Teaching and Learning Processes in Immersive VR – Comparing Expectations of Preservice Teachers and Teacher Educators

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Abstract: The usage of VR in higher education is not uncommon anymore. However, concepts are mainly still focusing on technical rather than pedagogical aspects of VR in the classroom. The exploration of the expectations of teacher educators as well as of preservice teachers appears indispensable (1) to achieve a sound understanding of requirements, (2) to identify potential design spaces, and finally (3) to create and to derive suitable pedagogical approaches for VR in initial teacher education. This paper presents results of guideline-based qualitative interviews comparing the expectations of teacher educators and of preservice teachers regarding teaching and learning in immersive virtual learning environments. The results showed that preservice teachers and teacher educators expect VR to enrich classes through interactive engagement in situations that would otherwise be too costly or dangerous. Regarding the design, teacher educators put the emphasis on functionality. Student teachers emphasized that they do not want to miss social interactions with their peers. Furthermore, both groups stated preferred modes of collaboration and interaction taking into account the characteristics of a virtual learning surrounding such as being able to use diverse learning spaces for group work. Interviewees agreed on two vital factors for effective learning and teaching processes: flexibility and the possibility of customization considering technical properties that are to deal with. Apart from this, preservice teachers emphasized strongly their worries about data usage and the ethics regarding using avatars and agents for representation.

Keywords: initial teacher education, virtual reality, teacher education, educational technology, competency-based teaching, media pedagogical competencies

Introduction

The increased need to use digital media in classrooms induces a modification of the requirements and demands regarding teaching competencies. These competencies also have to cover a responsible and efficient media usage (e.g. KMK, 2016; U.S. Department of Education, Office of Educational Technology, 2016). The need to acquire such media pedagogical competencies for the beneficial pedagogical use of new technology in the classroom is comprehensive. It turns-up for most groups and stages in the teaching system, e.g., for preservice teachers as well as for teacher educators (Herring, Thomas, & Redmond, 2014). As a consequence, learning scenarios at universities need to integrate innovative concepts that promote the usage and reflection of digital media in initial teacher education (Borthwick & Hansen, 2017).

Media such as VR can offer a promising potential for fostering media pedagogical competencies in initial teacher education programs. Yet, as with any medium, the sheer integration of VR in teaching and learning does not guarantee an additional value or improved learning success. A growing number of research works confirms its affordances (Latoschik et al., 2019) and suggests additional values when it is included into educational settings reasonably (e.g. Lamb, Hand, Etopio, & Yoon, 2019). It is essential to plan the implementation of the medium carefully and to consider several factors such as prerequisites and requirements, but also the process of iterative development to ensure successful and useful learning processes supported by VR (Huang, Rauch, & Liaw, 2010). So far studies have dealt

with either the students' or the teachers' perspective. Seldom both views are taken into account (Radianti, Majchrzak, Fromm, & Wohlgenannt, 2018).

Against this background, this study, as the preliminary work of an iterative research process, seeks answers from both teacher educators as well as preservice teachers for the question: What do student teachers and teacher educators expect of a successful virtual reality application in Initial Teacher Education (ITE)? This research question is highly relevant as the design and use of Virtual Reality (VR) in the curriculum of initial teacher education as a learning and teaching tool is gaining in importance in higher education (Adams et al., 2017).

Implementing VR in Initial Teacher Education

Focusing on post-secondary Education, Concannon, Esmail and Roberts (2019) found that VR has mainly been implemented in educational disciplines like Science and Tech as well as Health Sciences. Regarding the pedagogical perspective, works miss setting standards for teaching and learning in VR (Fowler, 2014).

As the main focus of this study deals with learning and teaching processes, central components that are linked to them have to be taken into account: These include (1) learning prerequisites, (2) learning objectives, (3) teaching and learning activities, technology and social forms (Tulodziecki, Herzig, & Grafe 2019). These criteria will be used to systematize the following literature review adopting both perspectives, i.e., the teacher educators' and the students'.

Regarding the learning prerequisites, teacher educators often do not have sufficient knowledge, skills and competencies of how to use VR in seminars (Goktas, Yildirim, & Yildirim, 2009; Uerz, Volman, & Krai, 2018). They need continuous professional development to be able to foster preservice teachers' competencies in using digital media pedagogically in the classroom (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013; Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017), for example in the form of further training courses. However, as research and practice of using immersive VR technology in teacher education is scarce, but expanding (Billingsley, Smith, Smith, & Merrit, 2019), at some departments teacher educators with rich experiences can be found, too. They are a rich source for learning about expectations on how to implement immersive VR successfully in teacher education programs and will be addressed in this study. With regard to preservice students it can be stated, that they see the advantages of implementing VR in the classroom, but they lack self-efficacy to use it themselves (Browne & Cooper, 2000).

