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Learning of surface and volume formulas by augmented reality: experimental studies

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Abstract

It is commonly claimed that emerging technologies, including Augmented Reality (AR), open up new perspectives for education. Today, the finding of this research is that few objective data support the hypotheses that are made about the interest, effectiveness, usability and acceptability of these technologies that are based on interaction and immersion in real time. In this article, we present a review of some of the ergonomic problems of AR in teaching surfaces and volumes of 3D geometric shapes. In this approach, AR is considered and evaluated as an educational resource that helps with the activity and briefly explains the concept of AR and the envisaged interests of this technology for teaching.

Key words and phrases: Augmented reality, teaching, interaction, immersion, 3D geometric shapes.
AMS (MOS) Subject Classifications: 97Qxx, 97Rxx.
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1 Introduction

The adoption of digital in education and technological developments are opening up new perspectives for the use of Augmented Reality (AR). These technologies can help teachers working on interactive and immersive systems in real time using AR and allow the implementation of learning, thus improving their efficiency. However, integrating these new tools into existing teaching processes remains complex, due to technological aspects and the data continuum to be implemented, by identifying the use cases and associated gains and by the diversity of actors and business experts involved in this process: the intelligent system expert, the designer, and the IT developer. In order to address these different issues, based on state of the art scientific and technological advances, our research focuses on proposing a data model to facilitate the creation of AR content for the learning of surfaces and areas of geometric shapes. In the second part of this work, in order to evaluate the effectiveness of this technology, we have set up learning and teaching methods to evaluate the use of AR.

1.1 Objectives

One of the objectives is to improve usability compared to traditional 2D method and to increase student motivation. Moreover, there are two other lines of argument concerning the interest of RA in learning 3D geometric forms: Compared to Virtual Reality (VR) systems, AR devices would pose fewer sensory problems, including "simulator sickness" [1]. Thus, in many VR devices, perception is partial and characterized by inconsistencies between the information processed by the different receptors [2]. AR would increase the learner's motivation for 3D geometric shapes due to the novelty of the interaction mode [3]. The lack of empirical validation of the above assumptions can be partly explained by the fact that nowadays the design of AR systems is mainly within the framework of a technology-centered approach.

1.2 Satisfaction and Motivation

In the majority of cases, learners find the proposed functionality and performance of RA prototypes useful and satisfactory [4]. Learners of geometric shapes say they are ready to use this technology. However, the studies surveyed do not give answers as to a possible increase in learning motivation due to the novelty of the mode of interaction. This method allows the user to have perfect synchronization between the real and the virtual; there is no difference between the rendering of the real world and the displayed increase. However, the user sees the real world through a camera. His/her vision is therefore impaired because the current devices do not have a sufficiently high field of vision.

2 Methods

This method is the closest to the ideal case presented. Indeed, the user can look at the real system and have the information in augmented reality in front of his/her eyes. However, it is necessary to calibrate this type of device for each user [5]. To remain consistent, augmented reality information must not be displayed at the same level if, for example, the glasses are worn high or low on the user's nose. It would even be necessary to calibrate the pair of glasses again if it moved on the user's nose during its use. In conclusion, we emphasize the importance of a user-centered approach to learning throughout the design and evaluation.

3 Results

The Area of a base, usually marked as Ab, is the area occupied by the figure(s) used as the base for the various solids. The lateral area, marked AL, is the area occupied by figures that do not serve as a foundation for solids. The total area, usually marked AT, is the surface covered by all figures forming the relevant solid. The volume, often denoted by V, is the portion of space occupied by a solid (in a 3D space). The volume is calculated in cubic units (u^3) [6].

