



The effects of computer-based games and collaboration in large groups vs. collaboration in pairs or traditional methods



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ABSTRACT

As new technologies have emerged in the last few years, the learning process has been changing. New and powerful e-learning systems are being developed and new teaching methods can be used in classrooms. In this paper, we present a computer-based game with an educational background that is played on a large-size tabletop display. The game can be used as reinforcement for educational content related to historical ages. The game uses natural interaction. A study to compare the traditional learning method with a collaborative learning method using the game was carried out. A group of up to 12 children could learn together using the game. The experience of children in large groups was also compared with the experience of children playing in pairs. One hundred children between 8 and 11 years old participated in the study; they were divided into three groups (LGroup, Pairs, TClass). When the pre-test and the post-test results were compared, it was shown that the children learned the contents in all three groups. The results also showed that there were statistically significant differences between the traditional method and the game played in a large group in favour of children who played the game in the large group. The knowledge acquired was independent from gender and age. There were no statistically significant differences between learning in large groups or learning in pairs. In both cases, the children expressed their satisfaction for the game and found it easy to use. Therefore, playing games of this type collaboratively in large groups or in pairs can be a valuable learning method that can be combined with traditional methods.

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1. Introduction

Most children of this generation have grown up playing with electronic devices, computer games, and using advanced technologies having been surrounded by technology since they were born (Bekebrede, Warmelink, & Mayer, 2011; Tapscott, 1998). Technology manufacturers nowadays consider the children to be a significant market target and they are focusing on them as such (Read & Markopoulos, 2013). This might create expectations about the learning environment that can be found in the classroom (Oblinger, 2004); however, the education of this generation is still using old methods (Beck & Wade, 2006; Prensky, 2001). New technologies can be recognized to be learning tools that help young children learn in relevant ways (Couse & Chen, 2010; Gimbert & Cristol, 2004). Today's children handle digital information, communicate with others via mobile technologies, and play more games than previous generations (Beck & Wade, 2006). Game-based learning might be a more appropriate approach for teaching and engaging the children in a more successful way than traditional learning methods (Prensky, 2001). This may also affect motivation, which is related to the children's willingness to participate in tasks and activities. According to Malone and Lepper (1987), there are seven factors that promote motivation: challenge, curiosity, control, fantasy, competition, cooperation, and recognition. Many of these are present in games (Prensky, 2001). Games of this kind also provide an

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argument for learning in a collaborative mode, which offers benefits over individual learning (Johnson & Stanne, 1986; Slavin, 1988). Hogle (1996) suggested that there were some advantages to learning with video games such as trigger instinct, proving high-level thinking, practice and feedback, and memory reserving.

Natural User Interfaces (NUI) have not been widely used in learning environments like classrooms and schools. NUI could be a good complement to the traditional approach to education. Currently, there is a trend to eliminate all gamepads, joysticks, and other input methods and to use detection of the position of different parts of the user's body to control the device. According to Fishkin et al. (Fishkin, 2004), NUI facilitate the acceptance of an application by users. Interactive tables are also enjoyable and engaging to use (Rick et al., 2009) and promote equity of participation (Harris et al., 2009) and encourage learning (Falcão & Price, 2009; Jamil, O'Hara, Perry, Karnik, & Subramanian, 2011).

Previous works have compared collaborative and individual learning, such as Sung & Hwang's work (Sung & Hwang, 2013). Three different groups participated in Sung & Hwang's study: experimental group that learned using a collaborative educational computer game with a repertory grid approach (three or four students made up a team); a control group (Group A) that learned using conventional collaborative game-based learning (three or four students made up a team); and a control group (Group B) that learned using an educational computer game individually. From their results, it was found that the learning achievements of the experimental group were significantly better than those of the students in control groups A and B. The collaborative educational game with a repertory grid approach also benefited the students by enhancing their learning motivation.

Although previous works (e.g., Sung & Hwang, 2013) have compared collaborative and individual learning and have also studied the positive influence of new technologies, to our knowledge, this study is the first work in which a collaborative computer-based game played on a large-size tabletop display and involving up to 12 students at the same time has been compared with traditional learning. This work also compares the game played in large groups with playing in pairs.