With regard to learning objectives in teacher education, the demand for digital competencies increases with the rise of new technologies, such as VR (Borthwick & Hansen, 2017). Since preservice teachers have to be prepared for the pedagogical integration of media in class, also their educators should acquire the corresponding knowledge (Kay, 2006; U.S. Department of Education, Office of Educational Technology, 2017). Preservice teachers' and teacher educators' requirements differ in regard to the way of acquiring and fostering media pedagogical competencies (Krumsvik, 2014). Models addressing preservice teachers' and teacher educators' competency acquisition may serve as a theoretical basis for defining learning objectives for using fully immersive VR in teacher education. With regard to (student) teachers' competencies the Technological Pedagogical Content Knowledge Framework [TPACK] (Mishra & Koehler, 2006), the Digital Competence Framework for Educators [DigCompEdu] (Redecker, 2017), the UNESCO ICT Competency Framework for Teachers (UNESCO, 2018) and the Media Pedagogical Competencies Model [M³K] (Herzig, Martin, Schaper, & Ossenschmidt, 2015; Tiede & Grafe, 2016) can serve as systematic frameworks. With reference to teacher educators' competencies the Teacher Educator Technology Competencies [TETCs] framework (Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017) and the Media Literacy Reference Framework for learners, teachers and teacher educators [Media Didactica] (Meeus, Van Ouytsel, Driesen, & T'Sas, 2014) are the only frameworks which address teacher educators as a target group explicitly. However, the authors of the DigCompEdu Framework claim to cover educators of all stages (Redecker, 2017). For the use of VR in teacher education learning objectives which address teaching and learning in fully immersive VR explicitly have to be derived from these frameworks.

Having dealt with the learner's prerequisites and their learning objectives, the question arises how learning and teaching processes using different social forms can beneficially be influenced by the technology of fully immersive VR. To answer this question, firstly the technical main characteristic that distinguishes fully immersive VR from other VR systems, such as desktop-based VR, has to be mentioned. Fully immersive VR can be described by Biocca's and Delaney's (1995) definition of VR as ''the sum of the hardware and software systems that seek to perfect an all-inclusive, sensory illusion of being present in another environment'' (pp. 57- 124). A recent article by Skarbez et al. (2017) includes an up-to-date discussion of immersion and presence. They propose a model that distinguishes between different qualia of VR systems, i.e., presence being composed of and affected by the social presence, plausibility, and place illusions, where the place illusion is a function of immersion as an objective

characteristic of a virtual experience. The multi-sensory experience of VR leads to the brain's interpretation of the virtual stimuli as real world's stimuli (Kilteni et al., 2015). The resulting full immersion of the user into another world that pretends to be real brings with it the possibility for educators to create learning scenarios that otherwise would be difficult or impossible to integrate into the real world classroom (Grenier et al., 2015). To benefit from its nature, in higher education, fully immersive VR has mainly been implemented for the purpose of training skills (e.g. Moro et al., 2017) or promoting interactivity (e.g. Lamb et al. 2018). In their literature review Radianti et al. (2019) found that 68% of works with VR implemented in higher education did not state the underlying learning theories such as cognitivism (cf. Dede, 2009) or constructivism (cf. Sharma, Agada, & Ruffin, 2013). Also, very few authors give explicit suggestions or best practices regarding learning and teaching processes in fully immersive learning environments. Huang, Rauch and Liaw (2018) for example suggest, in their case study about learners' attitudes towards VR, to use the advantages of the immersive nature of VR with the help of a constructivist learning approach. Starting from the understanding of learning processes in virtual learning environments that is based upon elementary aspects of a constructivist learning theory (cf. Shih & Yang, 2008) the authors propose theory-guided five learning strategies for instructional designers: (1) Situated learning, (2) Role playing, (3) Cooperative/ collaborative learning, (4) Problem-based learning and (5) Creative learning. These derive from combining constructivist's elements with fundamental features of VR, such as immersion, interaction and imagination (cf. Burdea & Coiffet, 2013). The practical implementation and the effects of the learning strategies on the learning outcomes, however, have not been researched so far and still represent a desideratum in literature. In general, works focus on either the technical or pedagogical characteristics of VR. Radianti et al. (2019) suggest for future research to complement technology with pedagogy and vice versa as well as to combine the teachers' and students' perspectives. So far, works concentrated on one target group led to a one-sided evaluation (*ibid.*).

