Utilizing Augmented Reality Technology for Teaching Aid Tools based on Model-based Learning (AR-MB)

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Highlights: The success of model-based learning requires extensive preparations and the adoption of appropriate strategies. This is because object visualization plays a crucial role for this type of learning with student engagement in self-imagination being significantly reduced. Therefore, a prototype was developed using the Augmented Reality-Model-Based (AR-MB) framework to test its effectiveness in providing a better learning tool to students. A study involving a group of university students, who were enrolled in the Ethnic Relation subject was conducted to enhance their understanding of the Iranuns – a Sabahan ethnic group. The study concluded that 86% of students agree that AR can enhance their understanding of the related subject matter. Hence, the prototype proves to be a successful model that could also be implemented in other subjects. Future applications include the adaptation of a developmental framework for architectural modelling courses.

Key words: *augmented reality, model-based learning, teaching aid, 3D modeling*

Introduction

Numerous subjects taught in educational institutions are based on the show-and-tell approach (Clifton et. Al., 2105). However, this approach may not be the best mode of instruction in educational settings. Educators face many problems in ensuring that students are beyond objective thinkers who tend to only memorize without clearer representations of the material. This is in contrast to students who have photographic memories and are better at remembering things they learn.

Another problem that arises in learning environments is the lack of interest in the subject matter. Contrary to the belief that students are lazy, the reason for the disinterest is due to the materials being dry and lacking creative burst (Jordan et. al., 2014). In addition, students may understand better when they are able to use other senses, such as touch, as opposed to vision and hearing. Currently, technical subjects use books as their main references. However, these books are static and provide a one directional experience to students that prevents them from communicating creatively with the books (Bacca et. al., 2016).

As a solution, an interactive system or courseware is needed to boost the learning experience of students. Lomaliza et. al. (2016) and Diaz et. al. (2015) discussed that the usage of practical virtual objects will enhance an individual's learning capabilities. These interactive visual aids are not only fun but will also improve the memorizing process of students (Novotny, 2013; Bacca et. al, 2015).

Objectives

We have identified several objectives in conducting the study.

i. *To Identify the suitability of augmented reality (AR) in model-based learning.*

   We have developed a framework for the implementation of AR technology in line with specific subject objectives. By using this framework, it will ease the process of developing AR for model-based learning.

ii. *To develop AR-model-based(AR-MB) learning prototype.*

   Based on the proposed framework, we developed an AR courseware for an ethnic study subject, known as I-ranun AR courseware, which is an introduction to one of the ethnic groups in Sabah, recognized as the Iranuns.

iii. To analyze the effectiveness of the proposed model in higher learning institutions.

   The developed prototype that uses the AR-MB framework is tested on university students to observe its effectiveness on their learning experiences.

AR-MB Development Framework

This framework is based on the Augmented Reality Integrated Simulation Education (ARISE) conceptual model (Carlson et. al., 2016) and Connectivism learning environment (Techakosit & Wannapiroon, 2015). Furthermore, ARISE is based on in-situ learning, which is applicable in critical learning environments. In-situ learning is also being used by Mendoza et. al. (2015) and Je□ábek et. al. (2015). For AR-MB, no on-site facilitators are needed due to the nature of this framework that can be built and used via mobile devices.

The combination of ARISE, model-based learning, and mobile devices contributed to the successful development of our prototype. We developed the system without any problems due to each component of the AR-MB framework complementing one another.

Figure 1 : AR-MB Development Framework with Important Attributes Need to Consider

Prototype Development (I-ranun)

I-ranun consists of a 3-Dimensional (3D) representation, video, and animation of the Iranuns' unique cultures such as their official wedding ceremony and musical instruments. This mobile application employs the AR techniques that offer users the opportunity to explore and gain an in-depth understanding of the Iranun people, who are one of the minority ethnic groups in Kota Belud, Sabah, Malaysia (Takhta, 2016).

Background

This prototype comes with a book of the Iranuns that acts as a 'trigger image'. This function allows the users to scan an image which would lead to the 3D objects, video or animation appearing on the screen. The book of I-ranun will be designed creatively to attract the users to view it by following the designing principle. The user can experience the real object in all views instead of the traditional 2-dimentional (2D) images in the book. Additionally, other functions are also available to enhance one's learning experience such as sound, movement, and extra info. By using an AR, information about the Iranuns can be easily understood and assessed in an interactive manner.

Testing

Thirty students from Universiti Malaysia Pahang, who were enrolled in the Ethnic Relation subject, tested this AR-MB application. After experimenting with the device, the students answered a set of questionnaires as shown in **Table 1**.

Result and Discussion

Table 1: Usability Testing Result for AR Model-based Learning Implementation on I-ranun

Questions	Result		Summary
	Yes (percentage)	No (percentage)	
Did you easily understand how to use the app?	100	0	The system is easy to use
Do you think I-ranun is suitable for youngsters?	80	20	A suggestion to add more items in contents
Do you think 3D modelling is suitable to represent the Iranun culture?	80	20	A suggestion to design more realistic 3D modelling

Do you think you were able to gain more information about the Iranun culture?	80	20	Lack of contents
What do you think about the I-ranun book design?	100 (attractive)	0 (not attractive)	The book's design is acceptable
Did you think I-ranun could preserve the originality of the Iranun culture?	80	20	Only preserve the information of the Iranuns.

The results in **Table 1** show that 86% of students agreed that the I-ranun, which is an AR-MB application, is able to enhance their knowledge by providing an interesting platform to learn the material while preserving the originality of the Iranun culture.

Key Benefit

i. Represents a model for educators to develop an interactive model-based teaching aid for any subjects.
ii. Able to enhance the students' motivations, goals, collaborations, interactions, attitudes and enjoyment of the learning process.
iii. Speeds up the transfer of knowledge between students and educators.
iv. Supports the e-learning idea of students having access to the materials by downloading them on their mobile devices whenever they need them; as a result, they are able to independently learn and revise.

Advantages to Education and Community

i. Emphasizes storytelling instead of the conventional book-reading.
ii. Enhances one's ability to deliver a message to the community via modelling through AR instead of reading a text.
iii. Supports autistic individuals who may have difficulties in comprehending written knowledge.
iv. Encourages advancements in public education by providing an alternative interactive medium of information.

Commercial Values

The commercial values of AR-based software/courseware are based on its content. As an example, the prototype provided here has the potential of being used as a tourism app to allow a deeper immersion of a group's culture. Furthermore, the same framework could be used to develop site helpers at cultural and historical locations (Mendoza et. al., 2015). By using markers at these sites, we could animate 3D AR for historical education to improve one's experience (Cianciarulo, 2015). Additionally, since AR applications require devices with a camera feature, mobile devices, such as tablets or smartphones, are the best avenues to expand the usage of this prototype since these apps will have market values through Google Play Store and Apple Store.

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