Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 6.017

IJCSMC, Vol. 6, Issue. 3, March 2017, pg.118 – 125

Increasing Levels of Interaction and Usability of Mobile Learning based on Augmented Reality

Abdullah S. Alotaibi
Department of Computer Science, Shaqra University, KSA
a.shawan@su.edu.sa

***Abstract:** The widespread ownership of mobile devices has lead to an increased interest to ubiquitous learning that is supported by a wide range of mobile devices. Active learning depends on the interaction between learners and their teachers. This study aims to design a user-friendly augmented reality Mobile learning (M-Learning) application that will improve the interaction between learners and their teachers, arouse learners' interest and promote learner-centered approaches in the field of education. Using a particular course, the suggested application was designed and utilized in an iPhone gadget. The learning materials were deployed in augmented reality application using context awareness. In addition, a prototype framework for smart phone devices was created to investigate issues such as usability in M-learning systems.*

***Keywords:** Mobile Learning, Augmented Reality, Interaction, Learners, Teachers*

1. Introduction

An increasing number of researchers in the fields of instructional design, learning sciences, and educational psychology argue that complex knowledge domains the most challenges, both for designing effective learning environments and for determining factors which contribute to learning [2, 3]. The mobile phone is a very versatile tool that can be used for different purposes which include communication, watching films, video conferencing, playing music, scanning barcodes, browsing the internet among others. As a result of the widespread use of the mobile device in the current generation, educational providers are now using this opportunity to provide learning materials to learners through the mobile phone. The mobile gadgets enable education providers to deploy learning resources to even those learners who live in remote areas. Wang et al. [23], states that mobile gadgets can be used to submit online learning resources to students in higher educational learning institutions. Similarly, Pensky stated that as far as learning resources are properly designed, learners can learn everything. The internet gives an immense opportunity to both learners and educational providers. The learners can access learning resources through their mobile phones wherever they are. On the other hand educational providers have the opportunity to give access to learning materials to many students at the comfort of their home. E- Learning which can be defined as deploying learning resources through portable devices can be divided into collaborative learning and individual learning. Collaborative learning is a type of learning where learners actively participate in group activities, share ideas and educational materials. Through online learning platforms, students can have real time interactions with each other and with their instructors using video-conferencing, instant messaging, chats among others. M-learning, enables students to access customized learning resources that is designed to specifically satisfy their personal needs. Most learners are interested in online learning platforms because of its flexibility. Learners can choose their preferred mode of learning. They can also learn at their own pace, time and location. When designing computer educational applications, there are many usability standards that must be adhered to. However, it is very difficult to adhere to these usability standards when designing M-learning system. This is mainly because these standards do not take into account the shortcomings of cellular gadgets which include small screen size, low memory and slow download speed. These devices also require internet connectivity in order for learners to access the materials. The designs of cell phone applications do not have usability guideline standards. In M-learning, usability factors have not been the centre of focus as compared to technical issues. Studies have indicated that usability factors can greatly affect the performance of M-learning programs. Few studies have been conducted to investigate the models of usability such as efficiency, learnability, satisfaction, effectiveness, and accessibility of these cellular programs. All these factors should be taken into consideration when designing an effective M-learning application. M-learning applications with all these models of usability are likely to have higher user satisfaction [7, 10, 12].

In this paper, we will review the related work following by next section. Then in section 3 we will present the mobile augmented reality. In section 4, we will give a design modules and framework. Section 5, show the discussion of result analysis. Finally this paper will be concluded with conclusion and future work in scection6.