Interview Research Methodology

To systematically explore the requirements of preservice teachers and teacher educators an analysis of needs was conducted with the two target groups using guideline-based qualitative interviews (Przyborski & Wohlrab-Sahr, 2014). The central components of teaching and learning with technology (Tulodziecki et al., 2019) served as an orientation for the development of the guideline-based interviews. Furthermore, it was important to achieve a sound understanding of technical requirements for the VR system to identify potential design spaces. In addition, it was necessary to investigate possible pedagogical and technical forms of support for the successful implementation of VR in Initial Teacher Education:

1) Prior experiences of preservice teachers and teacher educators with VR;
2) Assumptions about potential teaching and learning scenarios in VR to achieve different goals in initial teacher education;
3) Assumptions about the characteristics of these teaching and learning scenarios in VR in initial teacher education;
4) Technical requirements for the VR system itself but also for the ways of communicating in a virtual environment; and
5) Support, technically and pedagogically, that both groups might need to use VR in class

The interviews were conducted with two convenience samples of $n_1 = 12$ preservice teachers and $n_2 = 10$ teacher educators from a university in Germany. The target groups were chosen intentionally from the same department as both groups experience the same pedagogical implementation of digital media in seminars.

The preservice teachers and the teacher educators were expected to have different levels of experiences regarding the use of VR in their leisure time and in teacher education. Based on the specific focus on digital media and VR in teacher education of this department, however, the prior experience of teacher educators with and exposure to digital media and VR in particular can be expected to be richer than the average of other German institutions. As mentioned above, they are a helpful source for learning about expectations on how to implement immersive VR successfully in teacher education. The varied expectations based on their differing experiences of teacher educators and student teachers in the sample is considered to be very valuable to get a holistic image of the combination of technical and pedagogical aspects involved in ongoing teaching and learning processes.

To be able to compare the perspectives of teacher educators and student teachers, the two interview guidelines for student teachers and teacher educators were designed widely congruently. Both guidelines share the same main categories but vary in elements because of the differing characteristics considering the nature of a teacher's and learner's role. For example, teacher educators were asked about possible scenarios for further education concepts

while student teachers' interview focused on full seminars. Each person of both groups was interviewed individually for the duration of an hour. Participants were contacted via email and chose to participate voluntarily. Due to organizational reasons, the teacher educators had to be interviewed via an online video call, while student teachers were interviewed in person. However, the interview procedure was identical to minimize possible differences between the online interview and the face-to-face interview.

The interviews were recorded, transcribed and analyzed by means of qualitative content analysis (Mayring, 2015). They were all coded using MAXQDA (Rädiker & Kuckartz, 2019). The following categories were determined deductively in advance, based on the shared main foci of the two interview guidelines and following the approach of Mayring (2015):

1. Experiences with VR
2. Potential teaching and learning scenarios in VR
3. Characteristics of teaching and learning scenarios in VR
4. Technical requirements
5. Forms of support for teacher educators and student teachers

Findings

The interviews conducted with preservice teachers and teacher educators revealed a number of findings on the expectations of both groups regarding the design of learning and teaching processes in VR in educational contexts. In the following, selected findings will be summarized systematically based on the derived categories.

1. Experiences with VR

The preservice teachers in the sample had few learning opportunities with VR in their studies. However, they used VR in their leisure time on gaming consoles. Having gained teaching experiences with digital media in the local initial teacher education program, teacher educators brought along multiple prior experiences with VR that range from implementing VR systems in seminars to promote competences (e.g classroom management strategies) on a regular basis, to using VR applications only from now and then as tools for designing classes. Approximately half of the sample of the teacher educators described using VR in their seminars with preservice teachers. The other half, however, although having basic knowledge about VR, has few or no practical experiences implementing VR in seminars.

2. Potential teaching and learning scenarios in VR

Preservice teachers imagined VR to be useful in the classroom for the presentation of information, e.g., "how does an active volcano work?", that otherwise would not be possible, too costly or too dangerous to show to students. In the teacher educator interviews, participants developed various potential scenarios for using VR in initial teacher education. Phases of regular seminars were mentioned, e.g., group work phases or presentations. The teacher educators also suggested using VR to display locations and objects which would otherwise not be accessible. Also, role plays in VR were mentioned to allow for practice in challenging situations.

