University of Tartu
Faculty of Social Sciences
Institute of Education
Curriculum of Educational Technology

Taavi Raidma

VIRTUAL REALITY IN PRIMARY AND SECONDARY EDUCATION: A STUDY ON TEACHERS' PERSPECTIVES

MA Thesis

Supervisors: Eric Roldan Roa, Emanuele Bardone

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Abstract

Virtual reality (VR) is making its way into education and has shown the potential to support learning through immersion and interactivity. For widespread use of this technology, a range of barriers exist, such as technological development, content availability and cost. Moreover, teachers' perception plays a crucial role in the successful integration of VR to better align their motivation to integrate VR into their processes. Therefore, this study investigates the perspectives of primary and secondary school teachers on the role and potential of VR-based learning applications. Our results showed that most teachers in the study saw VR as having a redefining role in learning task design. The study also found no difference in the results by teachers' age, work experience, VR experience and self-assessed digital literacy.

Keywords: virtual reality, computer-aided education, new technologies, head mounted displays, virtual environments, educational technology

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Introduction

The development of immersive virtual reality (VR) technologies has opened new possibilities for experiencing more visualised and interactive learning. Research shows that visualisation and interactivity positively impact learning outcomes and that skills acquired in a virtual world could be transferred over to real-world situations. This could be particularly useful where skill acquisition benefits from repeatedly practising in a safe environment with low or no cost (Hamilton et al., 2021). This is achieved through facilitating better content visualisation and immersive experiences for students in a focused alternative environment. For example, students can use VR to learn about cells in 3D, turning a usually two-dimensionally presented and abstract concept into something they can see and interact with. (Thompson et al., 2020), practice foreign languages, acquire new vocabulary by visiting a foreign city from their desk (Alfadil, 2020), and conduct experiments in chemistry with no health hazards (Hu-Au and Okita, 2021). These and other similar examples present a huge potential for enhancing and transforming learning tasks in schools of all levels.

The current use of VR technologies is still rare in schools, to a large part due to high unit costs and lack of software (Cook et al., 2019). However, as the price is rapidly decreasing and the number of educational VR software is increasing, it is essential to consider teachers' perception and understanding of this technology as the educators are the most critical drivers of technology integration (Ley et al., 2021). Therefore, for the broad integration of VR in curricula, it is necessary to understand teachers' views of VR as a teaching tool.

Most studies about VR have focused on the effects virtual reality has on students' learning outcomes through one-off and subject-specific contexts (Luo et al., 2021), with a much smaller share looking at teachers' points of view (Castaneda et al., 2021). The studies about teachers have been about the assessment of students in a VR-enabled classroom (Castaneda et al., 2021), challenges of using VR in classrooms (Fransson et al., 2020) and general perception and willingness to use VR in classrooms (Lee and Shea, 2020; Cooper et al., 2019).

The limited understanding and research on teachers' views and openness to virtual reality make it challenging for virtual reality technology developers, educational technologists, and school leadership to make informed decisions about virtual reality's potential, optimal development roadmaps and integration methods. This study's broad objective was to fill part of the gap by identifying a technology integration framework within which teachers' views on the technology can be placed and identified by designing a process and instruments for conducting the measurements, validating the instruments, as well as gathering data using the said process and instruments.

The aim of this concurrent mixed method study is twofold. Firstly, to understand primary and secondary school teachers' attitudes and perceptions of virtual reality as a learning tool – what role do they see it playing and how could it reshape existing learning tasks. Secondly, the study explores whether variables related to teachers' experience, age, prior VR experience and digital literacy influence their views on the potential role of VR in education.

Quantitative data was collected through a questionnaire after the teachers had a hands-on experience with educational VR applications. After that, interviews were conducted with all participants to collect open-ended answers to three interview questions to enhance, verify, and expand the quantitative results. Data analysis was performed on both quantitative and qualitative data separately as well as combined in the discussion of the results.

The research questions for the study are the following:

RQ1. What role do teachers see VR could have in primary and secondary education?

RQ2. Is there a relationship between teachers' age and their view on virtual reality's role or teachers' work experience and their view on virtual reality's role?

RQ3. Is there a relationship between the teacher's previous VR experience and view on virtual reality's role?

RQ4. Is there a relationship between a teacher's self-assessed digital literacy and view on virtual reality's role?