2. Related Work

Most of mobile learning studies emphasize the adoption of digital learning aids in real-life scenarios [18, 22]. However, regarding supplementary mobile learning aids, the interaction between digital learning aids and the actual environment needs to be emphasized to enable students to effectively manage and incorporate personal knowledge [21]. For example, it is expiated that students can select a virtual learning object from the actual environment using a mobile learning aid, which allows them to obtain a first-hand understanding of the learning environment and, subsequently, increases their learning motivations and experiences. Such a learning support technology is achievable through the use of Augmented Reality (AR), which combines human senses (e.g., sight, sound, and touch) with virtual objects to facilitate real-world environment interactions for users to achieve an authentic perception of the environment. For example, users who employ mobile devices with AR facilities to seek a target building on a street are able to see additional information surrounding individual buildings when they browse the buildings via the camera of their mobile device. Researchers have documented the potential of employing such facilities to assist students in learning in real-world environments in comparisons with traditional instructions which showed that AR technology contributed to improve academic achievement compared to traditional teaching methods [1, 6, 14].

Augmented reality (AR) is a growing phenomenon on mobile devices, reflected by the increase in mobile computing in recent years and the common ubiquity of Internet access across the world. The NMC Horizon Report for 2011 named augmented reality as the highest-rated topic by its Advisory Board, with widespread time-to-adoption being only two to three years [11]. What was once seen by many as being a mere gimmick with few applications outside of training, marketing/PR or sport and entertainment, is now becoming more mainstream with real opportunities for it to be used for educational purposes. Augmented reality application integrates the real environment with the virtual world. Virtual objects are created that interact with objects in the real world in 3D. Figure 1 below illustrates the AR system.

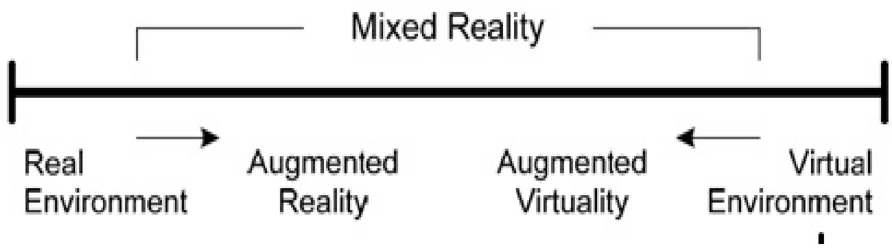

Figure 1: Milgram's reality-Virtuality continuum

3. Mobile Augmented Reality

Augmented reality (AR) is a variety of virtual reality where a transparent layer of computer generated graphics is overlaid on the real world in order to enhance certain features. The use of AR technology is growing rapidly and is now being adapted in various fields. There is very high level of interest among researchers in studies related to AR. Today AR is a revolutionary technology that can be applied in different fields such as healthcare, education, industries, entertainment etc. For example, in the area of healthcare, the technology has the potential to be used in performing surgical procedures. Augmented reality is a very interactive technology that enables users to interact with 3D virtual objects. AR provides users with the unique experience of interacting with distant virtual objects. Learners will develop strong interest in learning if educational resources are provided to them through their mobile devices using AR applications. Active learning requires learners to participate in the learning process. The use of AR and other interactive web programs that are used in cellular devices have the potential to improve and excite learners in the field of education. Instead of just reading course materials passively learners can actively engage in various activities such as combining chemical elements in a virtual laboratory or explore the various internal parts of the human body in 3D simulations. Teachers can also promote creativity and higher level of thinking among their students by enabling them to create augmented reality experiences about various topics of their course content using their own mobile devices. AR provides endless tools to teachers to spice up their teaching in various ways that captivate and arouse their learners' curiosity. Figure 1 above was designed by Milgram and Kishino to illustrate the reality-vitality continuum. The continuum extends from a real environment to a virtual environment. In between the two ranges, there is augmented reality and augmented virtuality. In augmented reality, virtual objects augments the real while in the augmented virtuality the real objects augment the virtual.

The above explanation of AR illustrates three important issues:

1- AR enables us to see virtual objects in the real world with the help of a camera and a head mounted display.
2- The definition does not only include sight but will likely include other senses such as smell, hearing etc.
3- Real objects are removed virtually from sight by superimposing virtual objects on the real objects hence techniques such as mediated reality and diminished reality can be part of AR.