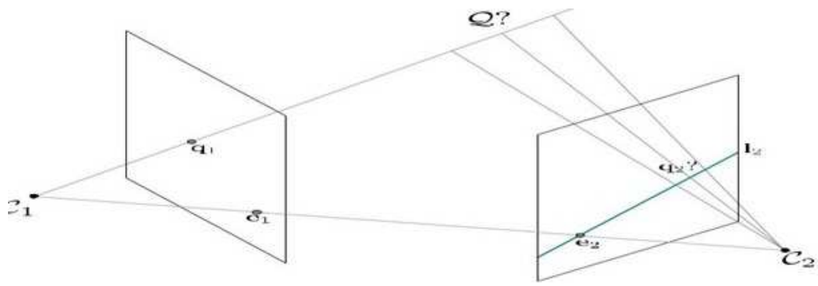

Figure 1: Theoretical study on paper, classical method

Figure 2: Experimental study, 3D modeling and application of augmented reality on the 3D cube model

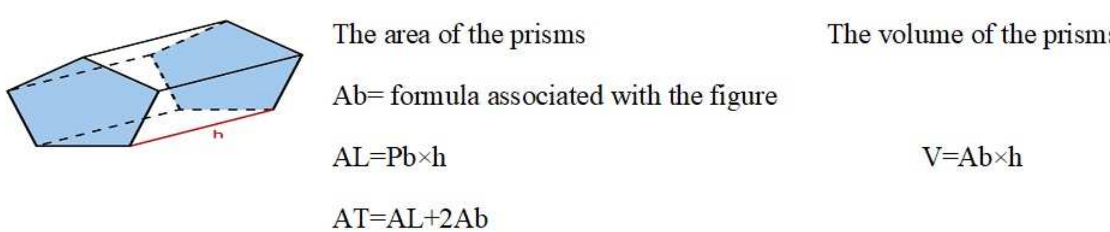

Figure 3: Theoretical study on paper, classical method

Figure 4: Experimental study, 3D modeling and application of AR on the 3D prism model

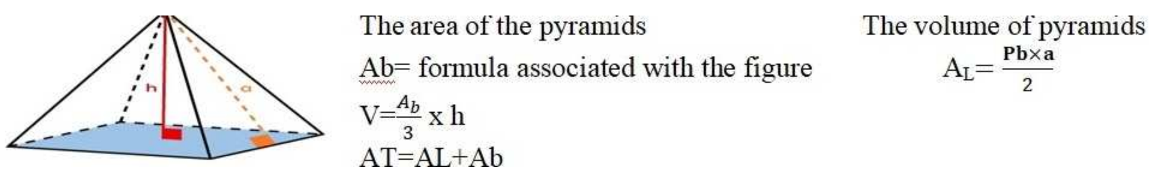

Figure 5: Theoretical study on paper, classical method

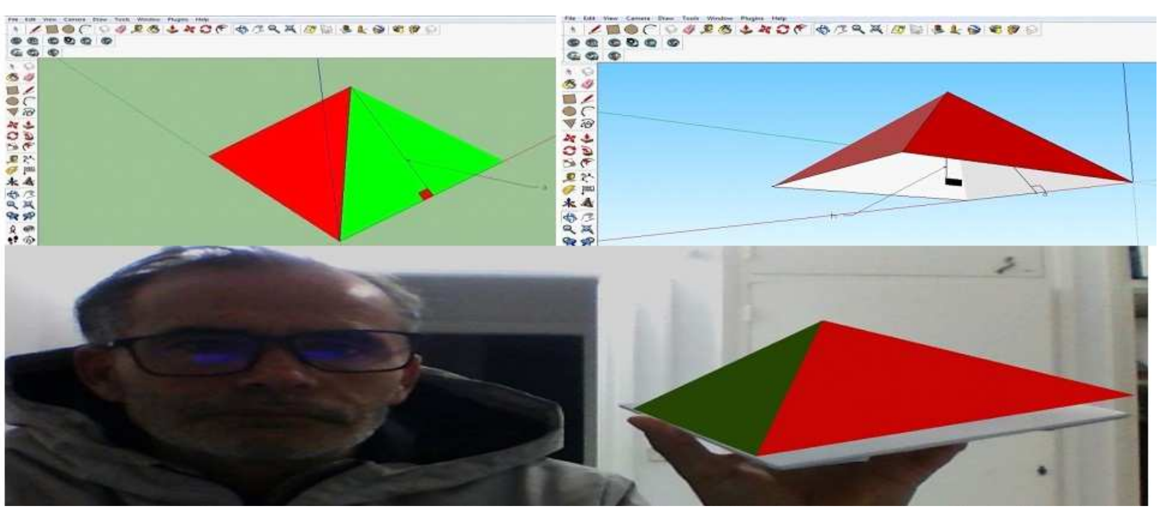

Figure 6: Experimental study, 3D modeling and application of AR to the 3D pyramid model

