Chapter 5
Developing Design Knowledge and a Conceptual Model for Virtual Reality Learning Environments

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ABSTRACT

This chapter focuses on applying design science research for virtual reality learning environment (VRLE) design processes. Six selected case studies are presented in the context of VRLEs. The case selections were analyzed in terms of their contributions to design knowledge. The objective of this book chapter is twofold: 1) for researchers, the design knowledge contributions of case studies are highlighted for future reference, and 2) for developers and practitioners, design principles are presented for the development of VRLEs. The final outcome of the present study is a conceptual model describing the current design knowledge in the field of VRLEs and identifying the research gaps that should be addressed in future research on the educational use of VR.

INTRODUCTION

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The use of information and communications technology (ICT) is increasing in various educational institutions as well as in workplace learning settings. However, in order to effectively use ICT in educational settings, information about learning outcomes in a variety of technology-enhanced learning environments, as well as the design of its usage as part of the entire learning path, need to be known. The types of ICT used in educational contexts include computers, tablets, mobile phones, augmented reality (AR), virtual reality (VR), and robots.

This article presents the development of design knowledge and a conceptual model for virtual reality learning environments (VRLEs). Following Gregor and Hevner (2013), the article aims to help researchers to understand the design knowledge contributions of their studies regarding VRLEs and position them better. Furthermore, for the practical development of VRLEs, the aim of the article is to make visible and point out which kinds of design knowledge should be taken into consideration when designing VRLEs. Based on the findings of Radianti et al. (2020), it would be beneficial to share the best practices across different subjects in the field of VRLE research. In furtherance of that purpose, six case studies presenting different levels of design knowledge from specific subjects, limited to more abstract and mature knowledge, are introduced. The case study selection was drawn from a systematic literature review in the field of VRLEs (Lähtevänoja et al., forthcoming). The focus of the case study selection is on various design knowledge contributions and differentiated design knowledge following Gregor and Hevner (2013) and vom Brocke et al. (2019). Although the analyzed case studies did not directly conduct design science research methodologies, they provide design knowledge and understanding for further research and development, which are summarized in a conceptual model of VRLEs at the end of the article. The application of the conceptual model among practitioners and in future research is also discussed.

BACKGROUND

Virtual Reality and Virtual Reality Learning Environments

VR can be defined as an artificial, computer-generated digital environment in which users can interact with the environment (Milgram & Kishino, 1994). In VR the real-world physical boundaries (e.g. gravity) can be exceeded. Furthermore, VR can enable activities and interactions which may be dangerous, expensive or even impossible in real world (Tatli & Ayas, 2011). In addition to games and entertainment, virtual reality can be used in educational settings. VRLEs can be viewed with many technologies (e.g., head-mounted displays [HMDs] and desktop monitors). In this study, "VRLE" is used to mean an HMD-based VRLE.

However, while VRLEs have potential in educational settings, active learning in VR is not gained automatically. For example, it is dependent on various dimensions with multiple factors, such as the successful integration of VR into broader pedagogical and social scenarios of the classroom (Gouveia et al., 2017). In addition, more research on the learning outcomes of VRLEs is needed to justify the acquisition of the technology to educational institutions (Holopainen et al., 2020; Vesisenaho et al, 2019). Based on a systematic literature review regarding the use of VRLEs in higher education (Radianti et al., 2020), only a few articles address how VRLEs can be adapted to the teaching curriculum. While there are an increasing number of studies addressing these issues, the research field lacks coherent frameworks combining existing knowledge on VRLEs and guiding future research (Sandoval, 2014; Walsh et al.,