Chapter 20
Mission HydroSci:
Distance Learning through Game-Based 3D Virtual Learning Environments

James Laffey
University of Missouri, USA

Sean Goggins
University of Missouri, USA

Troy D. Sadler
University of Missouri, USA

Joseph Griffin
University of Missouri, USA

Ryan Nicholas Babiuch
University of Missouri, USA

ABSTRACT

Distance Learning through game-based 3D virtual learning environments has promise for helping rural and other communities that have become increasingly dependent upon online learning to meet the Next Generation Science Standards. The team developing Mission HydroSci (MHS) envisions a learning product that integrates a game-based 3D VLE with a learning progressions approach to curriculum and innovative methods for teacher support and learning analytics. MHS uses an eight level game which at each level immerses students in a simulation environment for learning about water systems and then requires the student to put that knowledge into practice in a context of developing their competencies for scientific argumentation. This chapter describes the vision for MHS at the beginning of the development process funded by a grant award from the Investing in Innovation (i3) Fund of the U.S. Department of Education.

INTRODUCTION

Serious concerns regarding science education for precollegiate learners have been voiced by educators, business leaders and policy makers in the United States. Put simply, most students do not become proficient enough in reasoning through scientific problems and using scientific practices to be well prepared for science-related careers or for dealing with scientific issues in their lives (NRC, 2011). Literature suggests that traditional methods of science instruction, heavily weighted to memorization and isolated laboratory experiences, need to be replaced (NRC, 2011). Scientists, Science

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Educators and Policymakers are calling for a new orientation to science teaching and learning, an orientation that requires students to *engage with science* by applying core ideas from the disciplines through scientific practices. These ideas have been advanced through creation of new science standards, the *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013). Knowing and learning science, as envisioned by the NGSS, require learners to develop understandings of and apply scientific ideas, principles and theories as they engage in meaningful scientific practices such as posing questions, carrying out investigations, developing models, and arguing from evidence. Implementation of NGSS is an ambitious challenge even in the most well-resourced classrooms, but as a nation we must also attend to students in diverse and constrained circumstances. Online learning, which includes students learning at a distance and in blended environments, is an approach to meet the needs of diverse students in diverse settings. However, substantial challenges must be overcome before online learning can readily deliver the deep engagement with scientific ideas and practices needed to achieve the vision of NGSS.

Finding teaching and learning practices that lead to *engaging with science* and that can be used in distance learning (DL) where the teaching and learning is fully mediated through computer experiences, is a substantial challenge. Recent surveys on the use of online education in K-12 report DL reached 1.5 million students in the 2009-10 school year alone and there are expectations for substantial growth in the future (Picciano & Seamen, 2009; Wicks, 2010). Small and rural schools, in particular, are turning increasingly to online DL as a way to overcome the challenges of attracting and keeping well qualified teachers and to offer a full range of courses for their students (Hannum et al., 2009). Therefore, in order to ensure equitable access to high quality science learning experiences for all students, including learners from small and rural communities who tend to be underrepresented in science related fields (Avery, 2013), new and innovative approaches for supporting online science education are necessary.

A recent review (NRC, 2011) of the role of games and simulation in science education suggests that games and simulation may be an important approach to meeting learning goals presented in the new standards. The report concludes that: "Simulation and games have potential to advance multiple science learning goals, including motivation to learn science, conceptual understanding, science process skills, understanding of the nature of science, scientific discourse and argumentation, and identification with science and science learning." (p. 54). In short, the potential of game-based learning aligns well with the NGSS. However, the same report also concludes that "Evidence for the effectiveness of games for supporting science learning is emerging, but is currently inconclusive. To date the research base is very limited" (p. 54). The report goes on to call for a research base that can accumulate across the variety of simulations and games and in the face of the constant innovation that characterizes them. While the research base is limited, some progress has been made on the design and development of games in science education. There are a few well-developed 3D game-based learning environments being successfully implemented in schools. However, these learning systems, such as Quest Atlantis (Barab et al., 2010), River City (Clarke et al., 2006), Mission Biotech (Sadler et al., 2013) and EcoMuve (Metcalfe et al., 2009) primarily are supplements to in-class teacher-led activity and do not attempt DL with both teachers and peers at a distance. Once the physical classroom is removed from the pedagogical process, the human-computer interaction and human-to-human via computer interaction of the learning system must meet the full requirements of delivering effective instruction and meet all the needs of the teacher and student as they take on teaching-learning practices. This chapter describes an approach to meeting those requirements so as to impact science education in schools and communities dependent upon DL.