

# Assessing the Effectiveness of the Augmented Reality Courseware for Starry Sky Exploration

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## ABSTRACT

Augmented reality tools and applications have been shown to have powerfully impelled the development of the field of education. In this article, the authors designed and developed an augmented reality technology-based courseware “Starry Sky Exploration—Eight Planets in the Solar System” and explored how AR can bring an immersive learning experience to students and improve students’ learning effectiveness. This article presents and evaluates AR courseware applicable for the geography curriculum in secondary schools in China. In this study, 36 students from Shanghai secondary vocational school were invited to participate in the experiment, the authors use reliability analysis, regression analysis and brainwave analysis to evaluate the effectiveness of the AR course. The authors found that students have higher learning satisfaction and behavioral willingness in AR-based experiential learning activities. It can be seen that AR helps to stimulate students’ interest in learning.

## KEYWORDS

Augmented Reality, Effective Assessment, Experiential Learning, Learning Effectiveness

## INTRODUCTION

Experiential learning is an important way of learning. The essence of experiential learning is that learners acquire new knowledge and skills in the process of cognition, experience and perception through hands-on, proactive practice, methods, attitudes and quality (Kolb & Kolb, 2017). In the era of intelligent information technology, the rapid development of various emerging technologies provides conditions and assistance for the application and promotion of experiential learning in practice (Ouyang & Stanley, 2014).

AR can be used as a key means by which to increase the learning effect and improve the learning experience. It can help promote the optimal integration between learners and technology, and to prompt the transformation of the existing learning paradigm, so as to improve the learning effect. Johnson et al. (2010) posited that “AR has strong potential to provide both powerful contextual, on-site learning

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experiences and serendipitous exploration and discovery of the connected nature of information in the real world.” For instance, Kaufmann and Schmalstieg (2003) applied AR technology to develop a 3D construct in the teaching of space geometry in mathematics, and their experiments showed that learners could efficiently acquire the knowledge of the space geometry through the view and interaction with 3D graphic stereo images. Enyedy et al. (2012) had tried to utilize AR technology to create a virtual learning scenario to facilitate students’ understanding of object movement and Newtonian mechanics in physics. In the context of astronomical learning in secondary school in China, Li (2015a) and Li (2015b) found that students have both interest and curiosity, and are willing to explore further, but abstract knowledge contents are constrained by the traditional textual presentation forms and plain teaching methods in middle schools in China. Early in 2002, Shelton and Hedley (2002) adopted AR technology to simulate the environment of the galaxy and carried out experiments on teaching about the planets to help learners master the knowledge content. However, in their research, the AR system was fixed in one room and users were required to wear a head-mounted display (HMD) with a video camera connected to a computer.

The research in this paper was based on the application perspective of augmented reality for experiential learning activities. This study tested the positive effects of AR technology on attracting learners’ attention and factors that affect the learning effect. In this article, an AR technology-based courseware “Starry Sky Exploration—Eight Planets in the Solar System,” was designed and developed, and 36 computer majors students from Shanghai secondary vocational school were invited to experience this courseware, and their feedback questionnaire data was collected for the effectiveness assessment of the AR courseware. Collecting data through questionnaires and analyzing the factors that influence learners’ learning outcomes at different modules of the curriculum. In order to analyze the learner’s learning effect at different stages of the learning activity, the learner’s brainwave data analysis was added to the study.

## **LITERATURE REVIEW**

An AR system combines real world objects with virtual objects or superimposed information (Pappa & Papaopoulos, 2018). AR is not restricted only to the sense of sight; it can be applied to all senses such as hearing, touch and smell. AR allows for combining virtual content with the real world seamlessly (Azuma, Billinghurst, & Klinker, 2011). Many students spend long periods of time watching TV, surfing personalized content on the internet or playing engaging games using their desktop computers or mobile phones. This fact necessitated a change in teaching methods or, more accurately, in learning methods (Prensky, 2001).

Today’s students found it harder to become absorbed in classroom lectures (Sue, Maton, & Kervin, 2008). As an example of the current AR applications in education, Ibanez et al. (2014) created an AR application for teaching the basic concepts of electromagnetism. In this application, students could explore the effects of a magnetic field. For that purpose, the components used in the experiment (cable, magnets, battery, etc.) could be recognized using the camera of a mobile device like a tablet. As a result, students could see superimposed information such as the electromagnetic forces or the circuit behavior using the tablet. The results of this research showed that AR improved academic achievement and provided instant feedback.

Augmented reality technology was used to aid teaching. Augmented reality technology could create simulated learning situations and was applied to specific teaching practices in some disciplines (Fernandez, 2017). Shelton and Hedley (2002) applied augmented reality technology to geography teaching, used augmented reality technology to simulate the galaxy environment, carried out teaching experiments on the nine planets to help learners master the knowledge content. Noel (2012) applied augmented reality technology to physics teaching by selecting one class from the first grade and one from the second grade to conduct experiments. He used augmented reality technology to create virtual learning situations and simulated ground conditions with different friction, such as ice, grass,

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