Chapter 3
Exploring Cognitive Load in Immersive Educational Games: The SAVE Science Project

Brian C. Nelson
Arizona State University, USA

Diane Jass Ketelhut
Temple University, USA

Catherine Schifter
Temple University, USA

ABSTRACT

SAVE Science is a research project focused on creating an innovative model for assessment of learning in STEM. In SAVE Science, we are implementing game-like modules for evaluating science content and inquiry in grades 7-8, using an assessment rubric of student interactions in a virtual environment designed to capture evolving patterns of scientific understanding among students. We are also investigating two "conditions for success" for virtual environment-based assessment: managing the effects of cognitive load students experience in complex virtual environments, and helping teachers integrate technology into their pedagogy. In this paper, we provide an overview of our design approaches aimed at helping students manage the high levels of cognitive load they report experiencing in virtual environments. By reducing the perceived complexity of virtual environment-based assessments, we hypothesize that learners will be better able to attend to the processes associated with the assessments, leading to more accurate evidentiary data.

BACKGROUND

Educational virtual environments have emerged in recent years as a platform for hosting science curricula centered on inquiry situated in realistic simulations of the visual contexts and functional processes found in the real world (Nelson & Ketelhut, 2007; Slator, Hill, & Del Val, 2004; Zacharia, 2007). For example, students can view books in a digital library, talk to computer-based residents of virtual towns, and test the water quality of rivers and lakes. Importantly for educational purposes, students in virtual environments can also conduct

DOI: 10.4018/978-1-4666-0029-4.ch003

realistic inquiry activities and seek solutions to complex problems modeled in the game-like environments. In the *SAVE Science* project, students have an overall goal of uncovering the likely contributors to a series of problems facing a small virtual town (sick farm animals, weather-related crop failure, and climate-related problems with the town's water). To accomplish the overall goal, students need to apply knowledge and skills learned in their classroom-based science curricula through a series of assessment quests embedded in the *SAVE Science* virtual world. Students enter the *SAVE Science* world multiple times over the course of a school year, conducting a new inquiry quest on each visit.

The *SAVE Science* project makes use of an educational virtual world called Scientopolis that we have developed. Our virtual environment has been designed to incorporate and build upon findings from our extensive previous research with the River City Project. The River City curriculum is centered on scientific inquiry skills, particularly of hypothesis formation and experimental design. The main learning goal for students exploring River City is to discover why residents of the virtual town are getting sick (Nelson, Ketelhut, Clarke, Bowman, & Dede, 2005). The River City virtual world is set in the late 1800's, and named for the river that runs through most of the town. River City includes a main street with shops, a library, and elementary school, along with institutions such as a hospital, university, and city hall. Upon entering the city, students can investigate why town residents are sick by interacting with computer-based city residents, explore possible contamination sites such as muddy streets or an insect-filled bog, and encounter auditory stimuli such as the sounds of coughing town residents that provide tacit clues as to possible causes of illness. Students work in small teams to develop and test hypotheses about why residents are ill. Three different illnesses (water-borne, air-borne, and insect-borne) are integrated with historical, social and geographical content, allowing students to develop and practice the inquiry skills involved in disentangling multi-causal problems embedded within a complex environment (Ketelhut, 2007).

A series of studies have been conducted investigating the viability of the River City virtual environment and curriculum to motivate students to learn science and improve science learning. A subset of the results from a series of controlled implementations of the River City virtual environment are listed below:

- Upon analyzing final student reports, looking for evidence of understanding of inquiry (e.g., uses data to design hypothesis, experiment is designed to test hypothesis), reports written by students in the River City treatment scored twice that of those written by students in the control treatment ($p<.05$; $n=173$; Ketelhut, Dede, Clarke, & Nelson, 2007);
- Use of an embedded individualized guidance system led to significantly higher scores from pre- to post-tests on scientific inquiry skills and disease transmission knowledge for both boys and girls ($p <.05$; $n=272$; Nelson, 2007);
- River City girls outperform all students in either treatment on learning scientific inquiry skills ($p<.05$; $n=449$; Nelson & Ketelhut, 2007).

Although studies into learning and engagement with the River City environment have been largely positive, evidence gained through classroom observations, student interviews, and surveys indicates that many learners in River City struggle to cope with the complexity of the virtual worlds. Students often report not knowing where to focus their attention in the environment, and difficulty in keeping track of the many sources of information encountered while exploring the virtual worlds (Nelson, 2007). For example, roughly a quarter of the students in the embedded guidance system study with access to guidance messages did not