

## Chapter 12

# User's Experience with a 3D Educational Mobile Game to Support Spatial Instruction

**Norena Martin-Dorta**

*Universidad de La Laguna (ULL), Spain*

**Isabel Sanchez-Berriel**

*Universidad de La Laguna (ULL), Spain*

**Jose Luis Saorin**

*Universidad de La Laguna (ULL), Spain*

**Manuel Contero**

*Universidad Politécnica de Valencia (UPV), Spain*

### ABSTRACT

*Spatial abilities are critical skills in scientific and technical fields. In recent studies, the role of computer games, particularly those with 3-D simulations, have been examined for their impact on the development of spatial skills. The work presented in this chapter describes the design and user evaluation of a 3D construction mobile game called iCube. A trial version was brought out and evaluated by twenty-two students. Users pointed out that the game is useful for improvement of spatial ability and is fun. However, some difficulties arose with use of the tactile screen, as fingerprints caused problems while interacting with the game's 3D environment. The results revealed that it is necessary to have this item in mind during the game's design, where screen action is continuous.*

### INTRODUCTION

Over the last half century, spatial abilities have been given increasing recognition and, despite the fact that not so much attention has been paid to them as to verbal and numeric abilities, research

accentuates their importance in the traditional fields of engineering, technology, and art, as well as in almost any other aspect of life. As it has repercussions in almost all scientific and technical fields, spatial abilities remain an active field of study, especially in the engineering domain.

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Spatial skills may be associated with success in scientific areas (Smith, 1964). Non-academic activities, such as playing with construction toys as a young child and playing three dimensional computer games seem to have strong relationship with spatial visualization ability. The interest of video or computer games for improving spatial skills has been analyzed by numerous research (Deno, 1995; Sorby, 2007).

Several authors have analyzed the impact of games on education and there is wide empirical evidence supporting the positive effects of computer games as instructional tools (Amory, Naicker, Vincent, & Adams, 1999). Various experiments have tested tools in handheld devices, indicating that they strengthen and support learning in fields such as languages, science and mathematics. Mobile devices allow for learning everywhere; when walking, in the street, on the bus, in the school, or even on the subway (Salinas & Sánchez, 2006), creating the potential for a new phase in the evolution of technology-enhanced learning, marked by the continuity of learning experiences across different environments (Chan, et al., 2006). The use of touchscreen handheld devices, such as smartphones and tablets computers appears to be one of the most significant tendencies in the current market. The majority of manufacturers are in favor of incorporating touch screens to their new devices. Market tracker iSuppli Corp. expects smartphone shipments to rise 105% from 246.9 million in 2010 to 506 million units in 2014. Shipments of tablet computers like the iPad are expected to grow from 19.5 million units in 2010 to 208 million units in 2014, according to Gartner Inc. media analysts (Gartner, 2010).

Most recent research in the field of spatial abilities focuses on how these relate to new technologies (Rafi, Samsudin, & Ismail, 2006; Rafi, Samsudin, & Said, 2008; Martin-Dorta, Saorin, & Contero, 2008; Rafi & Samsudin, 2009). The possibility of using games to develop cognitive skills opens up enormous opportunities to connect education to the daily life experiences of learners and their learning styles. This, in turn, could

increase their motivation for and commitment to learning (Sánchez & Olivares, 2011).

Based on the above mentioned findings and on our experience in developing multimedia spatial ability training tools (Martin-Dorta, Saorín, & Contero, 2008; Martin-Dorta, et al., 2010; Martin-Dorta, et al., 2011; Martin-Dorta, Saorín, & Contero, 2011), the present study tries to join the potential of touchscreen handheld devices, digital games and playing with construction toys to develop spatial skills. In the following sections, we present an overview of spatial ability and digital games, the architecture of the system designed, description of the applications and the study with users to know their experience with the mobile game.

## **SPATIAL ABILITIES**

The ability to represent and process spatial information is important for many common activities. Through a survey of engineering professionals, Jensen (1986) found out that spatial abilities are the most important engineering graphic skills that an individual needs to be able to succeed in the engineering profession. Engineers use spatial reasoning and visualization in tasks like designing and documenting parts to be assembled, imagining the shape of cut hillsides for highway construction, laying out circuit designs, or finding optimal crystal configurations. In many engineering disciplines, students need to imagine objects in different orientations, translate two-dimensional drawings into three dimensions. These skills have been positively correlated with retention and achievement in engineering, mathematics, and science disciplines (Hsi, Linn, & Bell, 1997).

Spatial ability is an important human aptitude, which plays significant roles in how individuals perceive, organize, and interact with their environments (McGee, 1979). Clements and Battista (1992) define spatial reasoning as consisting of “cognitive processes by which mental representations for spatial objects, relationships, and

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