Abstract

Education is a field of research in which Natural User Interfaces (NUI) have not been extensively exploited. NUI can help in the learning process, specially when used by children. Nowadays, children are growing up playing with computer games, using mobile devices, and other technological devices. New learning methods that use new technologies can help in the learning process.

The use of autostereoscopic vision is rising. At present, we can find many devices capables of rendering images that can give us a 3D perception without the use of glasses or any other wearable device. With this technology, new applications with more immersive environments can be developed and brought it to user's disposal.

Considering the importance of games and new technologies for learning, in this thesis, two different systems that use NUI for learning about a period of history were designed and developed. One of these systems uses autostereoscopic visualization, which lets the children see themselves as a background in the game, and that renders the elements with 3D sensation without the need for wearing special glasses or other devices. The other system uses frontal projection over a large-size tabletop display for visualization. The two systems have been developed from scratch. The Microsoft Kinect device is used in both systems for interaction.

A total of five studies were carried out to determine the efficacy of games with NUI interaction with regard to acquiring knowledge, ease of use, satisfaction, fun and engagement, and their influence on children.

In the first study, a comparison of the autostereoscopic system with the frontal projected system was carried out. This study analyzed different aspects such as engagement, increase of knowledge, or preferences. A total of 162 children from 8 to 11 years old participated in the study. From the results, we observed that the different characteristics of the systems did not influence the children's acquired knowledge, engagement, or satisfaction; we also observed that the systems are specially suitable for boys and older children (9-11 years old). The children had the depth perception with the autostereoscopic system. The children considered the two systems easy to

use. However, they found the frontal projection to be easier to use.

A second comparative study was performed to determine the mode in which the children learn more about the topic of the game. The two modes compared were the collaborative mode, where the children played with the game in pairs; and the individual mode, where the children played with the game solo. A total of 46 children from 7 to 10 years old participated in this study. From the results, we observed that there were statistically significant differences between playing with the game in the two modes. The children who played with the game in pairs in the collaborative mode got better knowledge scores than children who played with the game individually.

A third study that compares traditional learning with a collaborative learning method (in pairs and in large groups) using the game was carried out. A total of 100 children from 8 to 10 years old participated in this study. The results are in line with the second study. The children obtained higher score when collaborated in large groups or in pairs than attending to a traditional class. There were no statistically significant differences between playing in large groups and playing in pairs.

For personalized learning, a Free Learning Itinerary has been included, where the children can decide how to direct the flow of their own learning process. For comparison, a Linear Learning Itinerary has also been included, where the children follow a determined learning flow. A fourth study to compare the two different learning itineraries was carried out. A total of 29 children from 8 to 9 years old participated in this fourth study. The results showed that there were no statistically significant differences between the two learning itineraries.

Regarding the online formative assessment and multiple-choice questions, there is usually a question and several possible answers in questionnaires of this kind in which the student must select only one answer. It is very common for the answers to be just text. However, images could also be used. We have carried out a study to determine if an added image that represents/defines an object helps the children to choose the correct answer. A total of 94 children from 7 to 8 years old participated in the study. The children who filled out the questionnaires with imaged obtained higher score than the children who filled out the text-only questionnaire. No statistically significant differences were found between the two questionnaire types with images.

The results from the studies suggest that games of this kind could be appropriate educational games, and that autostereoscopy is a technology to exploit in their development. The following general conclusions have been extracted from the studies carried out:

- The new technologies are appropriated for developing educational games and autostereoscopy is a technology to exploit in their development.

- With applications like the ones presented in this thesis, children can learn using new technologies and, at the same time, they can have a good time playing the game, which promotes their learning.

- To play in a collaborative way facilitates the effectiveness of games with educational purposes. Children can learn a wide variety of educational topics by using new technologies and having fun with other children at the same time they are playing with them.