The computer graphics pioneer, Ivan Sutherland and his students at both Harvard and Utah University presented a method of creating a 3D computer aided design in 1960s. In the 1970s, 80s, and 90s, a tremendous success was achieved in the field of computer graphics by researchers affiliated to NASA Ames Research Center, the University of North Carolina (Chapel Hill) and the Massachusetts Institute of Technology. Gadgets such as digital watches, personal digital organizers and the Sony Walkman mobile gadget were produced during this period. In the 1990s miniature wearable computer gadgets worn on the body by the users were devised. The first palmtops including the Apple Newton Messaged, the Palm Pilot, the Psion I were produced in 1993, 1996 and 1984 respectively. Personal digital assistants (PDAs), cell phones, and personal computers can be used to deliver augmented reality applications. The term augmented reality is attributed to two researchers at Boeing Caudell and Misell who created it in the 1990s to describe a digital display system that was used by the electricians of Boeing aircraft to overlay computer graphics onto physical world. However, a few years later, a system that utilized GPS sensors was developed to assist people who were visually impaired in their outdoor navigations. The system used infrared sensors to detect obstacles that arose in front of the visually impaired persons. A Mobile Augmented Reality System (MARS) was first designed by Feiner et al. [19]. MARS overlays 3D graphical tour information to an environment where sight seers could view historical monuments and other artifacts. Great interest in AR began in the 1990s when augmented reality emerged as a new area of research. The international Workshop and Symposium on Augmented Reality and the International Symposium on Mixed Reality was held. Organizations that promote augmented reality were established. This included Arvika Consortium3 in Germany and Mixed Reality Systems Laboratory (Nottingham MRLab). As a result of these developments, augmented reality programs could be easily designed because of the availability of free AR toolkits. Various survey studies that evaluated AR applications were conducted. The surveys investigated the challenges associated with the use of AR systems. The International Symposium on Mixed and Augmented Reality4 (ISMAR) became the premier academic symposium where all issues related to augmented reality are discussed. Issues discussed in this conference include computer graphics, AR technologies, and human-computer interactions.

4. Design Modules and Framework

Designing a system that blends AR applications into M-learning is a difficult and intricate process. According to Chang and Sheu, [4, 5], before creating an interactive system one must find out the necessary prerequisites and establish the needs. Therefore, to device a successful M-learning application that integrates AR system, one must carry out need assessment and then evaluate the experience of the users on the mobile AR system. In order to assess the potential use of the AR systems in M-learning program, this research undertook three types of feasibility studies:

1- The learners were interviewed in a study that was carried out to assess the following:
   I. Their pedagogical needs when studying in an M-learning context.
   II. The ability of the system to promote their learning.
   III. The kind of framework that users require which supports learner-centered understanding.
2- A technical research was then conducted to evaluate how the learning resources could be deployed into the cellular devices to ensure that the materials adequately fit into the screen sizes of different cellular phones.
3- System usability study that included graphical user interface design of the software program of cellular devices and the interaction of the users with the devices.

Figure 2 below clearly shows the design specifications of the system which is composed of ten elements.

