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Educational magic toys developed with augmented reality technology for early childhood education

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ABSTRACT

Shaping children's experience, enhancing their imagination and affecting their behaviors, toys have great importance. Recently, toys have gained a digital characteristic and many children have tended to use them. For this reason, educational magic toys (EMT) were developed with augmented reality technology in this study. It is called as EMT because virtual objects such as story animations, 3D objects and flash animations appear on the toys. EMT has included puzzles, flash cards and match cards to teach animals, fruits, vegetables, vehicles, objects, professions, colors, numbers and shapes for average 5–6 age children in Early Childhood Education. The aim of this study is to reveal teachers' and children's opinions on EMT, to determine children's behavioral patterns and their cognitive attainment, and the relationship between them while playing EMT. Mix method was used and the sample consisted of 30 teachers and 33 children aged 5–6 in early childhood education. As data collection tools, a survey, an observation and interview form were used. This study revealed that teachers and children liked EMT activity. In addition, children interactively played with these toys but not had high cognitive attainment. From this point, we can say that these toys can be effectively used in early childhood education. However, collaborative and interactive learning with these toys should be provided. Moreover, this study will provide an important contribution, present a new educational AR application, and fill the gap in the educational technology field.

1. Introduction

Playing is an essential part in children's development (Hinske, Langheinrich, & Lampe, 2008) and it always been considered to be of primary importance for children's learning. Therefore, early childhood curriculums provide opportunities for children to play and interact with toys (Yelland, 1999). The relationship between play and learning is proved by researchers, practitioners and parents. Especially integrating new technologies to learning environments bring some benefits for children (Plowman & Stephen, 2005). For example, it enhances the educational value of children's play (Hinske et al., 2008) and enables physical objects to be seamlessly connected to virtual content (Yelland, 1999). Combining physical and virtual worlds such as traditional games and interactive computer games is very beneficial for children (Hinske et al., 2008). So, the nature of the concept of "toy" has changed considerably over the last decades (Yelland, 1999).

Recently, many children have tended to use computer-mediated toys (Kara, Aydin, & Cagiltay, 2012b) and spent a great deal of time playing with them (Johnson & Christie, 2009). Shaping children's experience, enhancing their imagination and affecting their behaviors, toys have great importance for them (Kara, Aydin, & Cagiltay, 2012a; Kara et al., 2012b; Klemenović, 2014). Equipped with computers, digital materials and other smart technologies, toys called as "smart toys" have gained a digital characteristic. Smart toys have some advantages as they integrate multimedia materials in traditional toys (Kara, Aydin, & Cagiltay, 2013). Enriching their play with providing them a more creative environment is one of their advantages. Another one is to increase fantasy play and to enhance interaction (Lampe & Hinske, 2007; Kara et al., 2013). Combining physical and virtual realities, they also provide mixed reality (Kara et al., 2013; Lampe & Hinske, 2007; Stapleton, Hughes, & Moshell, 2002). Besides these advantages, toys can be used for educational aims. In particular, early childhood educators should be aware these educational potential, context for learning and social aspects of play (Yelland, 1999). A toy-based learning environment can provide physical interaction between

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toy and children. According to Lampe and Hinske (2007), the ideal learning experience comes from the combination of physical experience, virtual content and the imagination of the child. In addition, learners can use the toy's abilities according to educational aims (Kara et al., 2012b). Some researches on educational toys have been conducted in the literature. For example, Demir and Sahin (2014) studied the scientific toys used to teach physics, chemistry and biology concepts. They evaluated the toys according to scientific creativity. Kara et al. (2012a; 2013) developed smart toy for storytelling activity and examined storytelling skills, creativity and narrative activities. Both of studies showed positive effects of toys on their depended variables. However, there are few studies on how children play with these toys (Johnson & Christie, 2009). These smart toys facilitate child's social skills (Hinske et al., 2008). Moreover, limited researches on integrating multimedia and new technologies on traditional toys have been conducted. Some researchers developed augmented toys for children integrating multimedia tools on traditional toys, but not using AR technology (Hinske et al., 2008; Marco, Cerezo, & Baldassarri, 2010). In this study, we integrated 3D models, animations and videos on traditional toys by means of augmented reality (AR) technology. Therefore, this study will provide an important contribution, present a new educational AR application, and fill the gap in the educational technology field.

