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ScienceDirect

Procedia Computer Science 25 (2013) 62 – 70

Procedia Computer Science

2013 International Conference on Virtual and Augmented Reality in Education

The Development of a Didactic Prototype for the Learning of Mathematics Through Augmented Reality

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Abstract

This work applies Augmented Reality technology in the educational process through a didactic prototype that promotes visualization skills related to the learning of mathematical content. An initial prototype has been designed and built with the purpose of arriving at 3 dimensional objects performing specific actions, in space and time, executed with 2 dimensional objects. The AR production of mathematical objects with which student may interact offers the opportunity to mentally record the process through which they are generated, favoring visualization skills. In the initial academic phase, an analysis of the first three college calculus courses was carried out. The objective was the identification of a transversal content suitable to be developed in AR environment. Once this content was established and discussed, the conceptualization of the prototype was carried out, identifying first the platform of technological and human resources available for the project. The technical phase was focused on developing the AR technology prototype around the didactic design concept. The adjustment decisions in this process were based around the academic-technical integration meetings. A pilot experience for exploratory purposes was developed with Mathematics I for engineering students during May 2013. The aim was to describe the actions the prototype encourages from the students and to capitalize these results to determine limitations and reaches of this first prototype, from a didactically and technically point of view. The pilot experience confirms that AR technology in education increases the current motivation to learn by students. The work aims to study about the development of didactic resources that serve students in the learning of a visual and tangible mathematics.

Selection and peer-review under responsibility of the programme committee of the 2013 International Conference on Virtual and Augmented Reality in Education

Keywords: Mathematics; Calculus; learning; Didactic prototype; Augmented reality

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doi:10.1016/j.procs.2013.11.008

1. Background

The work presented here is the outcome of collaboration between various academic branches in the Campus Monterrey, part of the Tecnológico de Monterrey, educational institution in Mexico. The guiding purpose of this collaboration is to establish emerging digital technologies as a central tool in the educational process. In particular this work refers to the learning process corresponding to Mathematics.

In said institution, a didactic method for teaching and learning is being practiced in Mathematics courses at a college level, promoting the transfer of Calculus knowledge to the different existing specialty branches. Through this method, the application of learned knowledge is emphasized, favoring the student's understanding of the utility of this knowledge in the solving of real life problems [1, 8-9].

This different method of interaction with the content of the curricular sector of Calculus involves the use of technologies, including spreadsheets and specialized graphing software. These tools have been included in the development of mathematical knowledge through the didactic design, inviting maximization in learning efficiency by means of their use. This new discourse is explained in the three textbook collection: Applied Calculus: Mathematical Competencies through contexts [10-12].

Another subject worthy of mention is the record of technological production and innovation developed in the institution, which led to the collaboration of authors in the search of a new, favorable impact in education. Previous projects like the Augmented Reality engine available through Campus Monterrey (www.bienetec.es/) and their experience with products, services and technological solutions for 3D and AR, certify the feasibility of this new path product development, seeking a product that generates a synergy between educational, and technological knowledge [2, 5].

The project, Augmented Reality: a promoter of visualization in the learning of Calculus, is being developed in response to the Call for Innovation Novus 2012, an initiative of Tecnológico de Monterrey to favor projects in the field of educational innovation. With the project, a didactic prototype has been created, one that is explained in the present paper.

2. AR and MATH

Augmented Reality technology is an attractive prospect when trying to make Mathematics "real" to students that, more often than not, find only "intangible abstractions" in their concepts. This being, by default, a natural part of this science. The idea of AR inclusion, undoubtedly, provides motivational elements with consequences of improvement in the interest of mathematical studies. However, the goal proposed with this project is focused on a didactic intention of offering useful and applicable knowledge to students, in tandem with a new sense of accessibility from a cognitive point of view. In this sense, the present work involves the creation of a prototype that contemplates the development of cognitive abilities, which will be used in the relation of algebraic, numeric and graphic representations of mathematical knowledge. In addition, a new way for the role of technology is pursued, giving to the technological resource's the assignment as a mediating feature between user and mathematical knowledge. The purpose of this interaction is the favoring of a co-action with digital technology, in such a way that it functions as a "cognitive partner" that contributes to reflect on learning, promotes visualization and, with it, Mathematics comprehension. The latter according to current theoretical frameworks in Mathematics Education [4, 7].

The construction of an Augmented Reality system implies the production of a virtual object superimposed in real time and place. It combines reality and 3-D-represented virtuality, promoting real time interaction with the object through its perception by the user. The virtual object shows information that the user does not detect directly through his bodily senses, and it is the transmission of this information that helps the user solve real world tasks; this is the use commonly given to AR in other areas. For the case described in this work, related to didactic applications, the impact of AR technologies is expected to be central in the activation of cognitive