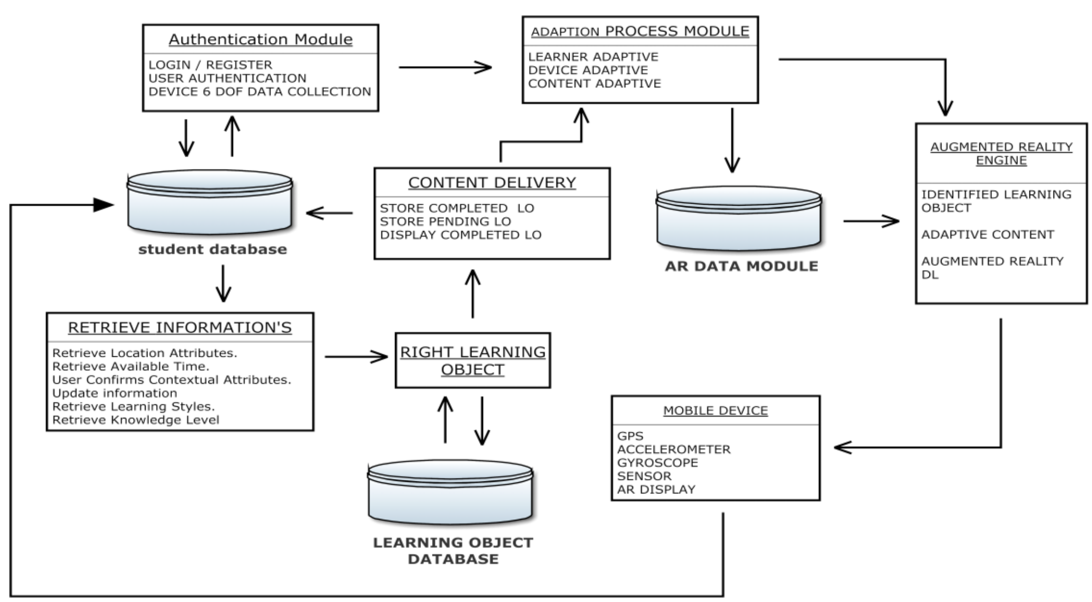

Figure 2: The Proposed Framework

5. Results Analysis

The two systems Mobile Learning based on Augmented Reality and Mobile Learning, were simultaneously evaluated. The relationships between the two applications were evaluated in order to find out whether users evaluated M-learning with AR and M-learning without AR separately. The Pearson correlation coefficient can be used to test the hypotheses H1 to H4 of the research show in the Table1.

Hypothesis	Section	Pearson Correlation Coefficient	Spearman Correlation Coefficient
H1	**Ease of Use**	0.06 **	0.09*
H2	**User Satisfaction**	0.20 *	0.21*
H3	**Attractiveness**	-0.010 **	-0.008 **
H4	**Learnability**	0.22 *	0.24*
H5	**General**	0.16 *	0.17*

(*) Significant at P-Value <0.05, and (**) insignificant at P-Value > 0.05.

Table 1: Analysis of the data using Pearson and Spearman Correlation Coefficient Methods

The Pearson Correlation is normally used in parametric statistics to investigate the relationship between two quantitative variables. The value of the Pearson correlation coefficient can range from +1 to -1. The value zero indicates that there is no association between the two applications. If the association between the two applications is stronger, then the Pearson correlation coefficient is closer. In statistical hypothesis testing, the P-Value is the probability of obtaining a test statistic. The lower the p-value, the less likely the result is if the null hypothesis is true, and consequently the more “significant” the result is, in the sense of statistical significance’ [8, 9]. The Spearman correlation coefficient is the non-parametric form of the Pearson correlation coefficient. It is used to test non-parametric data that assesses the relationship between two variables. Table 1 shows the result of the statistical analysis of the Pearson correlation coefficient and the Spearman correlation coefficient which are as follows that the usability, the results show that the Pearson correlation coefficient is statistically significant at 0.06 and the Spearman correlation coefficient is statistically significant at 0.09. The findings of Spearman correlation coefficient clearly indicates that our hypothesis is disproved. The two results contradict with one another and this contradiction could be as a result of error in the assessment since the finding of the Spearman correlation coefficient test is statistically significant at 0.027, which is close to 0.05. Another justification for the contradiction is that the finding of the Spearman coefficient was affected by the small sample size of only 96 subjects.

The relationship between the learners’ evaluation of M-learning with AR and M-learning without AR was tested using the Pearson correlation coefficient and the Spearman correlation coefficient. The findings of these analyses indicated that in some questions, the learners' assessed the two frameworks independently. The association between the two frameworks is positive since learners who expressed a favorable view about M-learning application with AR also had similar view about M-learning application without AR. Finally, this research makes the conclusion that M-learning application with augmented reality is superior to M-learning without augmented reality with regard to the features of usability, attractiveness, learnability and user satisfaction.

