Chapter 3
Augmented Reality: Opportunity for Developing Spatial Visualization and Learning Calculus

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ABSTRACT

This chapter intends to advance a sociocultural perspective to frame the integration of augmented reality technology for the learning of mathematics. It is discussed the design of an application already produced with this technology. The purpose of the application is to promote the development of spatial ability while also reviewing the visualization of some calculus topics at college. The author contends the benefits of focusing in the graphical representation to approach mathematics knowledge, especially because digital devices are part of the modern culture. Students today are familiar to explore in digital media, and this should be an opportunity to inquire the power of digital design to engage in mathematical thinking.

INTRODUCTION

Mathematics is the science par excellence, keeping us in a profound relation with our modern world. We take advantage of its potential, which allows us to transform our reality, even though Mathematics is acknowledged for its level of abstraction. The interaction between this science and our minds must be carried out through symbols. Any mathematical representation is a symbol, and the proper handling of these symbols is an important issue related to the comprehension of mathematics.

While performing a mathematical task, three representations may be required: the numeric, the algebraic, and the graphical representation. They appear as numbers, formulas (combining numbers and letters) and also graphics, which relate to both numbers and formulas. Among those representations, the graphical is the one that offers more scope for visual perception, but at the same time, it requires much insight to capture the rich information it offers at first glance.

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Up until now the teaching of mathematics takes place mainly through writing. In high school and college emphasis is placed in the practice of algebraic workouts that fit well with the classroom. To some extent, this has been the suitable kind of access to mathematics. Performing algebraic procedures on the blackboard results far easier than drawing mathematical figures. Written exercises have become the main test to certify the learning of students.

Today, one may wonder if emphasis on the algebraic representation of mathematical knowledge could be put aside to make room for graphical representations playing a key role in the learning process. The interaction with mathematics through emergent digital technologies as allies, allows for a new way to learn mathematics, introducing visual aspects. The access to graphical content enhancing the visual perception should improve the engagement of students with mathematics.

The present chapter is related with the conceptualization of a whole strategy integrating digital technologies to foster the students' interaction with mathematics and favor their engagement with the learning process.

In order to deepen the way these new technologies impact the learning of Mathematics, the author has been adopting a sociocultural perspective. It considers the incorporation of technology in education as part of a modern culture that impacts the cognitive process. This is attuned to the evolution of human consciousness presented by Donald (2001), who stresses the power of the representational capacity in humans' minds. In turn, the contribution of Moreno-Armella (2014) stands the mathematical thinking in the evolution of the human species. Concerning Mathematics Education, this work agrees with the perspective presented by Moreno-Armella and Hegedus (2013) about the advent of new types of digital technologies changing the nature of Mathematics reference fields. The symbolic thinking has been evolving from static notations (in paper or digital) to digital dynamic inscriptions, where mathematical representations could be grasped through intentional dragging actions. The present work also addresses an ecological perspective from Gibson (1979) and its use in design by Norman (1993), in order to underpin the affordances of digital technologies' environments in human perception, and promote the continuous act of perceiving, involving the co-perceiving of the self.

Since 2012 the author's research agenda addressed the effort to provide students an opportunity to "see" mathematics in a realistic way, taking advantage of Augmented Reality (AR) technology. The AR application that is presented here considers the Calculus learning for undergraduate students. It is intended to promote the development of spatial visualization skills through the route of several themes in Calculus courses at College. As a result of the reflective thought supported by the sociocultural perspective, the AR application should be understood as an environment for the interaction of students and mathematics, which emphasizes the human perception through eyes and body.

There are three objectives for the present chapter; the first one is to describe the features of the AR emergent technology and its involvement in education to date, addressing the discussion to the development of spatial visualization skills. The second objective is discussing about a sociocultural perspective that could frame the use of AR technology for mathematics learning. As a third objective, the AR application is described, making emphasis on its features. Its use will be discussed according to the calculus themes, and this will give the opportunity to value it as a tool for the development of spatial visualization and the learning of calculus simultaneously. Ultimately, solutions and recommendations, future research directions, and a conclusion, should stress the chapter's aim sharing a novel use of AR impacting in the interaction with mathematical knowledge.