On the Use of Virtual Environments in Engineering Education

D. Vergara, Vimet Group, University Catholic of Ávila, Ávila, Spain
M. Lorenzo, University of Salamanca, Salamanca, Spain
M.P. Rubio, Vimet Group, University of Salamanca, Salamanca, Spain

ABSTRACT

Virtual resources (VR) in the form of interactive media applications (IMA), didactic videos (DV), interactive virtual platforms (IVP) or Small Virtual Resources (SVR), etc. are becoming powerful didactic tools in university teaching. This is particularly important in the case of engineering studies where these VR allow overcoming spatial visualization problems, learning mechanisms operation, etc., and increasing the student motivation in learning process. Thus, the understanding of complex concepts in engineering can be solved. In this paper, a review of the student opinion with regard to the use of diverse VR is presented. To achieve this goal, during the last years (2013-2015) different VR in diverse forms (IMA, DV, IVP and SVR) were used in teaching of engineering degrees at three different engineering schools. The opinion of students was collected in the form of surveys applied at the end of the course. According to obtained results, students considered very useful the use of VR in teaching/learning. However, they do consider them necessary as a complement of the teacher master class. In addition, from students’ surveys, an estimation of the time distribution for each teaching activity can be draft which provides useful information for adapting the teaching of engineering studies.

KEYWORDS

Didactic Videos, Engineering Education, Interactive Media Applications, Interactive Virtual Platforms, Small Virtual Resources, Virtual Environments, Virtual Resources

INTRODUCTION

Using virtual resources (VR) in university teaching/learning is becoming a key issue (Mumtaz, 2000; Castro, Reboredo & Fanovich, 2014), especially in engineering degrees (Thornton, Nola, García, Asta & Olson, 2009; Balamuralithara & Woods, 2009; Alves, Viegas, Lima & Gustavsson, 2016; Hilfert & König, 2016). On the matter of fact, in the past years many scientific contributions were published on novel virtual environments which some teachers are applying in subjects linked with Engineering (Dobrzański & Honysz, 2009; Dobrzański & Honysz, 2010; Sinnott, 2013; Brophy, Magana, & Strachan, 2013; Vergara, Rubio, & Lorenzo, 2014; 2015). The general assessment of these experiences has been always positive for both teachers and students. Even so, according to scientific literature, doubts exist about the real effectiveness of using virtual applications in education. In fact, it is established that VR are not effective by themselves but depends on the applied methodology (Thornton et al., 2009). The potential shortcomings have been diminished with the technical evolution of the VR and, nowadays, most of the existing studies confirm that the use of virtual tools reinforces
the professor’s explanations, thereby enhancing a better comprehension of the considered subject (Chika, Azzi, Stocker & Haynes, 2008; Vergara, Lorenzo & Rubio, 2015).

In this way, it must be taken into account that the use of VR in the classroom must be framed within an appropriate methodological framework so that the educative objectives could be correctly obtained (Vergara & Rubio, 2012). Therefore, what is really important is not the use itself of teaching technologies, but how they are designed and applied by the teacher in the classroom in order to exploit their maximum teaching potential (Thornton et al., 2009).

Regarding subjects linked with engineering, the development of practical classes in a real laboratory environment entails potential shortcomings: danger of using products or machines, overcrowded classes, timetable schedule availability of the laboratory, etc. Furthermore, many engineering subjects or topics linked with spatial visualization entails serious problems of comprehension for the student body. To solve these problems, it is advisable to apply VR in the teaching/learning and, hence, there are several types of educational virtual applications depending on the necessities. For the sake of clarity, a brief description of the most common types of VR used with educational aims is included here:

- **Interactive Multimedia Application (IMAs):** A multimedia application that combines text, graphics, photographs, animations, sounds, and video.
- **2D Interactive Application (Virtual Laboratory):** Virtual laboratories are computer applications (commonly using 2D graphics) which, through modelling reality, allow the simulation and experimentation of diverse phenomena or real life situations.
- **3D Interactive Application (Virtual Reality):** They are similar to the virtual laboratory in modelling reality, simulation and experimentation but with additional advantages: high quality 3D graphics and high degree of interactivity (Wang, Zhao, Sun, Wan & Cui, 2012), and it also helps to visualize and to control complex information that, a priori, is difficult to be processed.
- **Augmented Reality:** It is a mixture of physical information (real) and digital knowledge (virtual) through a device. Augmented Reality consists in enhancing reality by adding images, videos or digital information with the help of a device which can be a computer, tablet, smartphone, glasses, camera, etc.
- **3D Small Virtual Resources:** They are small 3D applications that allow to understand and to visualize engineering concepts, especially those that require spatial visualization abilities.

In this paper, an analysis is presented of the engineering students’ opinion with regard to the use of diverse VR in teaching/learning. Specifically, the resources applied in this work were recently presented in several teaching innovation forums:

1. **Two Interactive Multimedia Applications (IMAs):** Materials and metrology (Rubio, González, Heres, Ruiz & Pérez, 2006);
2. **Didactic Video or DV of Short Length (5-10 minutes)** which are edited by some television channels or private companies;
3. **Three Different Interactive Virtual Platforms (IVPs):** Tensile test (Vergara, Rubio, Prieto & Lorenzo, 2016), concrete compression test (Vergara, Rubio & Lorenzo, 2014) and industrial radiology (Vergara & Rubio, 2015); and
4. **Three Small Virtual Resources (SVR):** Vectors (Vergara, Rubio & Lorenzo, 2012), ternary phase diagrams (Vergara, Rubio & Lorenzo 2015), a new prototype of virtual tool to visualize crystallographic nets.
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