Conceptualizing Immersion for Individual Learning in Virtual Reality

Henrik Kampling[1], Anna Schwarze[1], Oliver Heger[1], and Bjoern Niehaves[1]

[1] University of Siegen, Chair of Information Systems, Siegen, Germany
{henrik.kampling,anna.schwarze,oliver.heger,
bjoern.niehaves}@uni-siegen.de

Abstract. Immersive virtual reality technology (VR) receives more and more attention, especially since the release of the Oculus Rift (development kit 2) in 2016. This technology is not only used in the gaming industry but also in serious contexts such as product design or education. The creation of high immersion is commonly said to be the special characteristic of VR. We consider two perspectives on immersion: firstly, immersion in the task and, secondly, immersion in the technology. Our work focuses on immersion as part of the learning related theory of cognitive absorption to examine the theoretical difference between task and technology immersion in the case of individual learning with immersive VR technology. We conducted an explorative Grounded Theory approach with 10 in-depth interviews based on first-hand experience with a self-developed immersive VR application. We propose theoretical and design implications for how VR can potentially enhance individual learning.

Keywords: immersion, virtual reality, individual learning, grounded theory

1 Introduction

Virtual Reality (VR) technologies are gaining more and more popularity, especially since the market entrance of Oculus Rift (Development Kit 2) in 2016 [1]. Nowadays, there are a couple of virtual reality head-mounted displays (HMDs), such as HTC Vive or PlayStation VR. VR technology is not only used for gaming contexts but in a variety of serious cases, such as product design and manufacturing [2, 3], urban spaces [4], (landscape) architecture and environmental planning [5], travel fair [6], rollercoasters [7], healthcare [8], or education [9]. The latter, for instance, shows an overview of educational perspectives and contexts. Liu et al. propose frameworks for design and implementation of learning [9, part I] and case studies of immersive learning (part II).

Such technologies facilitate new opportunities to improve education. Nowadays, many teaching formats and materials are supported by digital technology, such as massive open online courses, collaborative learning through social media, blended learning concepts, or other e-learning tools. Besides increasing the detachment from local and time restrictions, an essential objective of digitally supported learning is the improvement of individual learning outcome. Recent research in Information Systems (IS) investigates in how far innovative learning strategies [10] and environments [11]

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can improve individuals or organizational learning outcomes, learning performance and the acceptance of e-learning technologies [e.g. 12].

VR environments based on head-mounted displays (HMD), such as Oculus Rift or HTC Vive, offer high potential to enrich learning experience and achieve better learning outcomes. In an immersive VR, the user is completely surrounded by an enclosing virtual space [13], which requires complex interfaces such as an HMD. Being in an immersive VR, users are entirely "beamed" to a virtual space, in which they interact with the environment using their entire body. Thus, the user is more strongly absorbed by immersive VR than in traditional non-immersive VR [14]. The use of HMDs in combination with the use of controllers allow users to interact with objects in a virtual environment in a more active and deeper fashion [15, 16].

Although we assume that HMD-based VR can significantly increase the immersion of its user compared to traditional screens and, in doing so, increase individual learning outcomes, to the best of our knowledge, no (empirical) research exists explaining interdependencies of immersion VR learning environments. Hence, the meaning and specific conditions of immersion in virtual reality learning environments have to be explored. Consequently, our study is guided by following research question:

RQ: How can immersion be conceptualized in the context of VR technology for individual learning?

Given its explorative nature, our study uses a Grounded Theory approach. In doing so, we use the literature on immersion, VR, and individual learning to get first insights into the subject. Afterwards, we propose our research method in which the interviewees of our study got first-hand experience with an immersive VR-HMD due to the novelty of the technology, i.e. a HTC Vive and a self-developed application. We then present and discuss our findings and provide implications for theory and design.