3. Characteristics of teaching and learning scenarios in VR

Avatar representations

The design of the avatars as virtual representations of the participants was an issue controversially discussed for both preservice teachers and for teacher educators. Opinions in both target groups ranged from a preference of realistic representations to a tendency for abstract representations.

Several preservice teachers felt uncomfortable with the thought of an avatar that resembles too much a human being in its appearance and preferred abstract versions. They reported that being able to tell the virtual world apart from the real world gives them a feeling of security. The ethical and moral aspects of avatar representation was emphasized throughout the interviews. Main concerns referred to the possible consequences of data protection and personal struggles with discrepancies between self-image and avatar representation.

On the one hand teacher educators are in favor of a realistic avatar representation, they argued, e.g., that realistic representations could increase the potential for identification. On the other hand, abstract representations were preferred by some participants because they expected easier access to the virtual learning environment and a lower risk for cyberbullying.

Room design

For designing the learning environment, preservice teachers put spaces for collaboration as a priority. Several of them preferred a classroom that offers a range of learning spaces where groups could gather and work together on projects. They put an emphasis on the social interaction with their fellow students. In their opinion, the learning surroundings should be held simple and clean in style and thus would not distract from the central purpose of the scenario.

The superordinate room design criterion for teacher educators was flexibility. The environment should be easily adaptable according to their own needs and preferences, ranging from purist designs to playful, friendly and motivating. Examples mentioned in this context included references to subject contents, such as Ancient Rome environments for History, or a virtual gym for Physical Education students. Also, in the context of furnishing, flexibility plays a vital role for them. Overall, the virtual learning arrangement needs to reflect the pedagogical approaches and methods applied by teacher educators, which means that it should offer options for easy re-arrangement and for spawning and de-spawning tables, chairs, media, and other furniture items.

Communication and interaction in the virtual room

From the preservice teachers' view, communication and interaction in the learning environment were important aspects that should work in VR. They suggested how the communication and interaction could be supported by measures like, for example, implementing a mechanism that signals to the participants, either visually or auditory, who is speaking, or giving the chance of using emojis to convey moods or feelings.

With regards to communication, teacher educators emphasized the necessity to control and regulate the auditive range for specific participants or groups. For example, it was suggested to have members of a group only hear each other without distractions from other groups. Also, teacher educators wanted to be able to limit or extend their range of addressees. More specifically, this means being able to select whether an input is to be heard by a single addressee, by a group or by the whole audience.

Teaching and learning methods

Basically, teacher educators and preservice teachers expressed the need to replicate practices known from face to face teaching settings also in the virtual environment. This applies to teaching and learning methods, such as open and constructivist learning formats, and changing social formats.

Preservice teachers stated the advantage of dividing learning content into several workload units and the importance of using learning methods that involve social interaction. They see the benefit of working closely together with preservice teachers that focus on other school forms than themselves in their studies. Teacher educators again emphasized the importance of flexibility and wanted to have their student teachers work collaboratively in flexible social forms in the virtual environment. This includes working on one's own, in groups or in a plenary with the possibility to change formats easily. However, group works were prioritized in a majority of cases.

Media

A central matter of concern for both groups, teacher educators as well as preservice teachers, referred to the question of writing in the virtual room. As participants do not have a keyboard at their disposal when moving in the virtual space, suggestions to compensate for this include, e.g., virtual keyboards, speech to text transcription, or handwriting recognition. Some teacher educators also thought about designing learning scenarios without writing and notes at all, while others considered this a serious constraint.

4. Technical requirements

Both for preservice teachers and teacher educators, technical feasibility was a frequently mentioned request. According to the interviews, hardware and software have to be intuitive and user-friendly. The hardware should be portable and ergonomic. Furthermore, the software should be stable and well designed and support immersion. It is also desirable to acknowledge aspects of inclusive design, e.g., to account for visual and auditory impairments.

5. Forms of support/ desirable knowledge and competency acquisition

Overall, both preservice teachers and teacher educators expressed a need for manifold support. Formats mentioned include tutorials, workshops, administrative support, and supportive feedback and helping functions within the virtual environment.

The preservice teachers wished to be accompanied closely in their exploration and use of the virtual environment, e.g., by supportive staff. Great importance was put on the face-to-face introduction and supervision by teacher educators.

