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Needs and Potential Use of Augmented Reality in Teaching and Learning Computer Architecture and Organization Course: A Pilot Study

Anis Salwani Binti Abu Bakar, Hasliza Binti A Rahim @ Abd. Rahman & Noraini Binti Desa

Jabatan Kejuruteraan Elektrik,Politeknik Sultan Haji Ahmad Shah,Kuantan, Pahang

anis@polisas.edu.my, haslizarahim@polisas.edu.my & norainidesa@polisas.edu.m

Abstract

Augmented reality generally defined as an enhanced version of the real physical world accomplished through the use of visual elements, sound, or other sensory stimulation delivered through various platforms of technology application. In the Electrical Engineering Department of Politeknik Sultan Haji Ahmad Shah, the Computer Architecture and Organization Course is still being delivered to students via conventional methods of interactive lectures and discussion in the classroom. Despite the fact that blended learning approach has been implied, students' understanding of the course is still at a low level based on their achievement in continuous assessment and final examination. Considering that this course is one of the difficult courses offered to students majoring in Diploma In Electronic Engineering (Technology Computer), the teaching and learning process always ends up with merely teacher centred learning rather than student centred learning. Hence this study aims to identify the needs and potential constructs or topics that are suitable to adopt augmented reality (AR) innovation in teaching and learning of Computer Architecture and Organization Course in order to help in increasing the students' understanding and achievement. Further findings reveal that students and lecturers showed very high perception of the necessity of using AR in Computer Architecture and Organization Course teaching and learning processes. The adoption of AR is expected to become an effective teaching innovation method for lecturers and consequently assist the students to improve their understanding and achievement in the course. Further study is also expected in reviewing the effectiveness and implementation of AR innovation model that will be developed later on.

Keyword

Augmented reality, teaching innovation, computer architecture, computer organization

Introduction

Augmented reality is a new form of technology advancement that enables users to merge real-life sensory experience with perceptions of the digital environment (Azuma, Baillot, Behringer, Feiner, Julier and MacIntyre, 2001). They also suggested that AR is built up by three main characteristics which are (a) real and virtual objects incorporated into reality; (b) collaboration between real and virtual objects, and (c) real-time interaction between real and virtual objects. This strong characteristic in AR allows users to communicate with the virtual objects that are placed within the real scenes around and consequently undergo the most natural interaction between real human and computer (Cai, Wang, & Chiang, 2014).

Fig.1 Augmented Reality

Computer Architecture and Organization course is classified as one of the specialisation courses offered to students majoring in Diploma In Electronic Engineering (Technology Computer). This course covers a broad area of knowledge regarding the concepts and principles of computer hardware operation and computer's component logic design. Furthermore, this course also enables students to correctly evaluate the design of a typical logic computer, connection between computers. In short, this course will equip students with the knowledge about basic computer logic circuits that is widely used in computer hardware systems.

Problem Statement

Looking at the current situation in Malaysia's Polytechnic teaching and learning environment, there are still insufficient counts of teaching aids innovation based on AR technology implementation. Computer Architecture and Organization Course is one of the toughest courses offered to students of Diploma In Electronic Engineering (Technology Computer). Referring to statistics gained from student's achievement during final examination for the Dec 2019 session, 27% of students that enrolled this course were unable to achieve less than 40 marks for the overall assessment evaluation causing them to fail the course. Findings from the questionnaires and interviews conducted to students that failed the subject suggested that they did not understand some of the construct or subtopic from the course that needed further explanation using visual aids in a more realistic way that could be achieved through innovation of teaching and learning methods via AR technology.

Research Objective

Referring to the problem statement above, this pilot study aims to

i. investigate the needs or any specification requirements for developing a teaching aids innovation using AR.
ii. investigate specific constructs or subtopics in Computer Architecture and Organization Course that need to be implemented in the teaching aids innovation using AR.

Literature Review

Rapid development of information technology in recent years has resulted in revolutionizing all aspects of life aligned with development of the Industrial Revolution 4.0 (IR4.0). Augmented reality technology as one of the emerging branches of the IR4.0 has been widely studied crossing all sorts of knowledge horizons. From computer games, advertising, business, medical and even educational aspects, ample studies have illustrated that AR technology is suitable to be applied in education (Billlinghurst, 2002). AR is reported to increase the level of student motivation, giving a positive impact on the learning experience especially for weak students (Frietas & Campos, 2008). Research focusing on empowering the teaching and learning methods of welding technology through the use of AR has proven that AR technology through *AugmentedArc* simulation machine is suitable to be used as an improvement of welding technology course (Asni & Fariza, 2018).