2 Background on Virtual Reality and Immersion

Virtual reality. In IS research, virtual reality systems are in the scope of interest. Since Oculus Rift (Development Kit 2) entered the market in 2016, the hype surrounding VR technology, particularly HMDs, grew [1]. VR is an interactive, computer-generated three-dimensional environment in which people become immersed [17]. VR applications within such an environment depend on the degree of immersion [13]. On the one hand, non-immersive VR refers most commonly to applications in desktop or laptop computers. On the other hand, immersive VR relates to users who are wearing complex interface technologies (e.g. head-mounted displays) and are completely surrounded by an enclosing virtual space. In addition, VR mostly refers to a single-user interaction in a virtual environment [18] and is typically limited to a single user session of 30 minutes [19]. An overview of current VR technologies, i.e. hardware and software, is provided in Anthes et al. [15].

Current research on VR is manifold and examines diverse topics and fields. A recent study on VR examines virtually high and low experiential products while shopping online [20]. Results show that consumer learn more about products, such as attitude and knowledge, in the virtually experiential high condition than in low condition.

Another study investigates virtual product experience and consumers' product understanding while it focuses on product presentation format and task complexity [21]. Further characteristics of immersive VR are arising through the use of HMDs and the use of controllers [22]. Both technological characteristics allow users to interact, create, and manipulate objects in a virtual environment [23, 24]. Against the background of VR and its origins in the consumer market with focus on gaming, VR is well-suited for applying gamification techniques for teaching cases within architecture and engineering 3D arts because it can help to engage into the learning process [25].

As mentioned above, an advantage of immersive VR is the increase of precision and permission of the visualization of objects and processes which are otherwise difficult or impossible to show in the real world which in addition allows to promote focused experiences, such as for the purpose of learning [14, 24]. Slater and Sanchez-Vives [14], for instance, describe four particular advantages immersive VR can have for educational purposes: First, VR can change abstract settings to tangible settings. For example, geometrical and mathematical concepts can be more easily understood in VR compared to traditional paper and pencil learning [26]. Second, VR settings allow a user/learner to actively engage than just observe how things work. For instance, surgical training, ideally paired with haptic feedback, can profit from practicing instead of observing handles [27]. Third, VR simulations allow to substitute methods that are desirable by teachers but practically infeasible or impossible in reality. If students have to study different elements such as Niagara Falls on week one and Stonehenge on week two, it will be infeasible to visit both places (due to time or resource restrictions) [28]. Fourth, VR environments are able to break the bounds of reality as part of exploration. Within such a virtual setting, physics can be manipulated such as changing gravity or making light speed and biological cell utilizing visible [29].

Immersion in the literature. A central component of VR generated, through the use of HMDs, is immersion [14]. In accordance with Slater [16], a user becomes immersed in a completely surrounding virtual setting (wearing a HMD) so that they can turn in any direction with head movements and motion parallax. Literature defines immersion, firstly, as task immersion (such as interactions and activities) "a mental state of being completely absorbed or engaged with something" [30] and, secondly, as technology immersion (such as software) "the experience of total engagement where other attentional demands are, in essence, ignored" [31]. Both are similar but have different research backgrounds and are measured differently. Within the context of learning, immersion is essential within the flow theory [32], and hence, it is a central component of Cognitive Absorption (CA) in the context of new information technology [31]. Both deal with an individual's mental state of absorption, a feeling of engagement and immersion, including intense concentration, a sense of being in control, a loss of self-consciousness, and a transformation of time [31, 32]. Hence, Flow and CA agree that the role of the flow experience shapes individual attitudes and behaviors when using information technology.

Cognitive absorption and flow have been the object of investigation in many studies. Flow, for instance, has been studied in relation to e-learning environments for higher education [12]. Here, processes of interactivity, imagery, and spatial presence influence flow (directly associated to intrinsic motivation) while the goal is to analyze the user's response towards a learning environment, such as continuance behavior. Another educational and more practical approach focuses on interaction and flow and its impact on e-learning acceptance by nurses [33]. The goal of the study is to analyze interaction factors (such as learner-system, instructor-learner, and learner-learner) and intrinsic (e.g. flow) as well as extrinsic motivators (e.g. TAM constructs, such as ease of use and usefulness) to explain the nurses' behavior of using an e-learning system for continuance intention.

