Chapter 11
The Use of Augmented Reality Applications in Second Grade Mathematics Course:
Students' Knowledge of Shapes

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ABSTRACT

This study aims to examine students' knowledge of shapes as well as the views of the students and their teachers about the use of AR applications in teaching and learning geometry in second-grade mathematics lessons. A convergent parallel mixed methods research design was employed. The data collected for this study come from tests on the knowledge of shapes, as well as semi-structured interviews with students and their teachers and open-ended questionnaires. The participants of the study comprised three primary school second-grade teachers and the students from these teachers' classrooms. The quantitative data were analyzed via paired sample t-test, while the data derived from the qualitative sources were analyzed by using a content analysis method. The results show that the AR application in the second-grade mathematics lessons positively affected the students' knowledge of shapes. In addition, both students and their teachers considered AR technologies as a facilitator for learning geometrical shapes.

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INTRODUCTION

Technology has developed rapidly, affecting not only daily lives but also classrooms in the 21st century. Technology has potential in education, and especially in mathematics, which requires the use of innovative learning tools. The National Council of Teachers of Mathematics (NCTM) (2008) stated:

With guidance from effective mathematics teachers, students at different levels can use these tools to support and extend mathematical reasoning and sense making, gain access to mathematical content and problem-solving contexts, and enhance computational fluency. In a well-articulated mathematics program, students can use these tools for computation, construction, and representation as they explore problems. The use of technology also contributes to mathematical reflection, problem identification, and decision-making (p. 1).

There are many technological tools that are integrated into K-12 education to help students obtain rich and meaningful instruction. Among them are augmented reality (AR) applications, which have gained popularity in both academic and industrial circles in recent years. Before discussing AR, however, it is helpful to give information about extended reality (XR) and the virtuality continuum. XR has changed the manner in which individuals experience physical and virtual conditions. "Extended Reality (XR) encompasses a wide range of technologies along a continuum with real environments at one end and fully immersive virtual environments at the other" (Pomerantz, 2019, p. 138). XR is an emerging umbrella term that includes representative forms such as AR, mixed reality (MR), and virtual reality (VR). Milgram and Kishino (1994) presented the term "virtuality continuum" to explain the concepts related to real and virtual environments. The world in which the user interacts can be placed on a continuum depending on the amount of computer production. There is a real environment at one end of this continuum and a virtual environment at the other. As the continuum progresses from left to right, the amount of virtual images increases and the connection with reality weakens. Milgram and Kishino (1994) also stated that AR is related to MR, and AR has started to be used in the literature.

AR can be defined as a technological tool that covers the real world with some parts of a virtual world (Azuma, Baillot, Behringer, Feiner, Julier, & MacIntyre, 2001). Azuma (1997) defined AR as technology where virtual objects blend with the real world, while real and virtual objects interact with each other. AR allows the user to see the real world with virtual objects added or combined into it (Azuma, 1997; Milgram & Kishino, 1994). Azuma (1997) identified three characteristics of AR as follows: 1) it combines the real and the virtual; 2) it is interactive in real time; and 3) it registers in three dimensions (p. 356). AR has been applied in many fields, such as the military, industry, the private sector, medicine, advertising, and marketing applications, and now it has also begun to be used in education. AR applications are used in various educational disciplines, including sciences, social sciences, history, and mathematics (Carmigniani & Furht, 2011).

AR technology has a significant impact on teaching as it combines the teaching materials of the real and virtual worlds and allows teachers or students to control these materials. Using AR, students can have rich experiences and can extend their learning. In addition, given the growing interest and investment in AR by technology companies, students studying with these technologies will benefit from entrepreneurship in their future professional careers (NMC Horizon, 2016). Researchers have described five directions of AR in educational environments (Yuen, Yaoyuneyong, & Johnson, 2011):