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VIRTUAL REALITY IN PRE-SERVICE TEACHER EDUCATION: CHALLENGES OF REALIZATION IN MUSIC EDUCATION

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Abstract

Virtual reality (VR) is seen as a tool that can enrich and advance education but there are still pedagogical and practical challenges to overcome. In this article, we present some findings on the VR usage in teacher education and student teachers' experiences and perceptions of employing VR especially in music education. We apply a categorization by Bower et al. (2020) to our analysis in order to structure student teachers' reflections. It appears that the VR applications for music are yet rather limited, their quality varies, and their pedagogical applicability seems to be poor. We argue that it is necessary to develop and design VR technology for educational purposes in collaboration with different stakeholders including teachers, and thus, address the current technical and pedagogical challenges.

Keywords: *Pre-service teacher education, student teacher, virtual reality, music education.*

1. Introduction

Virtual reality (VR) technology has caught educators' interest. It is seen as a tool that can enrich and advance education, take it to a new level. In general, VR and related technological solutions are considered to have tremendous potential for enhancing and transforming education (Fowler, 2015; see also Pendergast et al., 2022). Still, it seems that the pedagogical and practical challenges in using VR in different educational contexts are hardly overcome. As Fowler (2015) has stated, there is a need for pedagogical models and better understanding of the perspective 'design for learning' when the use of VR technology in education is discussed.

One way to meet these challenges is to investigate the user experience and delve into users' perceptions of VR as a tool for teaching learning. In this article we focus on studying the use of VR in teacher education similar to some other scholars (e.g. Cooper et al., 2019; Pendergast et al., 2022). We authors work as associated professors of teacher education at the University Helsinki (Finland). As a part of our academic work, we frequently examine fresh pedagogical approaches aligned with equipment. We test their applicability in engaging student teachers in using digital technology. In this research we focused on music education.

Music is a challenging school subject. It calls for a wide selection of crafts and skills. Our study is based on activities employing VR technology as a pedagogical teacher training instrument. This article presents our findings of student teachers' experiences and perceptions of using VR in music education.

2. Theoretical framework

Several scholars have noticed the importance of applying VR in pre-service teacher education. VR can provide student teachers authentic experiences and strengthen their willingness to use this technology in their future work. (Bower et al., 2020; Cooper et al, 2019). Both researchers and practitioners understand that there are still several essential issues to overcome. Typically, teachers are expected to solve independently, as a part of their classroom work, the pedagogical problems that are related to VR usage.

Users' willingness and attitudes appear essential for transforming practices. Bower et al. (2020) have examined student teachers' motivational background of intention to use VR in future work by employing the UTAUT model (by Venkateesh et al., 2003; originally a model for acceptance of new technologies by Davis, 1989). They claim that it is difficult to establish a rooted habit of applying VR technology in teaching and learning. However, they show that student teachers do value hedonic motivation (i.e. enjoyment) most as a catalyst for a change in their habits. Bower et al. (2020) categorize constraints of using VR in teaching and learning to three areas, which we also apply in our study:

- *External barriers* such as technology and functionality, access, logistics and support. External barriers associate to the organization of work, time and VR in working environment.
- *Internal barriers* such as attitudes and appreciation of the potential VR provides for education. The internal barriers are also related to expectations of technology in general. Internal barriers grow from the lack of experience and negative perceptions of technology. At the same time, there is some evidence that enjoyment and positive experience in technological design that fits classrooms improve confidence and willingness to use such technology.
- *Design-related barriers* refer to users' abilities to act creatively when using VR applications. This relates to their personal technical skills and attitudes but also how well they notice pedagogically meaningful tasks and function.

One way to address the need for pedagogical design for using VR is to consider applications for a specific subject area. Serafin et al. (2017) state that technologies might offer an alternative approach to areas of music education such as training rhythmic skills, playing together with others regardless time and place (i.e. creating social presence), training stage fear, training composition and music production, training STEAMS skills and training acoustics. Still, the potential of using VR in music education is recognized only in few areas of music education at school.

In this study, we apply the categorization by Bower et al. (2020) to our analysis in order to structure student teachers' reflections on their experience in music education. However, we extend our analysis to investigate both supportive and hindering aspects, and thus rename the three categories as external, internal and design-related factors.

3. Research data and approach

We started our project on using VR in music education as early as spring 2019. The global pandemic, however, caused lockdown restrictions which made it impossible to carry out any activities with the VR equipment. Our research involved a VR laboratory which again entailed a large classroom that was equipped with a VR system by Vive. We refer to VR as 3D-simulated environments where one interacts by employing a headset and two controllers. The immersive experience involves body movements, images and sounds. VR environments can be simulations of reality or fictional. (Hemminki-Reijonen, 2021; Vasarainen et al., 2021).

