmann. *Environments*, 6 (4), 355–385.
- [21] Rafi, A., & Samsudin, K. (2010). Impact of spatial ability training in desktop virtual environment. In Mukerji, K., & Tripathi, P (Eds.) *Cases on Transnational Learning and Technologically Enabled Environments*, (pp. 180-189). Pennsylvania, USA: IGI Global.

- [22] Leng, E. Y., Ali, W. Z. b., Baki, R. & Mahmud, a. R. (2010). Stability of the Intrinsic Motivation Inventory (IMI) For the Use of Malaysian Form One Students in ICT Literacy Class. EURASIA Journal of Mathematics, Science and Technology Education, 6(3), 215-226.
- [23] Dalgarno, B. (2001). The Potential of 3D virtual learning environments: a constructivist analysis. Retrieved from the Charles Stuart University, Australia website: <http://www.usq.edu.au/electpub/e-jist/docs/Vol5/No2/Dalgarno/Final.pdf>
- [24] Obikwelu, C., & Read, J. C. (2012). The Serious Game Constructivist Framework for Children's Learning. Procedia Computer Science, 15, 32-37.
- [25] Majid, N. A. A., Mohammed, H., & Sulaiman, R. (2015). Students' Perception of Mobile Augmented Reality Applications in Learning Computer Organization. Procedia-Social and Behavioral Sciences, 176, 111-116.