

# Chapter 45

## 3D Multi-User Virtual Environments in Science Education: Potential and Challenges

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### ABSTRACT

*The purpose of this chapter is to identify the potential and challenges in science education in the use of 3D MUVE science programs. These programs offer a number of instructional benefits in motivating and engaging students and in improving their science learning and scientific inquiry. 3D MUVE is a promising media in narrowing gender and racial achievement gaps and enabling an authentic and valid assessment of science education. Like all new instructional technologies, however, the wide use and implementation of 3D MUVE technology in mainstream science classroom is still facing a number of challenges, which are mainly related to technological complexity and cost, and design difficulty in incorporating some elements critical to inquiry-based learning into the 3D MUVE environment. To overcome these identified challenges and make optimal use of the opportunities, suggestions for integrating 3D MUVE into science curriculum and classroom are made and discussed, along with future research directions.*

### INTRODUCTION

U.S. students are lagging behind in science literacy. In the most recent Program for International Student Assessment (PISA) in science, the ranking of U.S. students fell from 19<sup>th</sup> in 2009 to 22<sup>nd</sup> in 2012. While the average science literacy score of 15 year-old U.S. students caught up with that of the OECD (Organization for Economic Cooperation and Development) countries, the ranking of

U.S. students is still trailing their peers in 15 of the 34 other OECD countries and 7 of the 31 non-OECD countries (National Center for Education Statistics, 2013). The 2011 National Assessment of Educational Progress revealed that less than a third of the nation's 8<sup>th</sup> graders were proficient in science and only 2% achieved the advanced level (National Center for Education Statistics, 2011). The science competency of U.S. students has caused a great concern. Mr. Duncan, U.S.

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Secretary of Education, called U.S. performance on the 2012 PISA “educational stagnation,” which “must serve as a wake-up call against educational complacency and low expectations” (U.S. Department of Education, 2013). In response to U.S. students’ consistent unsatisfactory science performance, President Obama has indicated that over the next decade, American students’ achievement in science education must move to the top in international assessments, including PISA (EdWeek, 2012).

While a number of factors may be responsible for U.S. students’ current middling scores on high-profile international tests in science and a relatively high percentage of students less proficient in science on the nationwide assessment, the dominant science instruction pedagogy appears to be the most problematic (Roth & Garnier, 2007; Wallance & Loudén, 2002). Heavily influenced by high-stake tests and aggravated by the relatively less time allotted to science teaching than to reading and math, which by law are the nation’s educational priority, one-way delivery of curriculum content and outcomes of science inquiry process in the classroom appear to be the only choice left for time-constrained science teachers. High interest activities and real life projects, which usually take more instructional time and demand more efforts that require higher-order thinking skills, have usually been introduced as a sidebar for innovation and engagement purposes, rather than as the mainstream pedagogy for science learning (Roth & Garnier, 2007). In response to the outcry against the lecture-based science education, hands-on activities have been introduced into the science curriculum in the past decade (President’s Council of Advisors on Science and Technology, 2010). While seemingly more effective than one-way delivery of science content, the use of hands-on instruction is no better than cookbook receipts, instructing students on “what to do next” (Ibarra, 2006). Students are not challenged to think and act independently and thereby acquire the scientific

inquiry skill that is at the heart of science and science education (National Research Council, 1996).

There has been a call for inquiry-based instruction in science education. The National Science Education Standards (NSES) include inquiry as a content to be learned and a way to learn science (National Research Council, 1996). The National Science Teachers Association recommends that all K–16 teachers use scientific inquiry as the centerpiece of the science classroom and ensure that students develop a deep understanding of science and scientific inquiry (NSTA, 2004). Despite the decade-long call for inquiry-based approach in science teaching and learning, its implementation in K–12 classroom has been problematic. Teachers’ unfamiliarity with and inability to effectively design and use the inquiry-based method is one of the most important factors (Kazempur, 2009). Many teachers, unclear how to design and implement inquiry in classroom, simply substitute real scientific inquiry with traditional “cookbook” experiments (Wallance & Loudén, 2002).

To address this unfortunate situation in science education, scientists, science education researchers, and school teachers have started joint efforts to explore how to optimize the use of technologies to improve science teaching and learning, including the use of emerging three dimensional multi-user virtual environment (3D MUVE) technology. As an innovative instructional tool and approach, 3D MUVE holds a great deal of potential in engaging and challenging students in a socially situated and distributed learning environment that simulates real-life, science-related issues/projects. However, like any other emerging learning tool, the design, development and implementation of 3D MUVE for science education are still facing significant challenges before its potential can be fully unleashed and realized. The purpose of this chapter is therefore to identify the potential and challenges in the use of this emerging technology in science education through reviewing and analyzing existing 3D MUVE science programs.

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