Current studies of CA investigate it in relation to perceived learning in a mobile training scenario [34] and to individual learning in groups through text and video [35]. The first one found out that CA plays a significant role in affecting the deep involvement of users. The second one analyzed peer influenced learning and individual CA on learning outcomes (i.e. satisfaction, perceived understanding, and performance). With regards to a virtual environment, Goel et al. [11] examine the effect of CA on learning in collaborative tasks. They analyzed the effects of CA on perceived learning, learner satisfaction, and task participation in a virtual world. Collaborative learning and cognitive absorption have also been studied in an organizational context including individual learning [36]. The authors focus their work on group-level behavior that, in turn, can reduce (self-assessed) individual learning. Another work focusing on online learning environments investigates social presence and interest as antecedents of CA which, in turn, affects satisfaction [37]. Burton-Jones and Straub [38] present a contextualized model of system usage and individual short run task performance in which CA and deep structure usage are antecedents of system usage. Their results indicate that inappropriate choices of usage measures reduce explanations of performance.

In summary, much research on VR and immersion already exists. With regard to learning, only a couple of studies have examined the actual individual learning but mainly in group or collaborative tasks [11, 36–38]. Nevertheless, these studies do not consider a differentiate view on the construct of immersion, and in this way, flow and CA. On the one hand, immersion is outlined as task or interaction specific [e.g. 11, 32, 36], and on the other hand, it relates to technology [e.g. 31, 38]. Moreover, due to the characteristics of VR-HMD technology (such as the opportunity of enclosed virtual spaces which offer high potential for interactivity, creation, and manipulation of objects), we assume substantial potential in the context of learning. In turn, the meaning of immersion, particularly the differentiation between task/interaction and technology immersion has not been focused yet. In addition, we assume this missing theoretical differentiation as a gap which could be essential for individual learning within VR.

3 Research Design

Methodology. Due to the novelty of VR-HMDs, we are not surprised that no solid theoretical base exists that is able to explain the central construct and the interdependencies of immersion within the context of virtual learning environments. Taking this into account, the study at hand was conducted to get initial insights to comprehend this phenomenon. As a consequence, a deductive approach cannot be used to investigate this context because there is a lack of a reliable body of existing theory to inform extensive a priori theorizing [39, 40]. Due to the explorative nature, we follow an inductive Grounded Theory approach [41–43] to explore and examine the central component immersion in the context of individual learning with VR systems. Grounded Theory is well suitable for exploring theoretical insights [41] and can be characterized along six dimensions [44]: i) development of theory for describing and analyzing the phenomenon of interest; ii) continuous data comparisons against different viewpoints by constant growing analytical and theoretical aspects; iii) a step-by-step coding of data across multiple steps as emerging theory develops; iv) along upcoming differentiating dimensions the theoretical sampling of data; v) the handling of prejudices that prevent relying on any certain theory as a starting point; vi) "an inextricable link between data collection and analysis that incorporates further sampling as part of ongoing analysis and theorizing" [1].

Data Gathering. Against the background of the novelty of immersive virtual reality technologies, such as HTC Vive, Oculus Rift, or PlayStation VR, we conducted the interviews in a virtual reality lab. Here, all interviewees were able to get first-hand experience by using a virtual reality head-mounted display (i.e. HTC Vive). They used a self-developed VR environment (created with the Unreal Engine 4). First-hand experience guarantees that each interviewee is able to answer questions regarding virtual reality systems. The interviews were guided by questions which aim to reveal insights of VR-based learning technologies and of learning (theories) useful for immersive systems.

One major challenge of the interviews results from the fact that VR systems are (to the best of our knowledge) popular but not yet part of everyday life and, as a consequence, largely unknown (particularly with first-hand experience) among non-experts. Therefore, before the interview started, we provided each interviewee with time to use a virtual reality head-mounted display to get first-hand experience. As mentioned above, each interviewee was able to use a self-developed application (c.f. Figure. 1). Each participant was guided to an enclosed room to ensure a quiet and controlled environment without external distractions. Only people who actually used the VR system were interviewed to guarantee that each interviewee was able to answer questions regarding the VR system. Within the self-developed demo, each interviewee was confronted with a scenario to move freely in a virtual room. Here, the starting point was in a room where a door has to be opened by using a key. The key had to be taken with the help of the controller and led to the door, which then opened. The participant had to walk through the door by real walking movements and to follow instructions in order to hand over a parcel, by using the controller, from one point to another, where a virtual avatar was waiting. The system provides feedback to the user through visualizations, i.e. green for correct conduction and red for making a mistake. In case the user made a mistake, he or she could restart the process until they conduct it correctly. Afterwards, each interviewee was given time to explore the virtual setting, such as interacting, playing, or manipulating objects. The aim of the VR demo is a parcel delivery process in which a participant is able to learn a step-by-step process.

