Chapter 24
Development of an Interactive Immersion Environment for Engendering Understanding about Nanotechnology:
Concept, Construction, and Implementation

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ABSTRACT

The advent of nanoscientific applications in modern life is swiftly in progress. Nanoscale innovation comes with the pressing need to provide citizens and learners with scientific knowledge for judging the societal impact of nanotechnology. In rising to the challenge, this paper reports the developmental phase of a research agenda concerned with building and investigating a virtual environment for communicating nano-ideas. Methods involved elucidating core nano-principles through two purposefully contrasting nano "risk" and "benefit" scenarios for incorporation into an immersive system. The authors implemented the resulting 3D virtual architecture through an exploration of citizens' and school students' interaction with the virtual nanoworld. Findings suggest that users' interactive experiences of conducting the two tasks based on gestural interaction with the system serve as a cognitive gateway for engendering nano-related understanding underpinning perceived hopes and fears and as a stimulating pedagogical basis from which to teach complex science concepts.

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THEORETICAL BACKGROUND AND RATIONALE

Importance of Nanotechnology and Nanoscience in Public Understanding and Education

Many scholars would agree that we are in the midst of a nano-revolution. From a scientific point-of-view, it is difficult to argue against the prediction that advances in nanotechnology will have a significant influence on the future of humanity. Technological progress at manipulating nanoworld objects, with sizes approximately one millionth that of a grain of salt, is underway culminating in the foreseeable production of nanomaterials, nanodevices, and nanobiopharmaceuticals (e.g. Teo & Sun, 2006). This rapid development places a huge demand on education-providers to deliver "nano-competencies", whereupon since 2001, the U.S. government has invested $6.5 billion in nanotechnology initiatives (Dyehouse, Diefes-Dux, Bennett, & Imbrie, 2008). In parallel, nanoscience is heralded as an opportunity to reform STEM education (Schank, Krajcik, & Yunker, 2007; Shabani, Massi, Zhai, Seal, & Cho, 2011).

While nanofever persists, Laherto (2012) and Lin, Lin, and Wu (2013) highlight the urgent need for nanoscience education to also consider public dimensions. Indeed, the societal impact of nanotechnology conjures up perceptions of fear and paranoia on one hand, and sheer wonder and excitement on the other. Nanoscience era role-players have a duty to empower citizens with a scientifically grounded basis for judging nanotechnology (e.g. Hingant & Albe, 2010). This emphasis is captured succinctly in Laherto's (2010) assertion that, "all citizens will soon need some kind of 'nano-literacy' in order to navigate important science-based issues related to their everyday lives and society" (p. 161). Gilbert and Lin (2013) have further unpacked this idea to reveal multi-level ideas underpinning nano-literacy.

Any nanoscience education agenda should also address citizens' reasoning, perceptions, understanding, decisions and judgments surrounding nanotechnology. Recent literature (e.g. Besley, 2010) has highlighted the opportunity that a nanotechnology context offers for exploring how citizens evaluate risk with little or no knowledge grounding. Gilbert and Lin (2013) have suggested "risk" as a core theme in nano-education, whereupon it is essential for citizens to construct informed views about nano. Consequently, a research mission unfolds that seeks ways to provide citizens and learners with tools for developing knowledge to make scientific judgments about the potential benefits and risks of nano (e.g. Cobb & Macoubrie, 2004; Gilbert & Lin, 2013).

Educational Virtual Environments in the Learning and Acquirement of Scientific Knowledge

A review by Mikropoulos and Natsis (2011) has suggested that educational virtual environments can contribute to knowledge construction and attaining learning goals. Similarly, Richard, Tijou, Richard, and Ferrier (2006) have reported that virtual reality platforms can cultivate science knowledge-building processes, and allow exploration of difficult to access abstract science concepts. For example, Merchant, Goetz, Keeney-Kennicutt, Kwok, Cifuentes, and Davis (2012) showed that a 3D virtual environment enhanced learning of chemistry concepts. Students' interaction with the environment also influenced a range of perceptual and psychological characteristics. Work in physics has revealed improvements in students' conceptual understanding of electric fields following interaction with a virtual environment (Dede, Salzman, Loftin, & Ash, 2000).

Mikropoulos and Natsis (2011) reveal that few studies have investigated virtual environments that contain intuitive interaction, as well as users' attitudinal dimensions, and identify these as emerg-

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