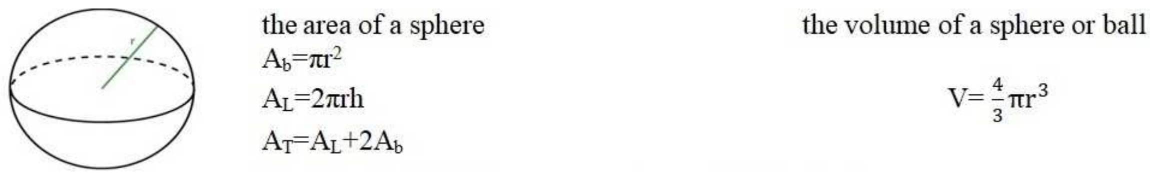

Figure 7: Theoretical study on paper, classical method

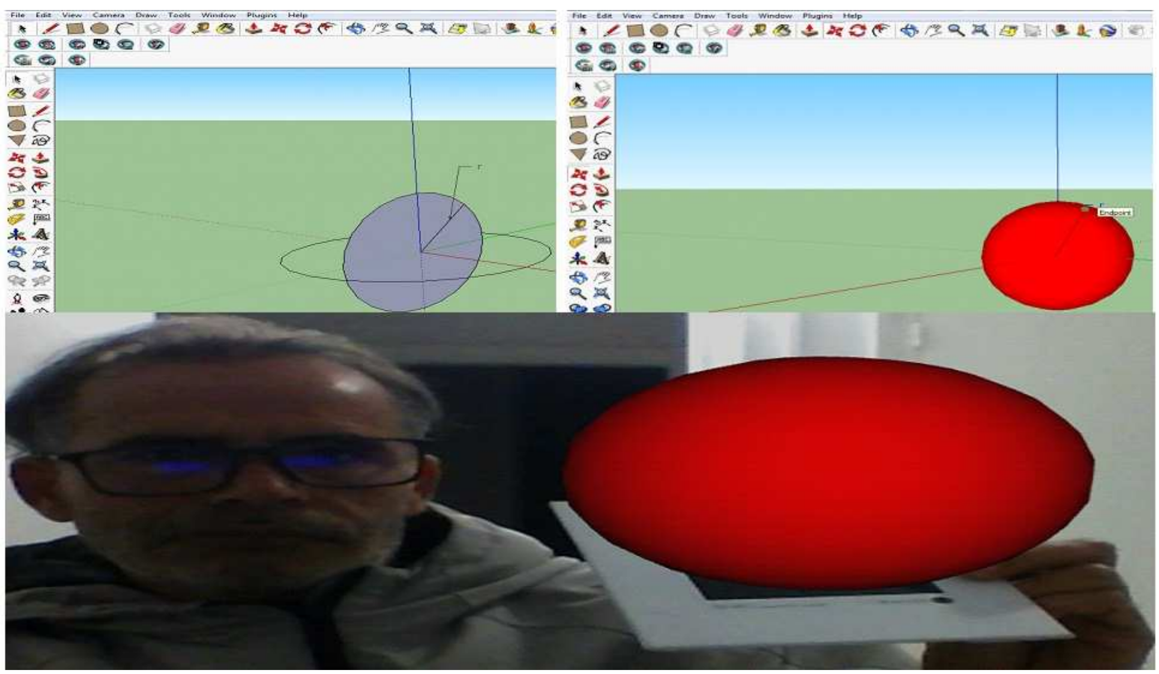

Figure 8: Experimental study, 3D modeling and application of AR on the 3D sphere model