For instance, the demo oriented itself within a perspective of a postman who hands over a parcel.

Figure 1. Self-developed immersive VR application

The interviews had an average duration of 67 minutes, whereby 6 male and 4 female persons were interviewed with an average age of 29 years. Within our interview group, we had one ERP consultant, one management consultant, one innovation consultant, one practice nurse, one research associate, one student of teaching, one student of environmental science, two students of information systems, and one student of business administration.

The study at hand follows an interview guide approach because it is more comprehensive and systematic for data collection than a purely conversational interview. Each interview was open-ended to ensure all interviewees can add concerns that we did not cover in our guideline [45]. Each interviewee was able to ask questions about the immersive VR technology while they were using it. Here, we followed the guideline of Darke et al. [45] who suggest to conduct an interview with at least two interviewers. We recorded the interviews to minimize data loss and to provide all answers and insights given by the interviewees. All interviews were fully transcribed.

Data Analysis. For reviewing our interviews, we used MAXQDA 12. Here, we looked for indicators of immersive VR technology, particularly insights into immersion, and specific conditions of individual learning in VR environments. To analyze the indicators, we draw from well-known methods from grounded theory [41–43, 46, 47], i.e. open coding, axial coding, and selective coding. Hence, we had three phases of analysis. These phases were done iteratively by the first two authors of the paper at hand, including phases of independent coding and code-matching to come to a joint result. Within this initial phase, i.e. looking for emerging aspects (open coding), we specifically took care that within the procedure no themes were excluded due to previous experience or prejudice. We then applied axial coding by building clusters of similar codes. The axial coding allowed us to identify different insights relevant for our subject. In a third step, we searched for relations between the insights to better understand the themes and to derive theory implications, we reflected them by matching them with the literature (selective coding). After we conducted 10 interviews, we finished collecting data because no new insights were found (theoretical saturation).

For the following presentation of our findings, we chose quotations which were most suitable to represent the overall findings.

4 Findings

Feeling naturalness within immersive VR. An immersive VR leads to the feeling that you can act with the virtual environment similar to the real world. Acting in VR feels natural for the users, so that a feeling of reality arises. Naturally executed movements by users and that everything behaves in such a way a user expects support this feeling. Their expectations are based on the experiences of the real world. This real feeling also creates barriers that do not exist in the virtual setting but which are perceived by the participant as real, based on their real world experiences.

"The application was very exciting. Firstly, because you really had to interact with the objects as in reality, and you had to be able to rely on the virtual environment reacting exactly as you would have expected. So that the physical effects of the virtual scenario match those of the real world. [...] Ok, I have to say that I really don't have the need to step into the table because I think it will hurt my knee, it is like an invisible barrier. It feels like walking through thick water. Of course, you don't feel anything but it feels like as you can rest on it." (Interviewee 1, ERP consultant)

Another aspect mentioned to enhance a feeling of naturalness relies on acting with real hands rather than controllers. These, in turn, can enhance the engagement within a virtual space. For instance, it was mentioned that connected gloves or similar technologies which visualize hands and fingers within the virtual space could change the kind of interaction with objects and strengthen the feeling of real behavior.

