Chapter 10
Mechanics Simulations in Second Life

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ABSTRACT
This paper examines the use of the 3-D virtual world Second Life to explore basic mechanics in physics. In Second Life, students can create scripts that take advantage of a virtual physics engine in order to conduct experiments that focus on specific phenomena. The paper explores two particular examples of this process: 1) the movement of an object under the influence of gravity, and 2) the movement of an object using simple forces. Findings suggest that Second Life offers a flexible and wide range of possibilities for simulations in mechanics; paradoxically, however, the environment also presents challenges for effective use by instructors and learners. Any implementation making use of the Second Life application requires technical knowledge of the system and a wide range of pedagogical and learner skills related to building, scripting, and educational design.

INTRODUCTION
This paper examines the use of Second Life as a way for students to explore basic mechanics and kinematics. Second Life includes an integrated physics engine, Havoc 4, which can be used to simulate the motion of objects. Additionally, the platform allows people to create objects with scripts that can interact with the physics engine directly and indirectly. A number of computational environments are available for focused studies of mechanics. They range from predefined applets such as those created by Phet (2009) to the Open Source Physics project that provides a comprehensive software suite for designing your own applets. Another option that is widely available is VPython (Scherer, 2009). These are all computational engines that allow students to set up computational based experiments. Our focus here, however, is to examine environments that provide an experience that allows for more interaction between participants within the environment itself, and we examine the teaching of mechanics within a virtual environment.
Investigators have constructed virtual environments specifically designed to explore diverse physical phenomena including Newtonian mechanics, electrostatics, and molecular interactions (Dede et al., 1996a). Other virtual environments have been considered for a wide range of activities (Dede et al., 1996b; Mason, 2007), but our focus is on the use of Second Life for mechanics.

One of the goals is to place students in situations that allow for rich exchanges between one another and to explore a wide variety of options. This goal is motivated by the challenge of creating an environment that supports active engagement by the students. As an example, the idea is to support the student’s “basic habits of mind.” The students should seek diverse representations of the phenomena of interest. They should compare and contrast their results to what they expected, and then be able to describe the results in a variety of ways (Dufresne et al., 2005).

The construction and use of a virtual environment can be a difficult task. One goal of the design of such environments is to explicitly define relationships between the concepts and concrete representations (Barab et al., 2001). The difficulty is that the visualizations that are created should be consistent with the way students internalize the ideas (Gilbert et al., 2008). At the same time the students are expected to be placed into contexts that allow them to be active and create enhanced learning situations (Barab et al., 2001).

A virtual environment provides additional tools to the instructor to place the students in situations that support such efforts. In the specific case of mechanics the tool allows students to focus on situations that emphasize ideas that are associated with common misunderstandings. For example, many students have an Aristotelian view that the direction of motion determines the direction of force (Gilbert et al., 1982). Student misconceptions can be confronted in effective ways by examining relevant contexts and fostering active learning environments coupled with careful assessment (Guidugli et al., 2005).

When implemented appropriately, computer simulations can change the conceptions held by students (Tao & Gunstone, 1999). Computer simulations offer one more way to engage the students and can make abstract ideas more concrete (Pena & Alessi, 1999). The use of such tools offers an advantage in that students’ preconceptions are not easily changed in traditional settings (Jimoyiannis & Komis, 2001). The use of more familiar contexts (Guidugli et al., 2005) and efforts to require students to explore the material more fully such as making use of prediction, observation, rich comparisons and multiple representations (Dufresne et al., 2005) provide ways to confront student misconceptions.

Multiple representations offer more ways for students to see and experience the ideas in different ways. Some representations provide exploratory models that allow simulation of physical laws. Other representations provide explicit models that allow the students to define the important relationships. The use of multiple representations, however, is not a magic bullet. Instructors must be careful in that misconceptions can be constructed on the spot (Rowlands et al., 2007).

The focus in this paper is on the use of one particular activity: the use of virtual environments for mechanics simulation. The importance of “immersion” within the virtual environment has been a focus of many studies. For example, some have examined the use of a head mounted display for a more complete immersion. The idea is that the level of interaction between the students and the virtual world are vital (Dede et al., 1996a; Dede et al., 1996b). The level of immersion is important with respect to the students to “trigger” a stronger reaction (Dede, 2009).

A less technically intensive approach is to focus more on the interactive aspects (Jimoyiannis & Komis, 2001) which is the approach discussed here. In particular the goal is to create an environment that allows students to change the parameters of an experiment and see the phenomena of interest in a variety of situations. This is more in line
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