AR can be defined as taking its' three properties into consideration: combining the real world with virtual worlds, providing interaction, and presenting three dimensional (3D) objects (Azuma, 1997). AR provides both virtual and real world simultaneously to users. Although virtual worlds have several advantages like 3D avatar, rich communication channels and rich interaction (Zhang, Ordóñez de Pablos, & Zhu, 2012; Yilmaz, Baydas, Karakus, & Goktas, 2015), real world experiences give valuable opportunities. Especially, appearing of 3D objects in real world creates a magical feeling causing a high degree of surprise and curiosity (Bujak et al., 2013). In addition, texts, images, videos and animations as well as 3D models can be used for educational AR applications. These characteristics of AR make it affective (Wang, Kim, Love, & Kang, 2013). Several AR researches have been done in various education fields (See in Fig. 1). AR technology also provides numerous educational benefits (See in Table 1). Bacca, Baldiris, Fabregat, Graf and Kinshuk (2014) reviewed educational AR applications. According to their results, most of the studies on AR in education were performed in higher education settings. Moreover, the target group such as children in early childhood education should be explored for the uses of AR in future. Besides, no study on educational toys developed with AR has been encountered in the literature. Also, while the potential of learning when playing computer games has already been extensively explored, learning in mixed reality environments such as AR has not been investigated yet (Hinske et al., 2008). Therefore, we focus on children in early childhood education and their play with educational magic toys (EMT) developed with AR in this study.

1.1. Significance and rationale of the study

New technologies make valuable contributions to educational technology field and researchers have been explored their effects on students' effective learning and they have focused on “How can modern software technologies support ubiquitous effective knowledge and learning management solutions?” (Lytras & Ordóñez de Pablos, 2011). Therefore, designers have developed some online educational contents. However, they have not captured the users' attentions for a long time because they are ordinary and boring. Besides, Wood and Bennett (1997) stated that if playing provides valuable contribution to learning environments, it should also add valuable contributions for teaching. From this point of view, EMT providing opportunities for teaching has been developed for children so that they interactively learn and have fun. Interacting with toys is important in child development (Butterworth & Harris, 1994 cited in Kara et al., 2012b). If rich and proper interactions are not realized between children and toys, these technologies may make children passive. As we know, AR enables children to interact and provides rich interaction (Azuma, 2004; Bujak et al., 2013; Ivanova & Ivanov, 2011; Kerawalla, Luckin, Selijefot, & Woolard, 2006; Wojciechowski & Cellary, 2013; Wu, Lee, Chang, & Liang, 2013). However, determining how children interact with toys and which behavioral act is important relates to deeper examination in interactions with AR. Especially, children's behaviors with digital toys are important because they provide self-motivation and lead them to learn about the world (Johnson & Christie, 2009). For this, behavior pattern analyses for AR applications have been performed in the literature (Chang et al., 2014; Cheng & Tsai, 2014a, 2014b; Lin, Duh, Li, Wang, & Tsai, 2013). Behavioral patterns enable us to understand the interactions in depth and lead educators to conduct environments (Hou & Wu, 2011). Furthermore, they allow us to understand how instructional strategies can be embedded in our environments (Hou, 2012). Therefore, we examine children's behavioral patterns while playing EMT. On the other hand, interaction with toys supports children's cognitive processes. Lin et al. (2013) suggested that further studies for understanding the user's experience and knowledge construction processes in AR application should be carried out (Bacca et al., 2014). From this viewpoint, we also determine children's cognitive attainment while playing EMT. Especially, Cheng and Tsai (2014b) study was grounded on determining the variables of behavioral pattern and cognitive attainment for different educational AR applications.

Lastly, we determine teachers' opinions about using EMT in education. According to the literature, teachers should know how to maintain a balance between traditional and new digital toys and should become more sophisticated about digital toys (Johnson & Christie, 2009). In addition, the choice of using a technology for education depends on teachers' access and acceptance of the technology. Therefore, we care their opinions in terms of technology acceptance model (TAM). Therefore, this study will examine the following research questions:

- What are early childhood education teachers' opinions about EMT in terms of TAM?
- What are children's opinions on EMT activity?
- How do children behave and interact with each other during EMT activity?
- What is the cognitive attainment of children when engaging in EMT activity?
- What are the relationships between their behaviors and cognitive attainment?

2. Method

2.1. Research design

In this study, triangulation method, one of the mix method, was used. While teachers' opinions about EMT and children's behavioral patterns were examined by quantitative methods, children's cognitive attainment and opinions were revealed by qualitative methods.

2.2. Sample

Sample consisted of all female teachers (N = 30) and children (N = 33) aged 5–6 including 15 boys and 18 girls in Early Childhood