"Only one grabbing mechanism is not enough, there have to be two times five fingers so that you act as if you were using the real hand. For example, in medical cases, you need sensitivity." (Interviewee 10, student of business administration)

"If you pull on a glove, one with some sensors on it would probably be even more natural. [...] A hand would be cool. Because now I have operated with the controller, I have seen the controller in the virtual reality. I wish I had seen my hands like the controller. Simply to be able to estimate the distance correctly even if I want to grasp something. If I don't have hands I don't know if I grab at the right place" (Interviewee 2, innovation consultant)

Against the background of traditional teaching formats and teaching in VR, positive and negative perspectives were mentioned. For instance, the reason why a learner can recall information could rely on the medium it was taught in. As a consequence, a VR space can enhance a learner to be engaged to specific content-related details as they exist in a real world environment.

"[...], the details in a lecture are between the lines or are available in texts. The medium of these lectures is the lecturer or the slides, in which I have two sources of attraction from which I must draw the information myself. In VR, I don't have the opportunity to write down information. It was beyond my familiar environment, so my head is naturally much more active to look at details and learn." (Interviewee 4, student of information systems)

Dimensions of Immersion. Almost all interviewees explained that they forgot the outside environment because they had the feeling of being inside the virtual setting and to be cut off from the real world. So far, virtual reality settings allow users to ignore distractions from the real world and to focus on the VR environment. In conjunction with haptic stimuli, the novelty, and variety of (inter)actions delivered by VR technology, users are (again) able to draw their attention to the intended learning task. The part of immersion in technology is, as defined above, the total engagement to a system while all other impressions are ignored (from here we call it *technology immersion*). Due to the technology immersion, the participant is in the position to feel like a part of the game or system, i.e. to dive into the VR system. Through the sensory immersion and interaction within the virtual environment, a feeling of being involved arises. In turn, this would make it difficult for an individual to "escape" the learning context because the VR provides an enclosed surrounding, engages, and transfer the user into virtual space.

"So, you were just in the game [VR system], you couldn't just look at it from the outside, like in a normal computer game. You were just in the game as part of the game." (Interviewee 3, student of teaching)

"Virtual reality is very engaging. It surrounds you and gives you another room. If you combine different media, such as writing, video, or audio, under a certain goal, then you have a great beneficial application. In VR, you have a much wider field of vision than on a PC display. Even if you put three displays side by side, the VR can surround you with a 360-degree environment freely for yourself. […] I think the non-perception of passed time is about the new environment, I have focused on many little things, this took so much time. The virtual room invites you to deal with everything; this shifts the perception of time." (Interviewee 3, student of teaching)

"I know that nothing can happen to me, so I can interact with the virtual reality very interested." (Interviewee 6, research associate)

The psychological perspective of immersion is a mental state in which you are immersed in a certain task or activity (from here we call it *task immersion*). On the one hand, participants are curious and engaged in the content, and on the other hand, there are some hazards that the user loses himself while interacting within VR.

"Yes, the technology is also interesting but more interesting is the presented content." (Interviewee 8, student of environmental science)

"I am already very curious to see what the scenario will look like. With these glasses [the HMD is meant] it will be a very exciting and engaging experience." (Interviewee 2, innovation consultant)

"[…] but the risks that I see in this context is that people get lost in the virtual reality activities." (Interviewee 9, practice nurse)

An emerged issue within the interviews is the loss of the feeling of passed time. In case an individual does not recognize the spent time while being active in the VR, this could be positive for concentration as well as learning. In contrast, if one is not sensing the spent time during VR activities than this could lead to a loss of perceiving the real world.

"I think it has a positive context because the loss of a sense of time is in general a sign for concentration. Therefore, to cut out the surroundings, I would say this could be useful [for learning cases]." (Interviewee 5, student of information systems)

"I think it is a danger that you completely lose yourself in virtual reality activities and you do not notice at all how fast the time passes in reality. You can lose the relation to reality." (Interviewee 9, practice nurse)

Finally, our findings reveal an essential insight about the relationship of task and technology immersion. In the context of problem-solving, a VR system can enhance an individual to cut off real world surroundings and to focus on a specific task. Hence, a higher degree of technology immersion allows a user to be engaged with a mental activity (i.e. a higher task immersion).