In the fall 2022, we involved 17 volunteer student teachers in our VR study project and accomplished a research data collection. These students studied for example the fundamentals of music theory, rhythm and pulse, composing and producing by experimenting with representative VR applications.

Our research data comprises of student teachers' written reflections in which they share constructive and critical views on how to apply VR both in higher education and schools. In addition to this data, we made some notions during the experiment, and these were helpful in our data analysis and interpretation of the student teachers' experience. Our qualitative research draws from theory-driven content analysis.

4. Experiences and perceptions of using VR in music education

In general students had positive expectations of VR technology. Most of them had employed VR but only for a brief time. All of them started testing in uplifted spirits and announced their enjoyment of the immersive, playful and inspiring experience. Soon as they had become more familiar with the VR technology, they felt ready to comment and criticize constructively it and the applications they had used as well.

We present our findings on student teachers' perceptions and experience by structuring them according to external, internal and design-related factors (cf. Bower et al. 2020). We limit our analysis to mainly those aspects that focus on music education and only briefly introduce some of the interesting additional material. We have anonymized our student responses and refer to them with acronyms S1-S17.

4.1. External factors

All students were fascinated by VR as a new tool. However, there were also several technological issues. In this regard, majority of the students mentioned the high cost of the equipment, considerable space requirements, VR applications' limited language selection (i.e. there were no tutorials available in students' mother tongue, Finnish), challenges related to sustainable development and equality, disability to work together in small groups, too complex or difficult applications and their badly designed tutorials. Obviously, this developing digital technology still has several general challenges to overcome before it can reach a wide popularity.

Learning to use VR system was seen somewhat time-consuming. VR also raised a concern of privacy and sensibility: Our VR laboratory was not completely private, and two students (S3, S14) reported that they felt vulnerable to outside impulses and disturbances (happening in reality) when they were deeply immersed in VR. Some students (S1, S6, S10, S15) brought up motion sickness and dizziness as a challenge when using VR (cf. Howard and Van Zandt, 2021). VR technology also has some other physical issues: A few students reported, for example, that the VR headset was relatively heavy to wear and could not be used for longer time periods (S1, S2, S8, S11).

4.2. Internal factors

It was somewhat surprising that student teachers hardly reflected on their personal stances towards using technology and especially VR in education. As some scholars have noticed (e.g. Bower et al., 2020; see also Cooper et al., 2019), teachers' perceptions and attitudes relate to their willingness to apply technological solutions in their work. For example, the lack of self-efficacy and not being convinced of the benefits of using VR do decrease teachers' motivation.

Due to students' strong pedagogical motivation and call, however, they did wish to reflect VR in more general educational levels. They acknowledged that VR does have plenty of various pedagogical potential. It offers, for example, a chance to visit far-away places, areas of music history, musical genres, concerts and environments that could otherwise be out of reach or beyond restricted access (S2, S3, S8, S10, S11, S12, S16). VR also grants an exceptional chance to design and paint 3D fine art objects (S2). In addition, students suggested that younger pupils could face frightening places or environments (e.g. heights and dark rooms), take part in physical education and learn about travelling in an airplane first and safely in VR (S11, S12, S14). In addition, a chance to learn biology and geography in VR was highlighted in several responses.

4.3. Design-related factors

Design-related factors refer to the users' abilities to act creatively with the VR. This relates to how well one can notice pedagogically meaningful tasks and function (see Bower et al., 2020). Apparently, the musical VR applications were not originally designed according to any pedagogical aims but simply for having fun with music and playing in VR. Our test group, however, had a severe interest in education and related matters. Therefore, the group members were imminently toned to observe these applications pedagogically.

Among the most popular musical VR applications the students explored were "Beat Saber", "Drops: Rhythm Garden", "EXA" and "LyraVR". Most of them saw the quality of the applications problematic. They were poorly designed for learning and teaching any fundamentals of music. Two students reported that they experienced EXA's dark and murky working environment distressing, heavy and unpleasant if compared to other applications' environments (S13, S15). Another two students (S1, S11) pointed out that actually those instrumental musical skills that one could learn in VR can hardly be removed to reality: playing of a virtual instrument does not directly benefit the playing of a real instrument. One student criticized the VR instruments' sounds being dissatisfactory and lacking timbral quality (S4).