For teacher educators, the following areas had been identified as potentially important for their own continuing education: 1) Technological skills, i.e., the skills necessary to operate and handle the respective devices and troubleshooting; 2) Application scenarios and best practice examples; 3) Methodology and teaching and learning approaches applicable in VR; 4) Attitudes and knowledge concerning VR in education; and 5) Legal, social and ethical aspects. Teacher educators discussed these proposed contents for continuing education rather controversially. There was common consent towards the importance of technological skills, application scenarios and best practice examples, and attitudes and knowledge concerning VR. However, opinions diverged concerning covering the topic of methodology and teaching and learning methods. While some teacher educators considered this a core constituent of their continuing education, others were confident to be able to integrate the virtual reality application also on their own without specific pedagogical training, as long as other aspects such as handling and technical skills are assured.

Discussion and Implications

The findings summarized above are subject to certain limitations. With regards to the samples of the study, it is important to note that both groups were convenience samples of the local department of educational sciences. Hence, against the background of the qualitative research approach and sampling method the interviewees are not representative of their respective groups and thus the results may not apply to other preservice teachers and teacher educators in the same way.

Against this background, a number of conclusions can be drawn from the interview results. Overall, it becomes evident that both the samples of preservice teachers and of teacher educators show considerable heterogeneity in certain cases with regards to their ideas and requirements. With regards to application scenarios, this heterogeneity led both samples to construct familiar learning settings on the one hand and to extend these to new contexts on the other hand. Also, the references to avatar representation illustrate how personal ideas and preferences shape the demands future users of a virtual reality environment bring along. There is no clear tendency in either of the groups to prefer abstract or realistic avatars. Notably, this finding corresponds to controversial findings from related research, where the effects of the avatar design vary as well depending on the outcome of interest (Latoschik et al., 2017). Additionally, in case of room design, personal preferences significantly shaped heterogeneous ideas of an ideal learning environment within the virtual room.

These observations substantiate the conclusion – which was also suggested by teacher educators in particular – that flexibility appears as a key criterion for the design and feasibility of a virtual learning environment to be used in initial teacher education. Teaching and learning scenarios are highly diverse and depend on a dense network of factors with regards to claims that the virtual environment has to fulfill.

Furthermore, it is noteworthy that both preservice teachers and teacher educators described teaching and learning scenarios in close connection to the conditions known from face to face teaching settings. This refers, e.g., to the design of the classroom, to learning formats, and to tools and media required, where the participants favored a realistic replication of face to face settings. Consequently, restraints from a technical perspective, e.g., with regards to the issue of writing or handwriting, were partly considered a serious limitation. Several teacher educators claimed to

refuse a redesign of their methods and approaches to account for the new circumstances proposed by the virtual environment. Also, innovative ideas and approaches to teaching and learning were comparably scarce.

Hence, it appears a research desideratum for future studies to balance the innovative potential of learning scenarios in virtual reality and to respond to the demands expressed by potential users at the same time. Designing the environment in accordance with these demands is likely to increase acceptance and feasibility but at the same time limits the potential inherent in virtual reality for teaching and learning purposes.

In terms of technical requirements, both samples emphasized the importance of accessibility and user friendliness. Acknowledging this focus will account for the varying levels of skills both student teachers and teacher educators bring along with regards to the operation of digital media. Finally, considering the results on desirable forms of support, it became evident that both preservice teachers and teacher educators need to be supported and accompanied closely in their acquisition of respective competencies. As identified in the interviews, there are multiple ways to ensure that the competencies needed are acquired adequately, as, e.g., continuing professional development or administrative support. In the case of virtual reality in teacher education, such an extensive support appears especially important due to the different facets of competencies that need to be addressed with regards to educational and pedagogical competencies on the one hand and technical skills on the other.

Further research perspectives are conceivable. To substantiate the findings that build on subjective opinions, it will be necessary to triangulate methods and to contextualize the initial requirements of preservice teachers and teacher educators with experiences and data collected in the actual implementation of a virtual reality environment in initial teacher education programs. Against the background of the interview findings, it appears relevant not only to design immersive virtual learning environments but also to develop pedagogical concepts based on theory and empirical data to advance the competencies of preservice teachers and teacher educators appropriately. The data collected with regards to the demands preservice teachers and teacher educators have for teaching and learning in virtual reality offer significant insights into aspects to be considered in this context. In accordance with emerging literature from the perspective of educational research (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014; Southgate et al., 2019), it will be insightful to expand the perspective and to evaluate teaching and learning processes in virtual reality not just from a technical, but also from an educational and pedagogical perspective, based on the foci proposed above. This way, a pedagogical design-based research approach (e.g. Tulodziecki et al., 2013) can contribute to the further exploration of virtual reality in teaching and learning processes to make sure that future teachers can benefit from the potential VR offers.

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