Chapter 2
How Immersive Virtual Environments Foster Self-Regulated Learning

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ABSTRACT

Over the past decade, immersive virtual environments have been increasingly used to facilitate students' learning of complex scientific topics. The non-linearity and open-endedness of these environments create learning opportunities for students but can also impose challenges in terms of extraneous cognitive load and greater requirements for self-regulated learning (SRL). SRL is crucial for academic success in various educational settings. This chapter explores how the immersive virtual assessments (IVAs), an immersive virtual environment designed to assess middle school students' science inquiry skills, fostered SRL. The analyses combining educational data mining techniques with multilevel analysis indicated that students developed self-regulatory behaviors and strategies as they used IVAs. Experience with IVAs prepared students to adopt more efficient note-taking and note-reviewing strategies. Students also learned to exploit more available sources of information by taking and reviewing notes on them in order to either solve inquiry problems or to monitor their solutions.

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INTRODUCTION

Self-regulated learning (SRL) is important for academic success in various educational settings (Zimmerman & Schunk, 2001). Research has indicated that even undergraduate students usually lack sufficient SRL skills and ability and are often faced with difficulties in using SRL (Moos & Azevedo, 2008). It has therefore developed as an important goal for many K-12 teachers to help their students develop into learners who can regulate their own learning with effective SRL strategies (Perry, Phillips, & Dowler, 2004). One increasingly popular strategy for fostering SRL is to use personalized learning within computer-based environments (Azevedo, 2005). An increasing number of personalized learning environments now include various types of support for students in developing SRL skills, including both modeling those skills (Khachatryan et al., 2014), giving regular reports about whether students are demonstrating SRL (Arroyo et al., 2007), and even providing immediate feedback when students demonstrate behaviors associated with poorer SRL (Roll, Aleven, McLaren, & Koedinger, 2007). The challenge of open-ended learning environments such as immersive virtual environments, even environments designed to personalize based on student knowledge, is that learners have to deploy self-regulatory processes and strategies in order to complete tasks and learn complex topics (Azevedo, 2005; Segedy, Kinnebrew, & Biswas, 2015). In the current study, we aim to explore how SRL manifests in an immersive virtual environment for middle school science, and how this environment can be enhanced to adapt to the needs and self-regulated learning of different learners.

Self-Regulated Learning

While researchers have developed many theoretical models of SRL (see Pintrich, 2000; Zimmerman & Schunk, 2001), most models and definitions agree that the cognitive and metacognitive operations used in SRL require effort (Winne, 2011), and characterize learners as actively monitoring and controlling cognitive, motivational, and behavioral processes. In an attempt to integrate all the definitions, Pintrich (2000) organized published research around a set of phases of SRL. He described self-regulated learning as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation and behavior, guided and constrained by their goals and the contextual features in the environment" (p. 453).

Winne and Hadwin's (1998) framework proposes four distinguishable but recursively linked stages that SRL encompasses: 1) task definitions; 2) goal setting and planning; 3) enacting study tactics and strategies; and 4) metacognitively adapting studying (p. 278). In these phases, students develop an understanding of the learning task, set goals and construct plans to achieve their learning goals, execute various learning tactics and strategies, metacognitively monitor and reflect on their learning process, and adapt their plans, behaviors, and strategies accordingly. This framework offers a metacognitive view of SRL that integrates a more complex cognitive architecture (Greene & Azevedo, 2007; Winne, 2011), and has been adopted to study SRL in other open-ended learning environments (Moos, 2009; Moos & Azevedo, 2008). Given the interactive and open-ended nature of immersive virtual environments, this chapter applies Winne & Hadwin's model of SRL to the context of an immersive virtual environment.