Augmented Reality Technology for Year 10 Chemistry Class: Can the Students Learn Better?

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ABSTRACT

The purpose of this article was to evaluate the effectiveness of using mobile augmented reality (AR) instructional material for Year 10 science students in a secondary school in Brunei Darussalam. Specific learning styles were identified for the control and the experimental groups. A mobile AR application of instructional material was developed for year 10 chemistry lesson focusing on redox reaction using Vuforia SDK and Unity3d. The material developed consisted of visual, audio and kinesthetic elements of learning modalities which aimed to stimulate students’ interest and improve their learning ability. The t-test (t = -3.39) in the posttest indicated a significant result (p = 0.00152) between the mean scores of the experimental (mean = 42.72) and control (mean = 26.36) groups. The result showed that the intervention of classroom lessons introduced by the mobile AR application had a significant positive impact on the learning outcome and supported the idea that AR can be a valuable teaching tool. Qualitative analysis also indicated that it improved the liveliness of the learning environment and the interaction amongst the students.

KEYWORDS

Audio, Augmented Reality, Instructional Design, Kinesthetic, Learning Style, Mobile Learning, Unity3d, Visual

INTRODUCTION

The recent development of portable devices with build in sensors, high speed 4G Internet connectivity and ease of access to mobile applications have led to increasingly popular use of Augmented Reality (AR) technology in the field of education. However (Cheng & Tsai, 2013) reported that studies on AR in science education are few in number and that the field is in its infancy. Recent research focuses on issues such as development, usability, and initial implementation (Barraza Castillo et al. 2015; Blake & Butcher-Green, 2009; El Sayed, Zayed, & Sharawy, 2011).

Teachers would normally adopt instructional strategies that have been successfully used without fully understand the different learning styles and preferences of learners at different levels in the classroom. Studies in the effectiveness of mobile AR technology in education associated to

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learner’s learning style from Dunn’s (Dunn & Dunn, 1992; Dunn, Dunn, & Price, 1981) model are non-existence. It would be a challenge for educators to use AR technology to teach whilst taking into account the different learning preferences of their students in the class. The first purpose of the study is to investigate whether there is a significant difference between the learning outcomes of students who use AR technology in their lessons and those who do not. The second purpose is to find out if AR could leverage on the different learning styles of students. And the third is to elicit the opinions of the students from using AR in their learning.

In this study, the experiment was conducted on Year 10 Science students of a secondary school in Brunei Darussalam who were preparing themselves for the Cambridge ‘O’ level examinations. The topics designed for the mobile AR modules were based on Chemistry redox reaction as part of the syllabus for their examinations. Prior to carrying out the experiment, the Learning Style Inventory (LSI) by R. S. Dunn et al. (1981) was administered on the subjects to profile their learning orientation. The profiling helped the teachers to understand better the learning preferences of the students in terms of modalities.

The design of the AR instructional materials was carefully crafted to incorporate the aspects of Visual, Auditory and Kinesthetic (VAK) based on the Dunn’s (1981) physiological stimulus to maximize the engagement of the students’ learning. The study performed statistical analysis on the pre- and post-tests questions for both the control and experimental groups to determine the significance of the interventions and impact of AR instructional material on their learning outcomes. Qualitative analysis was also performed on questionnaires distributed to the students at the end of the lessons.

The next section consists of the background study of mobile AR technology and applications followed by a description on VAK learning styles inventory. The instrument was discussed next followed by profiling of the students’ learning orientation and the design of AR instructional material. The experiment, results and discussion were presented in the next two sections. A discussion with conclusion was made at the end of the study.

MOBILE AR AND APPLICATIONS

AR is a technology that blends real world environmental elements with computer generated images or artificial information in real time. In a typical AR setting, a user’s current perception of reality and interactivity is enhanced through the use of interactive devices. Thus, the user feels like “interacting” with the real object. Krevelen and Poelman (2010) highlighted the uses of AR in many domain areas such as medical, military, advertisement, entertainment and so forth.

In the early days, due to the high cost of technology and computing power, AR applications were only found in areas such as in the medical, military and big manufacturers (Azuma, 1997; Carmigniani & Furht, 2011; Schmitz, Klemke, & Specht, 2012). In the medical field for example, Bichlmeier et al. (2007) research has been made to incorporate AR with medical imaging and instruments incorporating the physician’s intuitive abilities. Medical imaging and instruments such as video images recorded by an endoscopic camera device presented on a monitor viewing the operating site inside the patient. AR is applied so that the surgical team can see the imaging data in real time while the procedure is progressing. Bichlmeier et al. (2007) also introduced an AR system for viewing through the “real” skin onto virtual anatomy using polygonal surface models to allow for real time visualization.

On the other hand, military has been using AR extensively to enhance military combat simulation, aircraft navigation and weaponry control. In military aircraft the Head-Up Displays (HUDs) and Helmet-Mounted Sights (HMS) are used to superimpose vector graphics upon the pilot’s view of the real world. They not only provide basic navigation and flight information, but are sometimes registered with targets in the environment, providing a way to aim the aircraft’s weapons. For example, the chin turret in a jet fighter gunship slaved to the pilot’s HMS allowing the pilot to aim the chin turret simply by looking at the target. The new and future generations of combat aircraft will be developed with an HMD built into the pilot’s helmet (Wanstall, 1989).
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