Chapter 10
A Research Map to Leverage Augmented Reality in K12 Science Education

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ABSTRACT

This chapter presents a research map of designing an AR-integrated science trail for an inquiry-based curriculum for K12 science learning. Despite the potential advantages of using AR in education and its suitability for supporting science learning through simulation activities, AR's concrete uses are relatively not as well understood as that of other technologies. Prior studies have shown the value of inquiry-based learning complemented by computer technology in a scenario-based learning environment. To appropriate the potential of AR in education, this chapter aims at summarizing pedagogical affordances of AR in science education and exemplifying an AR-integrated science trail design. A comprehensive research map of designing an AR-enhanced science trail by integrating inquiry-based learning is elucidated in this chapter to provide insights for the design of AR-integrated subject learning and out-of-classroom learning.

INTRODUCTION

Augmented Reality (AR) technologies have been featured for their enormous potentials in learning and are recognized as one of key emergent technologies for education (Johnson, Levine, Smith & Haywood, 2010). AR offers tremendous possibilities for students in facilitating sensory immersion, navigation and manipulation, and have been reported to promote positive emotions while learning, enhance collaborative learning, and create more efficient and better learning outcomes (Cheng & Tsai, 2013; Wen, 2018; Wu, Lee, Chang, & Liang, 2013). As AR has the capability of integrating digital information into real-

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life scenarios, AR-enhanced inquiry lessons could engage learners in an immersive context to enhance scientific investigations where students can collect data outside classrooms, interact with an avatar, or communicate face-to-face with peers in a more authentic setting (e.g., Dunleavy, Dede, & Mitchell 2009). Despite the potential advantages of using AR in education and its suitability for supporting science learning through simulation activities, AR's concrete uses are relatively not as well understood as that of other technologies (Joseph & Uther, 2009). It has been recognised that AR is not designed for instructive pedagogies involving drill and practice techniques (Dunleavy, 2014), but we are only starting to understand how effective instructional or pedagogical designs for this emerging technology can be proposed. Existing review papers (e.g., Akçayır & Akçayır, 2017; Wen & Looi, 2019) on the topic have pointed out that more attention should be paid to exploring how to enhance the interaction between learners and the contextual information through pedagogical content design. As research in AR develops further, it will be important to ascertain what design approaches can optimise the distinct affordances of AR, and how one can mitigate its limitations and ultimately leverage its uses across the curriculum.

The potential of leveraging AR affordances to inquiry-based learning, particularly in science education, has been increasingly emphasized (e.g., Dunleavy et al., 2009; Nielsen, Brandt, & Swensen, 2016; Hsiao, Chang, Lin, & Wang, 2016). However, how to deploy the inquiry instructional technique and what scaffolding mechanisms can help to engage students in scientific inquiry activities should be further investigated (Ibáñez & Delgado-Kloos, 2018). Prior studies have shown that inquiry-based learning complemented by computer technology in a scenario-based learning environment can successfully increase learning motivation (Shih, Chuang, & Hwang, 2010; Soloway & Wallace, 1997). These inquiry-based learning tactics are student-centric exploration activities where teachers are facilitators, utilising structured techniques that prepare and encourage learners to problem-solve and learn proactively (Hwang, Wu, Zhuang, & Huang, 2013; Soloway & Wallace, 1997). When learners attain the techniques for problem-solving, they are better able to utilise the material to form a hypothesis or to propose answers to the problem (Looi, 1998). On this basis, we hypothesise that AR-based inquiry scenarios could be an effective innovative learning strategy in covering an extensive variety of domains— from observations and interactions to accessing actual scientific instruments or conducting more realistic experiments (Chiang, Yang & Hwang, 2014). We take the perspective that effective learning strategies supplemented with appropriate computer technology can greatly enhance learning motivation (Chu, Hwang, & Tsai, 2010; Jonassen, 1999; Hwang, Tsai, Chu, Kinshuk, & Chen, 2012; Jonassen et al., 1998). We argue that AR-based inquiry could be a point of entry into the transformation of classrooms into Splitter's (1991) communities of inquiry that preserve the "dimensions of inquiry and wonderment" at the forefront of the learner's daily learning activities (p.98).

In this chapter, we present a research map of designing an AR-integrated science trail for an inquiry-based curriculum for K12 science learning. The design is grounded with the situated learning theory which postulates that all learning occurs within a given context and the learning that happens is the outcome of the interaction and contact between the people, places, objects, process and culture within and related to the given situation (Brown, Collins, & Duguid, 1989). The purpose of the chapter is to exemplifying an AR-integrated science trail design to appropriate the potential of AR in science education.

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