

Chapter 28

Towards an Immersive Virtual Environment for Physics Experiments Supporting Collaborative Settings in Higher Education

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ABSTRACT

Literature survey on science education suggests the inclusion of interactive exploratory and collaborative learning experiences. However, recent remote laboratories and simulations do not sufficiently support the collaborative component. Thus, this book chapter introduces the development of an immersive virtual environment built on top of OpenWonderland to collaboratively experience remote laboratory experimentation and simulations. Motivated by previous experiences, utilizing iLab-based remote lab and TEAL simulations within MIT's physics courses, our research project focuses on the enhanced integration of physics phenomena. However, most of the outlined experiences and results are well able to be transferred to other subjects in science education. This book chapter outlines development and findings along the path of our research endeavor so far; it also gives related background knowledge and discusses possible future trends.

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INTRODUCTION

Educational systems and pedagogical strategies have to overcome more than ever challenging situations. Demography and students' preferences require modern and dynamic learning environments which must go far beyond traditional face-to-face lectures towards technology enhanced ubiquitous learning. In particular, the new generation of learners who grow up with technology and computer-media prefer interactive content, enjoy self-discovery and experimentation, take pleasure in the combination of education and entertainment, and like to work in groups. (Chang, Gütl, Kopeinik, Williams, 2009; Gütl, 2010)

Considering specifically the area of *science education*, many students have difficulties with learning scientific knowledge and inquiry skills. Moreover, in a number of countries students have a low overall interest in science and student numbers are decreasing. (Bransford, Brown, Cocking, & Donovan, 2000; OECE, 2008) An expert group established by the European Commission on this topic suggests: (a) a reversal of science-teaching pedagogy from mainly deductive to inquiry-based methods providing the means to increase interest in science. (b) Renewed science-teaching pedagogy in order to increase opportunities for cooperation and collaboration between actors in the formal and informal arenas. (European Commission, 2007) Consequently, it is vital that 21st century science education adapts accordingly in order to address not only motivational issues and demographic changes, but also the challenges of helping learners understand complex conceptual perspectives and theories of phenomena that are difficult if not impossible to experience interactively with conventional teaching approaches.

Experimentation is seen as one of the key concepts in science education to involve students actively and help them acquire science knowledge in meaningful context (Wofford, 2009; Chang, Chen, Lin, & Sung, 2008). For distance learning, a great variety of remote labs and simulations have

been researched and developed so far (Leleve, Arnous, & Prevot, 2009) but there is insufficient support for collaborative learning experiences (Gravier & Fayolle, 2009), in particular in distance education settings. Referring to the above outlined situation and findings, we propose an immersive virtual environment to access and experience remote lab experimentations and simulations collaboratively. Such an environment not only enables active interaction and participation; it also supports awareness, the feeling of presence in environment, and it facilitates multiple communication channels. Consequently, such environments support various learning styles such as collaborative learning, inquiry learning, and game-based learning. (Gütl, 2010)

One of the required MIT freshman physics courses on electrostatic and electrodynamic phenomena has been transformed from a lecture into a 'Studio physics' styled course. This was part of an institute wide initiative to improve undergraduate education. In this learning setting, small groups of students worked together, the classroom experience combined short lectures, shared lab experiences, and the use of simulations to demonstrate phenomenon. The setups based on iLAB and TEAL experiments were designed to provide understanding to the students of the forces at work by making the unseen seen. (Belcher, McKinney, Bailey, & Danziger, 2007) Based on previous experiences it was decided to research and develop an enhanced technology support for physics education of complex theories and phenomena by incorporating pre-existing iLab and TEAL experiments. The aim is not to recreate face-to-face classroom settings but to design and develop a learning environment to complement and expand classroom activities.

The functional requirements on an abstract level can be summarized as follows: (1) supporting access to remote and/or virtual laboratory experiments for different learning settings, (2) facilitating 3D visualizations to simulate formal mathematical models and represent objects, (3)

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