

Chapter 62

Learning in a Virtual Environment: Implementation and Evaluation of a VR Math-Game

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ABSTRACT

With the introduction of Google Cardboard, a combination of mobile devices, Virtual Reality (VR) and making was created. This “marriage” opened a wide range of possible, cheap Virtual Reality applications, which can be created and used by everyone. In this chapter, the potential of combining making, gaming and education is demonstrated by evaluating an implemented math-game prototype in a school by pupils aged 12-13. The aim of the virtual reality game is to solve math exercises with increasing difficulty. The pupils were motivated and excited by immersing into the virtual world of the game to solve exercises and advance in the game. The results of the evaluation were very positive and showed the high motivational potential of combining making and game-based learning and its usage in schools as educational instrument.

INTRODUCTION

Since the dawn of virtual reality (VR) headsets there have been major improvements in the head-mounted display technology in recent years. With the evolution of VR headsets and the announcements of products as Oculus Rift, HTC Vive, Samsung Gear VR etc., more and more manufacturers will release their headsets to the market in the near future to make Virtual Reality available to the public. Mobile devices

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Learning in a Virtual Environment

are complex computers which are gradually replacing Personal Computers (PCs) in all-day life (Gartner Press Release, 2016). With their high availability, the variety of embedded sensors, cameras and the availability of high computational power, mobile phones especially lie in the focus of researchers and developers. A new movement emerged in the last few years, namely, the Maker Movement (Schön, Ebner, & Kumar, 2014). Small computers as the Raspberry Pi or the Arduino offer new possibilities to invent and experiment with ideas and technologies. Makers meet at annual maker fairs to showcase inventions and experiments. When Google introduced Google Cardboard, a virtual reality headset can be made of a cardboard combined with a mobile phone. Therefore, making was combined with VR and mobile technology. The marriage of making, VR and a mobile device offers a great possibility to use concepts of digital game-based learning to create an immersive learning experience. Using VR techniques for learning, education or advanced training is an interesting research field with high potential.

The following research questions were examined:

RQ1: How could a VR device be integrated into a mathematical learning scenario?

RQ2: Which lessons could be learned while evaluating the learning scenario in a secondary school class?

RQ3: How could the learning experience be improved?

For this work, a simple virtual reality game has been implemented to evaluate the need for such educational games, supporting and motivating children in exercising math and the educational and motivational effects of combining making, gaming and learning. Finally, this chapter gives some recommendations how to integrate and augment school lessons with making and game-based learning.

BACKGROUND

In the following three sections, some background information is given about virtual reality (VR), game-based learning and the maker movement. The sections outline the key definitions used throughout this chapter.

Virtual Reality

Virtual Reality is a computer-generated illusion of the real world. The perfect Virtual Reality manipulates the human senses to be indistinguishable from the real world. Although, it is a utopian desire to create such a perfect virtual world (Stanković, 2015, p. 4). Common sense defines VR by head-mounted displays as Oculus Rift and/or data gloves, but this is not an adequate definition (Burdea, & Coiffet, 2003, p. 1). VR can also be accomplished by projectors in combination with Personal Computers (PCs) called the CAVE (Cruz-Neira, Sandin, & DeFanti, 1993). All sorts of computer games are also capable of creating a VR experience. The differences between VR and 3D movies are the possibilities to interact with the created world, change the state of the world and get a feedback (Stanković, 2015, p. 9). By having the possibility of interaction one can immerse into the virtual world. According to Burdea and Coiffet (2003, p. 3), interaction and immersion are two of three key features of VR. The third feature is imagination. Virtual Reality is often used to simulate real world processes. To restrict the parameters of the simulation to fully map a real world process, without breaking the simulation, is a difficult task which has to be solved by VR-developers and their imagination. Another important definition with respect to Virtual

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