Our first hypothesis is that children who learn by playing a computer-based game collaboratively on a large-size tabletop display and involving up to 12 students will obtain significantly higher learning outcomes than those who learn by attending a traditional class.

Our second hypothesis is that children who learn by playing collaboratively a computer-based game collaboratively on a large-size tabletop display and involving up to 12 students will obtain significantly higher learning outcomes than those who learn by playing with the same game, but playing in pairs.

Our third hypothesis is that children who learn by playing a computer-based game collaboratively played on a large-size tabletop display and involving up to 12 students will show significantly higher satisfaction than those who learn by attending a traditional class.

Our fourth hypothesis is that children who learn by playing a computer-based game collaboratively played on a large-size tabletop display and involving up to 12 students table will show significantly higher satisfaction and usability than those who learn by playing with the same game, but playing in pairs.

The paper is organized as follows. Section 2 focuses on work in game applications related to learning in school environments. Section 3 describes the game. Section 4 presents the description of the study. Section 5 presents the results, and Section 6 presents the discussion. Section 7 presents the conclusions and future research.

2. Related work

Recent studies have taken NUI interaction into account. One device that facilitates this interaction is Microsoft Kinect[®] (Kinect). For example, it has been used for physical rehabilitation (Chang, Chen, & Huang, 2011; Lange et al., 2011), for navigating with Google Earth (Kamel Boullos et al., 2011), or for videoconferences in which depth perception was added to the participants (DeVincenzi, Yao, Ishii, & Raskar, 2011). Other studies have used Kinect for learning purposes using NUI to compare two different types of learning itineraries: the linear learning itinerary (LLI) and the flexible learning itinerary (FLI) (Martín-SanJosé, Juan, Gil-Gómez, & Rando, 2014). The comparisons showed there were no statistically significant differences between the two learning itineraries. Many teachers have found that the systems that use interactive whiteboards are a great motivating teaching tool (Rudd, 2007; Warwick & Kershner, 2008). Lien, Huang, Wang, and Chen (2012) developed an L-shape platform where the students could learn by moving their limbs in an easy way.

With regard to studies in which traditional learning methods are compared with learning using new technologies, several works can be cited. Girard, Ecalle, and Magnan (2013) analysed game-based learning tools vs. traditional approaches. Their conclusion was that the users of game-based tools had the same learning improvement as with traditional approaches. In 2013, Al-Qahtani & Higgins investigated the effects of e-learning, blended learning, and classroom learning (Al-Qahtani & Higgins, 2013). Three groups were involved: the first group was taught by e-learning, the second group by blended learning (which combines e-learning and traditional teaching), and the third group was taught using the traditional teaching method. The sample consisted of 148 students: 43 students in the first group, 55 students in the second group, and 50 students in the third group. The Ethics unit from an Islamic Culture course was selected for the study and adapted for the online course (the e-learning method). The results showed that there was a statistically significant difference between the blended learning method and the other two methods. However, no significant difference was found between the e-learning group and the traditional learning group. Furió, Juan, Seguí, and Vivó (2014) compared the learning effectiveness and satisfaction of children using an iPhone game vs. the traditional classroom lesson for learning the water cycle. Thirty-eight children from 8 to 10 years old participated in the study. The children made significant learning gains about the water cycle regardless of the method used. Even though the results showed that the iPhone method achieved higher knowledge results than the traditional classroom lesson, no statistically significant differences were found between the iPhone and the classroom lesson. Chuang, Chen, Tsai, Lee, and Tsai (2014) studied how happiness can improve learning performance by using interactive systems. The proposed system was a somatosensory system, which is a system that is made up of a number of different receptors like thermoreceptors, photoreceptors, mechanoreceptors, or chemoreceptors like the human body. With this system, users receive abundant feedback in the activity since the responding is direct. The main goal of the users was to solve a puzzle in two modes: scoring mode and timing mode. From the results, Chuang et al. determined that the learners maintained a positive attitude when using their approach for learning purposes. Of all the factors they studied, enjoyment was the most significant one.

With regard to studies in which collaborative vs. individual learning is compared, several works can also be cited. For a single individual, it is hard to achieve complex tasks without the support of other people. Therefore, working together is nowadays highly valued in the

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