"There are situations where you get into a flow. In these situations, you just do and do not think. The VR can probably support that more than if I still have the ambient noises or other things that distract me. The VR can already support this. If I just say, I have a problem here and I want to deal with it now, and then, I put on the headphones and hide the world. VR would be notch up one's performance, which then supports me to ignore the real world and I concentrate on one thing [learning task]." (Interviewee 6, research associate)

5 Discussion

Conceptualizing immersion in virtual learning environments. Against the background of our findings, we conceptualize immersion within the context of individual learning in VR environments as manifold and suitable for educational purposes and the kind of absorption (c.f. Figure 2). Based on these, task immersion and technology immersion are dependent on each other in virtual reality learning environments. Task immersion, as described above, is a mental state of being psychologically engaged with something [30, 32]. Here, interviewee 5 mentioned that the interactivities are engaging and supports one's own concentration. Technology immersion is the total engagement with a technology while other attentional demands are ignored [31]. For instance, in our VR setting, interviewee 3 states that the virtual space surrounds and transport oneself in another room. An antecedents of immersion is naturalness. This can be subdivided into content-related details which enhances task immersion because the knowledge transfer from a VR and real similar setting might be easier than from an unsimilar. The natural feeling of interactions with one's own hands and control of movements in a virtual space rise the sense of naturalness which enhances the feeling of immersion with the technology because the activities are unbiased to interactions in the real world. Individual learning can be related to different purposes in which immersive VR technology can be well-suited to measure performance and learning outcomes. On the one hand, within virtual settings a learner can acquire declarative (theoretical) knowledge, i.e. cognitive outcomes, or they can develop (practical) skills. On the other hand, a VR technology can be satisfying for the learner [10].

There is a vast amount of literature on individual learning outcomes and individual performance measures [e.g. 10, 11, 37, 38] as well as on immersion and its defined categories on task and technology immersion [e.g. 31, 33–36, 48]. As a complement to that, our findings (Interviews 5 and 6) indicate that immersion influences individual learning outcome. Consequently, immersion and its two manifestations are essential and need explanation within the usage of VR technology.

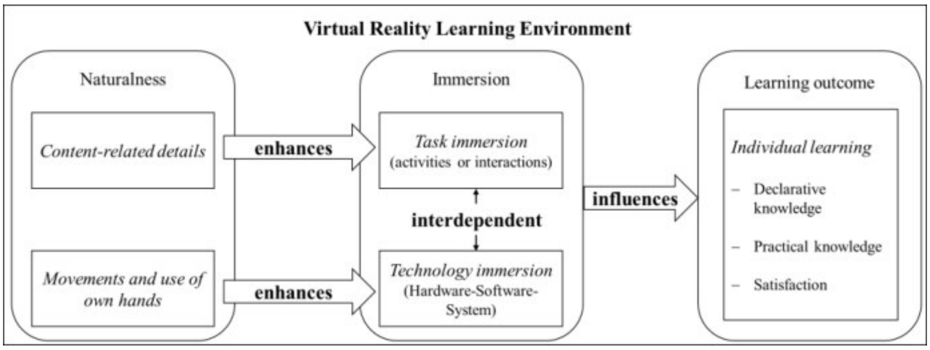

Figure 2. Conceptualization of Individual Learning in Immersive VR

Implications for theory and design. Immersive VR systems have the potential to improve individual learning through the specific characteristics underlying the VR medium. HMDs allow a user to dive into an enclosed virtual space and to interact, to create, and to manipulate objects by using controllers in the virtual environment. Moreover, immersion is essential for individual learning. Our research seeks to conceptualize this construct as a driver for learning outcomes (declarative, practical, and satifsaction). With regard to our RQ ("*How can immersion be conceptualized in the context of VR technology for individual learning?")*, we describe the manifoldness and meaning of immersion in the context of individual learning in VR (c.f. Fig. 2).

Our study provides several theoretical insights. We contribute to previous literature on individual learning outcomes and learning theory by extending the scope of analysis. Individual learning and/or immersion have been primarily investigated within group learning behavior [36], learner satisfaction [37], perceived learning, and task participation [e.g. 11, 34, 35], or from self-regulated learning strategy perspectives [10]. Yet, the use of immersive VR technology within learning contexts has not been focused broadly but already described from a subjective viewpoint [e.g. 9, 14]. We differentiate by interviewing direct user with first-hand experience in which way immersive VR technology can be used, what are preconditions for learning, and by examining the central aspect and the specifications of immersion.