Implementation of augmented reality in teaching and learning methodology has opened up a new chapter to educators in choosing a better teaching and learning medium that is more interactive, attractive and effective to students. In fact, the application of augmented reality in teaching and learning has proven to be a catalyst in developing more creative thinking, increase understanding and paradigm shifting of student learning methods (Huda Wahida et al, 2010). Therefore, the study of the necessity and suitability of AR as a teaching and learning aid for Computer Architecture and Organization course is mandatory.

Research Methodology

The method used in this study is divided into two which are:

i. quantitative method that used questionnaires as the research instrument to investigate specific constructs or subtopic in Computer Architecture and Organization Course that need to be implemented as potential use and contents in the teaching aids innovation using AR. Respondents for this pilot study include 18 students that had failed the course in Dec 2019 session and 5 lecturers that had the experience teaching this course at various sessions

ii. qualitative method that used interviews questionnaires as the research instrument to investigate

the needs or any specification requirements for developing a teaching aids innovation using AR. The interview was conducted between the researcher and 5 lecturers from the Electrical Engineering Department of Politeknik Sultan Haji Ahmad Shah who had the experience teaching this course at various study sessions.

Summary of Findings and Discussion

A set of questionnaires have been distributed to review students and lecturers' interpretation regarding the needs or any specification requirements for developing a teaching aids innovation using AR.Another set of questionnaire is also distributed among the same target to investigate specific construct or subtopic in Computer Architecture and Organization Course that need to be implemented in the teaching aids innovation using AR

In this research, Likert Scale with five levels of agreements has been applied to respondents. The five points of agreements are: (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree. The tendency level of mean score is summarised in **Table 1** while **Table 2** onwards represents the mean score range frequency level for each element investigated in the questionnaires.

Table 1

Mean Score Range Frequency Level

Mean Score Range	Frequency
1.00 – 2.33	Low
2.34 – 3.67	Average
3.68 – 5.00	High

Sourc: Landell 2001

Table 2

Items based on constructs or subtopics in Computer Architecture and Organization Course

General question: I still found out the * subtopic is hard to understand even though after completing the lecture regarding each topic

No	Item*	Mean	Frequency
1	Bootstrapping Process in BIOS System	4.54	High
2	Pipeline techniques in computer architecture operation	3.73	High
3	Arithmetic operation for numbering system in computer architecture	3.42	Average
4	Five-step of pipelined execution process	3.57	Average
5	Arithmetic operation in Binary System components comprise in Arithmetic Logic Unit	3.20	Average
6	Basic process in Arithmetic Logic Unit	3.65	Average
7	Operation of virtual memory in memory organization: Paging and Segmentation	4.07	High
8	Operation of cache memory in memory organization: Associative Mapping, Direct Mapping, Set-Associative Mapping	3.81	High
9	Block diagram of memory address decoder	3.73	High
10	Block diagram of interconnecting system components: Buses and Interfacing	4.14	High
11	Synchronous and Asynchronous data transfer technique	4.20	HIgh

Based on **Table 2**, there is no item that reaches the lowest level of mean scores. It is understandable that the targeted respondents are from the students that already failed in the particular course. None of the constructs are easily understandable by them. Few items from the questionnaire had touched the score at average level due to their preliminary knowledge gained from previous courses which cater the fundamental knowledge of Digital Electronic. While the rest of the construct items had achieved high level frequency of mean score because these knowledges derived from these constructs are theoretically new to them. The constructs that reached a high level of mean scores will be further included as the potential content in the development of teaching aids innovation using AR methods.

Table 3

Summary of findings from interview

Item	Summary of statements
Selection of constructs	Focus on construct with high mean scores
Reason for construct selection	Students need more understanding regarding those construct
Suggested delivery method via AR	Demonstration and simulation
Reason for suggested delivery method	Students are unable to imagine most of the process happen in a computer organization and process. Hence the constructs have the potential to be applied in AR
Suggestion improvement of current teaching delivery method	Development of teaching aids innovation using AR

Table 3 shows a compress summary of findings from the interviews series with lecturers that have experience teaching this course. All of them agreed to make a massive improvement to the current teaching delivery method by developing an innovation of teaching aids using augmented reality technology in order to increase the understanding of students about this course.

Conclusion

In a nutshell, this pilot study shows that developing an innovation of teaching aids with augmented reality approach is very necessary and significant in order to secure students' understanding of Computer Architecture and Organization course. The development of innovation of teaching aids by implementing the AR technology is expected to become an effective delivery method for lecturers and consequently assisting the students to improve their understanding and achievement in the course. Further study is expected in reviewing the effectiveness and implementation of AR innovation model that will be developed later on.

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