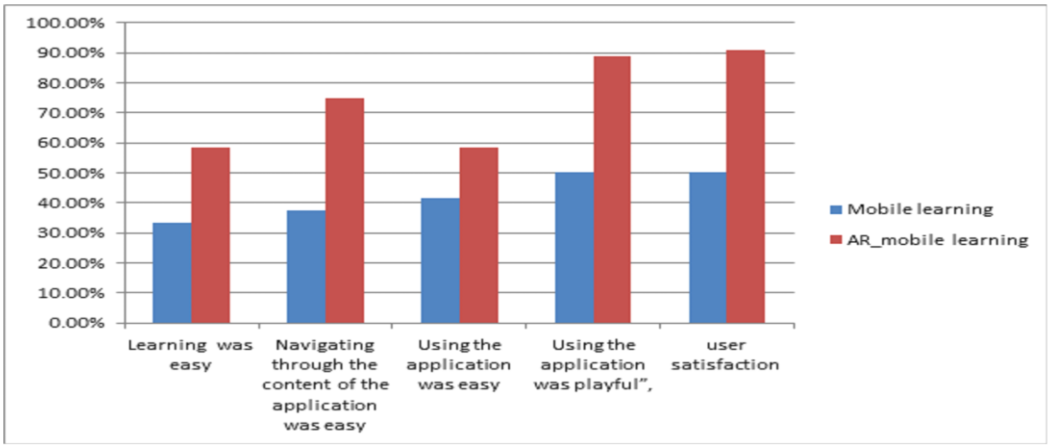

Figure 3. Comparing the Usability between Mobile Learning and AR in Mobile Learning

6. Conclusion and Future Work

In this paper we have present augmented reality for mobile learning to achieve the interaction activities between learners and teachers. A learning system was developed based on the proposed approach and an experiments has been conducted to evaluate effectiveness of the approach in an elementary school. The experimental results show that proposed approach augmented reality in mobile learning more efficient than other approach such as mobile learning. Also show that AR in mobile learning is able to improve students' learning performance in learning activities owing to use of AR technology. In the future we will try to apply my approach to other mobile learning application including scheduling mobile learning courses in cloud computing.

References

[1] Andujar J. M., Mejias A., & Marquez M. A. (2011) Augmented reality for the improvement of remote laboratories: An augmented remote laboratory. IEEE Transactions on Education, 54(3), 492-500.

[2] B. Meyer "MOBILE DEVICES AND SPATIAL ENACTMENTS OF LEARNING: IPADS IN LOWER SECONDARY SCHOOLS" 12th International Conference Mobile Learning 2016.

[3] Brevern, H. 'Cognitive and logical rationales for e-learning objects', Journal of Educational Technology and Society, vol. 7, no. 4, pp. 2-25, 2005.

[4] Black, M. and Edgar, W. 'Exploring mobile devices as grid resources: using an x86 virtual machine to run boinc on an iPhone', 10th IEEE/ACM International Conference on Grid Computing, Washington, DC, USA, pp. 9-16, 2009.

[5] Chang, C. and Sheu J. 'Design and implementation of ad hoc classroom and eschoolbag systems for ubiquitous learning', IEEE International Workshop on Wireless and Mobile Technologies in Education, Växjö, Sweden, pp. 8-14, 2002.

[6] Chang, V. ‘Web service testing and usability for mobile learning’, International Conference on Networking, International Conference on Systems and International Conference on Mobile Communications and Learning Technologies, (ICN/ICONS/MCL), University of Southampton, UK, pp. 2-21, 2006.

[7] Chen, Y. C., Chi, H. L., Hung, W. H., & Kang, S. C. (2011). Use of tangible and augmented reality models in engineering graphics courses. Journal of Professional Issues in Engineering Education and Practice, 137(4), 267-276.