There is an increasing amount of research on immersive VR with an educational purpose [e.g. 26–29]. Within such an environment, real but also abstract and unreal elements can be displayed with a diverse scope of interest. Here, we contribute to the literature by revealing the naturalness, and hence, the feeling of reality by using an immersive VR system that allows a user to develop and gain learning outcomes. Of course, the interviewees perception reveals these different possible outcomes but these are based on their own experience by using an immersive application with an underlying process which a user can learn.

In differentiating the theoretical construct of immersion in case of immersive VR technology for the purpose of individual learning, we contribute to literature by considering immersion in the learning task [e.g. 11, 32, 36, 49] and immersion in the technology [e.g. 31, 35, 37, 38]. Both play, as current literature suggests, an important role for IS educational purposes. From a theoretical perspective, it is worth to explore this phenomenon in more detail because we assume that a higher immersion to technology could decrease the immersion in the task what finally could result in a worse learning outcome. If one is more focusing the technology provided scenario (as a medium that provides the learner content) than the actual learning task, one might argue the learning task is less important or interesting, hence, a learner could be distracted through the technology. In turn, research also has shown that a too high immersion to a task can be detrimental because an intense absorption can lead an individual to ignore contextual cues in which they are immersed [50]. Moreover, if immersion is overemphasized, a learner is more likely to lose their concentration to their performing activity and, therefore, to suffer because of a disconnection from the contextual environment [51]. Here, a learner would rather focus the process than the activity itself. Furthermore, Illies and Reiter-Palmon [52] argue that a potential negative effect on individual learning arises by immersion because the learner might have a closed state of mind, in which they inhibit problem solving and information seeking.

As a consequence, there is a theoretical trade-off for research on immersive VR technology in the context of individual learning. On the one hand, we suggest that researchers should seek to consider this trade-off by focusing both kinds of immersion and taking these considerations into account. On the other hand, immersive VR technology has the potential to be beneficial for learning because such systems can be designed in a way that the antecedents of immersion are increased which, in turn, increases the immersion into the task as well as technology (for instance, design elements of presence [53]). Finally, our findings suggest that there is the opportunity that technology immersion can have a positive effect on task immersion because it can support a learner by ignoring the real world and to concentrate on the task activity.

In accordance with our theoretical implications, the theoretical trade-off can be addressed by designing certain aspects of an immersive VR setting. Users of such systems should be provided with a natural feeling when using the system. For instance, instead of using artificial controller for interacting within a virtual space, Schwind et al. [54] suggest the provision of a "leap motion" technology which could enable a leaner to use their own hands for interactions and perceiving presence. Another example for sensing naturalness refers to the idea that aspects within such a virtual setting has to be considered in a rich way, so that (expected) details are visualized. In contrast, a badly programmed virtual environment will decrease this sense of naturalness.

6 Limitations and Outlook

Our study has several limitations. First, this study is based on interviews, first-hand experiences with 10 participants following a convenient sampling strategy, and was conducted in central Europe. It does not cover how other cultures, certain professions, the elderly, or organizational backgrounds deal with topics around immersive VR technology and individual learning. The study could be extended to other cultures and backgrounds to get a broader perspective and deeper insights into the use of immersive virtual learning environments. Second, although the participants were provided with a VR-HMD experience before the interviews started, all of the participants were previously unfamiliar and inexperienced with such a technology. This first experience could have the effect of overemphasizing a feeling of curiosity or enjoyment with the technology which, in turn, could bias given answers.

As a consequence, this study offers potential for further research. For instance, within an experimental quantitative approach, the differentiation of immersion could be examined to develop a generalizable theory for individual learning (for instance, Jahn et al. [55] suggest in their research-in-progress article a theoretical model). Here, we assume an underlying potential for design theorizing with a focus on certain aspects of immersion to enhance the individual learning outcome. Different immersive VR-based design alternatives could be analyzed with regard to efficiency.

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