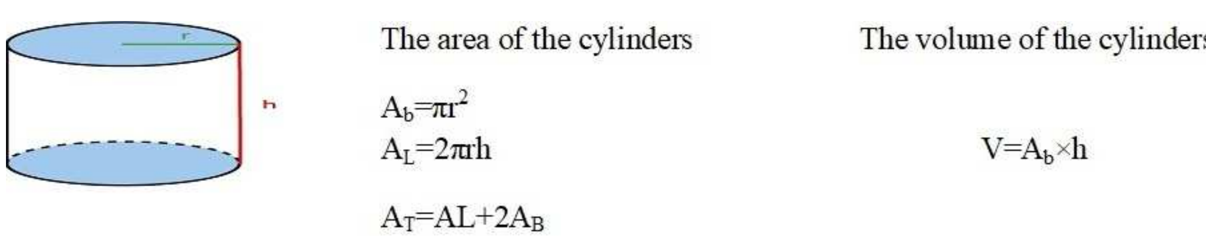

Figure 9: theoretical study on paper, classic method

Figure 10: 3D modeling and application of AR on the 3D cylinder model

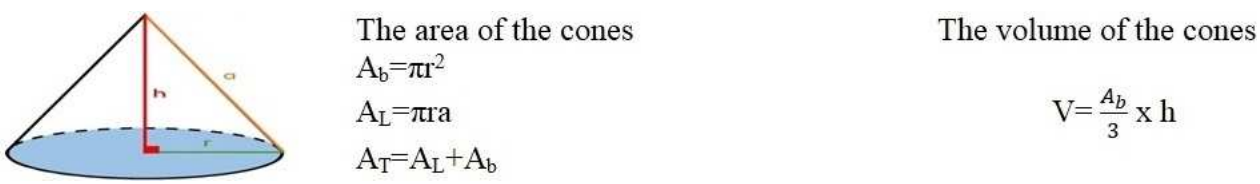

Figure 11: Theoretical study on paper, classical method

3.1 The area and volume of a cube

3.2 The area and volume of a prism

3.3 The area and volume of a pyramid

3.4 The area and volume of a sphere or ball

3.5 The area and volume of a cylinder

3.6 The area and volume of a cone

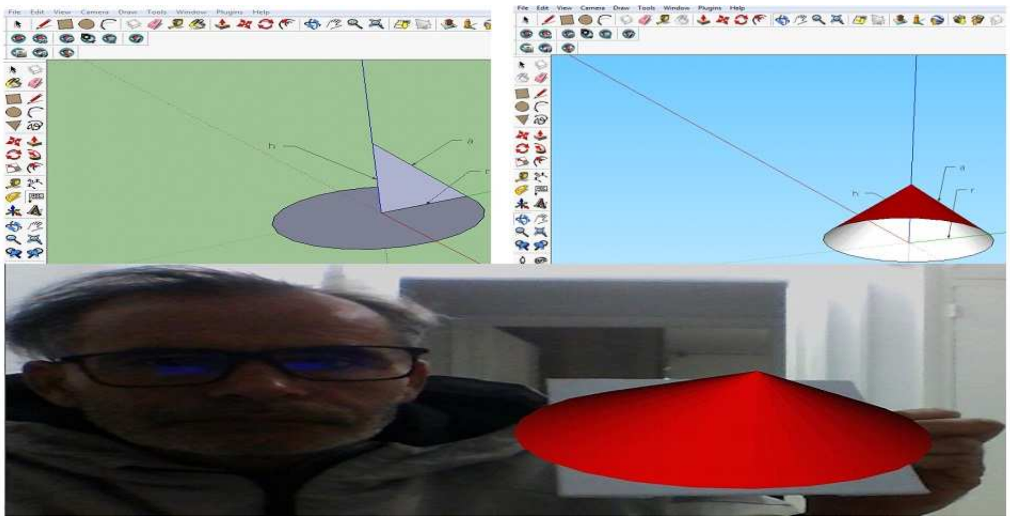

Figure 12: Theoretical study on paper, classical method

4 Conclusion

This research achieved good results following questionnaires and experiments carried out within the classes on the expectations and the real contributions of AR in learning surfaces and volumes. There are many more questions than those with established answers in the field. This applies equally to the pedagogical concepts and uses of AR at the national level [7]. The effectiveness of technology in learning surfaces and volumes, emerging or otherwise, depends heavily on taking into account factors related to users, process, and context [8].

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