Although safety is not a significant factor within music education, some students (S1, S8, S13) mentioned that this aspect could be taught in VR, just like precautions of dangerous tools in crafts (e.g. in welding). VR has been successfully applied in this fashion, for example, in surgical training (see Pulijala et al., 2018). Some students (S4, S7, S13) highlighted that through musical VR applications pupils could examine and try more special and traditional instruments, instruments they normally could not have access to since they are too expensive or rare, for example. Also, the immersiveness of VR may create a kind of embodiment or at least strengthen the internalization of musical information if compared to mere listening and following of music (S9). Testing musical VR instruments could as well work as a source of motivation to learn real instruments and related skills (S15).

One student (S4) pointed out that one could learn how to play in a small band in VR, reach sentiments of rehearsing with an ensemble instead of practicing alone. Another (S11) suggested that in order to overcome stage fright one could keep dress rehearsals of a musical performance in VR. A third (S16) saw aspects related to classroom pedagogy (e.g. observation of classes, recording and studying personal pedagogical performance) fascinating. Two students (S7, S9) forecasted that in the future people can connect to the same VR space from separate locations and that this will grant an exciting possibility regarding ensemble playing.

The application "Drops: Rhythm Garden" was among students' most favorite since it is based on a relatively simple but playful idea of constructing rhythms and soundscapes by adding obstacles to a brook of dropping, sounding marbles. Its tutorial also appeared to be approachable. One student (S5) envisioned that the "rhythmical sceneries" created in the application could be applied as a background for improvisations and physical musical activities (e.g. dance). According to another (S6), this application

could be applied in teaching directions, distances and other physical attributes of objects, musical tempo, measuring of 3D objects – and verbalizing and discussing these concepts. A third student (S9) suggested that pupils could be assigned to accomplish a shared construction by taking turns and adding obstacles one by one. This way they could learn the fundamentals of improvisation. One wished to celebrate the liberating and creative feeling that this application's playful concept did spark (S10).

EXA and LyraVR applications offer a chance to study and learn music production in an environment that reminds of a recording studio. This aspect was especially embraced by one (S2) student. Many others who learned and tested these applications unfortunately reported issues regarding the complexity of the workstations and their tutorials. Within these applications the musical information is visualized (but not notated) for the user. One student (S6) saw this inspiring and claimed that 3D notation in VR seems considerably easier to comprehend if compared to the traditional 2D musical notation.

Some students also discussed their VR testing experiences in relation to more general aspects and elements of educational sciences. Some (S4, S9, S15) agreed that VR embraces constructive learning models and phenomenon-based teaching. On the other hand, one wished to warn about VR technology taking to learning that is teacher-led (S4). It was also found out that VR indeed offered exciting potential within classroom pedagogy, training and practice (S9, S14). One noted that musical VR applications could be applied in developing kinesthetic memory that is a significant part of musical instrumental skills in reality (S10). Another initiated a project where a musical instrument was to be designed in VR and then 3D printed or crafted by hand (S17).

5. Towards VR that is designed for education

Our study focused on encouraging and hindering aspects that influence student teachers' willingness to develop their skills in using VR and their motivation to apply this technology in their pedagogical work. We analyzed student teachers' (N=17) reflections in terms of external, internal and design-related factors. Our categorization applied a model of three barriers that was originated by Bower et al. (2020). We wished to learn about student teachers' views and attitudes without announcing any specific goals for their VR adaptations. At the end we could report more on external and design-related factors and less on internal factors.

It was clear that the three factors can overlap and influence each other. Our results, however, are in line with notations by Cooper et al. (2019). They reported that despite student teachers' favorable dispositions towards VR technology and positive expectations (internal factor), one of the challenges is nonexistent platforms and pedagogical designs that are in an agreement with teaching syllabus (design-related factor). This implies that it is worth studying profoundly (student) teachers' perceptions and use of VR technology and attempt to develop a model for mapping out the influential factors.

Even if several scholars widely recognize the potential of VR technology and its usage and set high expectations for it, it seems that we still lack pedagogical models and approaches that could support us in employing VR for teaching and learning. Evidently this technology should overcome some practical issues of accessibility and functionality first: establishing a VR laboratory essentially leads to designing and re-organizing of a learning environment. VR sets are still relatively expensive as well. In regard to music education especially, it appears that the musical VR applications are rather limited, their quality varies, and their pedagogical applicability appears to be poor. We argue that teacher educators and teachers should be actively involved in application design processes, in order to make the applications successful both technically and pedagogically. Only then could we provide meaningful VR experiences for our student teachers and secure in them a willingness to use VR in their future work.

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