

Chapter 11

Teaching Basic Astronomy Concepts to Pre-Service Teachers Using 3D Virtual Environments: Results of a Study in Greece

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ABSTRACT

The study examines the use of two 3D virtual environments for teaching basic Astronomy concepts, to pre-service teachers. The motivation was the fact that pre-service teachers know very little about Astronomy and that the virtual environments can be used as tools for successfully teaching concepts related to this scientific field. Two online courses were also developed, in order to compare the learning outcomes. A hundred and twenty randomly selected students from the Department of Primary School Education, University of the Aegean participated in the study, divided into six groups. Two groups used the virtual environments, two groups used the online courses, while the last two were the control groups. Data was collected using evaluation sheets, questionnaires, and log files. Data analyses indicate that even though all groups that used an application showed significant progress regarding knowledge acquisition, the groups that used the virtual environments had better results. Implications are also discussed.

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INTRODUCTION

A common finding in several studies among students and adults is the broad range of problems, difficulties, and misconceptions they have, even for basic astronomical phenomena (e.g., Duit 2006; Bailey & Slater, 2003; Gazit, Yair, & Chen, 2005; Barnett, Keating, Barab, & Hay, 2000). For example, young students believe that the Earth is flat (Vosniadou, 2012). Older students cannot grasp the rotation of the Earth and of the other planets (Ozsoy, 2012). Astronomical distances are also a problem; the vastness of the universe (distances and sizes) is beyond the comprehension and the perceptual experience of most people (Miller & Brewer, 2010). Research has also shown that these misconceptions are persistent (Clark, Kirschner, & Sweller, 2012). For example, mistakes regarding lunar phases are, more or less, the same in many countries, in all ages, over many decades (e.g., Kuethe, 1963; Ault, 1984; Sadler, 1998; Trumper, 2003) and teaching does not always succeed in correcting these mistakes (Schoon, 1995; Stears, James, & Good, 2011).

Abstract and multi-dimensional phenomena are challenging in their comprehension and application. In order to understand astronomical phenomena, as well as other scientific concepts, individuals create mental models (Redish 1993; Barnett et al., 2000). These models are explanations of what we see, in a way that makes sense to us. Students come to school having preconceived notions of scientific concepts not compatible with the scientific thought and conceptual change is difficult (diSessa, 2006; Duit, 2006; Brown & Hammer, 2008). Young children start with the view that the Earth is flat, based on their experience that the ground is flat. Later, when they are taught that the Earth is round, they change their Earth model into a disk-shaped Earth (Vosniadou, 1991). They integrate the new information into the existing model, instead of discarding it. However, once a model takes root, disregarding it, or even changing it, might prove to be a challenging task. Students will often stubbornly maintain these misconceptions, especially in physics (Casperson & Linn, 2006). Teachers have to be aware of their students' mental models, understand the underlying reasons that led to these models and adapt the curriculum so to address these misconceptions.

It seems that students are not the only ones facing problems in understanding concepts related to Astronomy and physics in general. Both pre- and in-service teachers have problems in teaching physics topics (diSessa, 2000). Concepts with complex abstractions and few real-life references, or ones that incorporate invisible factors or forces, are particularly challenging for them (Chi, Feltovich, & Glaser, 1991). Supporting pre-service teachers in learning basic physics concepts has also proven to be a challenging task (Schoon & Boone, 1998; McDermott & Shaffer, 2000). When it comes to Astronomy, the literature suggests that in-service as well as pre-service teachers, experience difficulties in apprehending even very basic knowledge related to this science (e.g., Kanli, 2015, 2014; Trumper, 2006a). It is also noted that their misconceptions are very similar to the ones that younger students have (e.g., Frede, 2006; Trumper, 2003).

Pre-service teachers' difficulties in subjects related to Astronomy may also imply difficulties in other scientific fields, such as mathematics, physics, and chemistry. It is a paradox to expect teachers to be potent in their job while at the same time they lack understanding of major scientific subjects. Therefore, an intervention to rectify the problem is quite important. In line with the above, the main objective of the present study is to present the results of a project designed for teaching basic Astronomy concepts to pre-service teachers. For that matter, a 3D virtual environment was developed and its results were compared with the results of other, more conventional, teaching methods, as presented in the coming sections.

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