Chapter 27

Using Augmented Reality Technologies to Enhance Students' Engagement and Achievement in Science Laboratories

Rong-Chi Chang
Taiwan Police College, Taiwan

Zeng-Shiang Yu
Asia University, Taiwan

ABSTRACT

This article aims to explore the impact of AR on the learning outcomes of college freshmen and their knowledge about the biology lab course. In a study, a basic biology lab course app was developed using AR technology. The students used this app to prepare for a basic biology lab course, and carry on self-learning without the help of instructors. The results showed that by integrating AR technology into the instruction, the students took on a more positive autonomous learning attitude; they were able to gain a better grasp of the basic biology lab knowledge through the interactive operation as well as cooperative learning. In addition, the students were found to have learned the importance of scientific knowledge with this interactive technology. The basic biology lab course app developed in the study offered the benefits of autonomous learning, situational simulation and interactive experience.

1. INTRODUCTION

A learning environment created by information technology can encourage students' learning interest and effectively improve their motivation (Amory, 2010; Hsu, Chen, Su, Huang, & Huang, 2012). The use of information technology in education facilitates the learning process of students by adding simulation and imparting attractiveness and significance to the contents, thereby enhancing their enthusiasm for

DOI: 10.4018/978-1-5225-8179-6.ch027

learning. This educational model has changed the convention of learning through transforming learning into something more attractive and creative (Sumadio & Rambli, 2010). Technology-assisted learning is mainly presented in the form of multimedia, with the use of keyboard and mouse to manipulate texts or images on a user interface to interact with the learning materials. Compared to keyboard and mouse control, the use of a somatosensory control interface is more intuitive. Students can use somatosensory controls in a learning environment to gain a more intimate experience that is closer to reality, which is conducive in enhancing their interest and motivation.

In recent years, technology-assisted education is presented with a more naturalistic mode of operation, where voice recognition and gesture interaction are rising in popularity. The use of virtual reality (VR), for instance, allows students to use different mobile devices to interact with virtual learning materials, showing promising potential for integrating information technology in educational development (Yang, Chen, & Jeng, 2010). AR is a variant of VR (Arusoaie et al., 2010). By combining virtual systems and physical tools, a mixed reality platform is created to provide a more immersive experience for learners. Human-machine interaction in the mixed reality enhances learners' interest and learning outcomes (Hsieh & Lee, 2008).

A number of studies have shown that the application of mix-reality using hand-held devices can create a more realistic scenario-based learning and a ubiquitous learning environment (Chiang, Yang & Hwang, 2014; Wu, Lee, Chang, & Liang, 2013). The mobility of hand-held devices increases the interaction between students and the learning environment. Through the built-in wireless connectivity, GPS functions, and sensors like 3-axis accelerometer and electronic compass, AR technology allows various information, in the form of texts, pictures, images, sound or 3D models, to be superimposed in real environments. Students engage in a variety of situational simulations, games or visual activities to immerse themselves in learning. Many studies actually recommend the integration of AR in training and learning settings (Wu, Lee, Chang & Liang, 2013).

AR applications are characterized by three features: combination of reality and virtual worlds, real-time interaction, and 3D objects and virtual objects (Azuma, 1997). AR offers a learning experience that supports real-world interaction with virtual elements, operation of objects via a virtual interface, as well as the smooth transition between reality and virtual worlds (Park, Jung, & You, 2015). Unlike other computer interactive technologies that takes the user out of reality and focus only on a screen, AR lets learners gain a heightened immersive awareness of their surrounding environment. As a result, AR is regarded as a promising technology in education that supports and helps improve students' learning motivation and interest in educational settings (Alcañiz, Contero, Pérez-López, & Ortega, 2010).

The rapid advances in technology products, e.g., VR, AR, and mobile devices, have given rise to different experiences from the user end, making information technology applications in education an important topic worthy of discussion. The changes in human-machine interaction, shifting from the traditional keyboard and mouse manipulation to the image-based interface coupled with somatosensory manipulation, have attracted experts and researchers to pay considerable attention to the issue of user experience (Su, Hsu, Chen, Huang & Huang, 2014). The product, system, or service developed by the designer must improve the interface's content and user satisfaction by looking into the affective and experience feedback from users' interaction with the product (Hsu, Chen, Huang & Huang, 2012). The application of this emerging technology in education particularly calls for the understanding of user experience to gauge the practicality and usefulness of the technology and system.

In this study, a learning app for basic biology experiments—ArBioLab—was developed using AR technology. This app can be used in basic biology lab courses, enabling students to establish the cor-

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