[8] DiCerbo, K., Kovac, R., West, P. Frezzo, D., Behrens, J. and Sehnalakova, J. ‘Individual practice and collaborative inquiry: instructional configurations in a simulation environment’, 6th International Conference on Networking and Services (ICNS), pp. 335-339, 2010.

[9] Honeyman, M. ‘A valid alternative for higher education’? 20th Annual National Agricultural Education Research Meeting, University Park, PA: The Pennsylvania State University, Department of Agricultural and Extension Education, pp. 67-73, 1993

[10] Han, M. ‘New technology of distance learning in China’, International Conference on Computer Science and Service System (CSSS), Nanjing, China, pp. 517-519, 2011.

[11] Hoppe, U., Lingnau, A., Machado, I., Paiva, A., Prada, R. and Tewissen, F. ‘Supporting collaborative activities in computer integrated classrooms-the NIMIS approach,’ 6th International Workshop on Groupware, Duisburg University, Germany, pp. 94-101, 2000.

[12] Jin, Y. ‘Research of one mobile learning system’, International Conference on Wireless Networks and Information Systems, Guiyang University, China, pp. 162-165, 2009.

[13] Kukulska-Hulme. ‘Mobile usability in educational contexts: what have we learnt’? International Review of Research in Open and Distance Learning, vol. 8, no. 2, pp. 1-16, 2007.

[14] Kristoffersen, S. and Ljungberg, F. ‘Making place to make it work: empirical explorations of HCI for mobile CSCW’, International ACM SIGGROUP Conference on Supporting Group Work, New York, 276-285. 1999.

[15] Kamarainen, A. M., Metcalf, S., Grotzer, T., Browne, A., Mazzuca, D., Tutwiler, M. S., & Dede, C. (2013). EcoMOBILE: Integrating augmented reality and probeware with environmental education field trips. *Computers & Education, 68*, 545-556.

[16] Lobo, D. et al. ‘Web usability guidelines for smart phones: a synergic approach’, International Journal of Information and Electronics Engineering, vol. 1, no. 1, pp. 33-37, 2011.

[17] Parsons, D. and Ryu, H. ‘A framework for assessing the quality of mobile learning’, 11th International Conference for Process Improvement, Research and Education (INSPIRE), UK, Southampton Solent University, pp. 17-27, 2006.

[18] Prensky, M. ‘What can you learn from a cell phone? Almost anything’! vol. 1, no. 5, 2010. Available online at http://www.innovateonline.info/pdf/vol1_issue5/What_Can_You_Learn_from_a_Cell_Phone__Almost_Anything!.df

[19] Sharples M., Milrad M., Arnedillo-Sánchez, I., & Vavoula, G. (2009). Mobile learning: Small devices, big issues. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder, & S. Barnes (Eds.), *Technology enhanced learning: Principles and products*. (pp. 233-249). Heidelberg, Germany: Springer.

[20] Traxler, J. and Leach, J. ‘Innovative and sustainable mobile learning in Africa’, 4th IEEE International Workshop on Wireless, Mobile and Ubiquitous Technology in Education, Los Alamitos, USA, pp. 98-102, 2006.

[21] [15] Ting, R. ‘The advanced mobile learning practices: learning features and implications,’ 7th IEEE International Conference on Advanced Learning Technologies, (ICALT), Taipei, Taiwan, pp. 718-720, 2007.

[22] Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. Computers & Education, 62, 41-49.

[23] Wong, L. H., & Looi, C. K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers & Education, 57*(4), 2364-2381.

[24] Wang, M., Shen, R., Tong, R., Yang, F. and Han, P. ‘Mobile learning with cell phones and pocket-PCs’, Springer-Verlag Berlin Heidelberg, New York, pp. 332- 339, 2005.

[25] Wang, S. and Dey, S. ‘Adaptive mobile cloud computing to enable rich mobile multimedia applications’, IEEE Transactions on Multimedia, accepted, pp. 1-14, 2013.

