# Sensory Immersive Microworlds for Science Teaching

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**Abstract**

Virtual reality has been recently employed in a few educational applications. In order to explore this technology in an educational setting, we are developing a virtual environment, called "Virtual Water", which consists in a series of three-dimensional environments.

This paper focuses on the interactive and learner-centered design of “Virtual Water”. We are exploring the potential utility of sensory immersive interfaces for enhancing the learning of molecular concepts in Physics and Chemistry. Additionally, we provide multiple representations of molecular phenomena by allowing students to experiment various perspectives. We highlight educational contents and emphasize technology considerations which we think are important for designing these type of educational microworlds.

**Keywords*:*** virtual reality, water, molecular dynamics, quantum mechanics.

## Introduction.

At the Physics Department of the University of Coimbra, Portugal, and in collaboration of the Mathematics Department of the same university, the Exploratory Henry the Navigator and the High Education School for Technology and Management of Guarda, we are exploring a learner-centered approach for designing and evaluating virtual reality. Our project, “Virtual Water” (VW), is a series of microworlds for teaching science concepts and skills that students typically have difficulties mastering. Learner-centered design is a special type of user-centered design in which interactive evaluation is used to guide the development and refinement of the learning tools. In our project, high-school students are the initial users and Virtual Reality (VR) microworlds provide a suite of tools for their science inquiry activities [1].

Our research goal is to examine whether virtual reality´s sensorial immersion can help students to remediate some misconceptions. Through the design and evaluation of VW, we would like to better understand the utility of sensorial immersion in particular and virtual reality in general for science teaching. The full sensory immersion of 3-D microworlds isolates learners from external distraction. We can increase student’s motivation by implementing learning-by-doing activities that stimulate students’s fantasy and curiosity in a manner familiar to them because they are supposed to be familiar with videogame environments.

## Project Description

In VW our focus is on using multiple modes of immersive, sensory representation in order to increase the understanding the key concepts of the structure of matter. To make the experience multisensory, we use visual, auditory, and tactile cues [2]. The interface includes a Pentium II processor with 3D graphics accelerator coupled with a Head-Mounted Display, a Polhemus Isotrak II magnetic orientation and position sensing system with a Cyberglove and Cybertouch sensing unit, and stereo sound.

The three main virtual environments of VW are:

– <u>Training environment</u> - Scenery exploration is preceded by navigation in a training environment. The goal is to overcome the disorientation problems that some users experience when first using VR. This virtual scenery is a simple, familiar environment in which users can become familiar with the VR hardware before moving on to more complex and abstract environments.
– <u>Quantum mechanics environment</u> - In this scenery we deal with the geometry of the water molecule, its electron density, and molecular orbitals [3]. In this virtual environment students can build and travel through molecular orbitals and molecular density. In this way, they should gain a better idea of the molecular structure and clarify the chemical bonding.
– <u>Molecular dynamics environment</u> – In this component, we aim at understanding some water properties by direct simulation of molecules. We assume that the molecular dynamics can be treated classically using Newton's equations of motion with the Lennard-Jones potential. The user is able to interact with the environment in order to study the liquid, gaseous and solid phases and the respective phase transitions. A student can be situated at the site of a water molecule in the gas, liquid or solid (i.e., immersively perceiving the world from those perspectives).

## Conclusion

The use of 3D graphics and haptic interfaces is a powerful tool for visualizing and understanding complex and/or abstract information. By developing and evaluating a virtual world for science education, we hope to realize the advantages of sensory immersive microworlds for science learning at the high-school level. We also hope to understand how the hardware disadvantages currently limit the utility of virtual worlds. Feedback from students is being collected and analyzed.

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