Literature Review

Computers and technology have long been used and studied as teaching aids at different levels of schooling, supporting the preparation, presentation, practice, and assessment of educational content. Already close to half a century ago, Ellinger and Frankland (1976) found that technology-aided education produced similar outcomes to lecture-based approaches. The technologies and their roles have changed and expanded over the years, but the discussions over technology's role and effects on education remain.

The technology capturing the imagination of many educators today is virtual reality, as new pedagogical affordances could be explored. Virtual reality has been defined by Fernandez (2017) as an environment created by a computer system that simulates an actual situation, allowing for immersive experiences using a variety of senses, including sight, touch, and hearing. Today, VR is often synonymous with head-mounted displays (HMD), which were introduced to the broader market with the arrival of Oculus Rift in 2013 (Jensen and Konradsen, 2019). The subject wears HMDs for a fully immersive experience as they provide up to a 360-degree stereoscopic computer-generated or video environment which is enhanced by auditory stimulation provided by the use of earphones and the ability to interact and move around in the virtual space with the help of controllers and trackers (Hamilton et al., 2021).

While there are concerns around cost and implementation, research has shown that teaching using virtual reality technologies has many benefits compared to other environments. And the effects in K-12 education, which this article focuses on, are reported to be significantly larger than in higher education (Coban et al., 2022).

Drivers of teachers' technology use

The success of any new technology in an educational setting depends on several factors, including overcoming the common barriers to technology integration - lack of resources, lack of relevant knowledge and skills, institutional beliefs, setup and structure, teacher attitudes and beliefs, assessment requirements, and subject culture (Hew and Brush, 2007).

Teachers' openness to change is a crucial variable to successful technology integrations in a classroom (Baylor & Ritchie, 2002). Baylor and Ritchie also found that when teachers use new technology, it boosts their morale, and they become more technologically competent overall. As a surprising finding, they also discovered that the more teachers used computers outside of the school environment, the smaller the impact on their students' content acquisition. They guessed that this was correlated with the level of teachers' overall computer skill level - the more advanced they were, the more they focused on the technology and less on its applications in the classroom.

Teachers with innovative technology use often possess strong entrepreneurial skills, as they develop ties with technology people and research technologies for personal and professional development. Moreover, they have positive attitudes toward technology and use student-oriented pedagogical approaches (Drent & Meelissen, 2008; Tondeur et al., 2013). A high level of curiosity and interest in technologies can be a more potent driver of technology integration than training (Tondeur et al., 2013). Siyam (2019) found that self-efficacy played the most significant role in teachers' use of technology, followed by perceived ease of use, time, and access to technology. This suggests that providing appropriate introduction and training to technologies on top of access is necessary for promoting active and productive use of technological tools in the classroom.

Dogan et al. (2020) found three factors that are often connected in technology use by teachers. Firstly, one’s perceived skills for technology impact the view on its usefulness. Secondly, the level of support teachers receive impacts their perceived skills and confidence in using the technology. And thirdly, confidence impacts the perceived usefulness of the technology. Their study based on 1335 K-12 teachers confirmed that the most significant factor is teachers’ perception of their skills with a particular technology or software.

While it’s common to assume that younger teachers are more comfortable with technology, the general level of technology use does not differ significantly based on the years of experience, although technology uses differ (Bebell et al., 2004). Russell et al. (2003) did find that new teachers had slightly higher technology use levels, but more experienced teachers were more likely to engage students through technology in the classroom themselves.

Uses and benefits of virtual reality in the classroom

There has been an increasing body of research into the effectiveness and benefits of virtual reality in the classroom. Luo et al. (2021) found immersive simulated realism-based learning experiences to provide enriched learning experiences, higher engagement, improved knowledge transfer and collaboration and embodied presence. The article also concluded that VR seems to be more suitable for introducing abstract concepts and procedural knowledge, which it’s currently more common in subjects such as chemistry, astronomy, history, and surgery.

Brij and Belhadaoui (2021) found the benefits to be the safety of otherwise dangerous activities, cost of some activities, ability to visit distant locations, communication with remote collaborators, increased motivation and collaboration, lower cognitive load and the understanding of abstract and complex phenomena. In a similar line, Jensen and Konradsen (2018) found that the primary motivation for using immersive virtual reality is the sense of presence it creates. Finally, Cooper et al. (2019) listed visiting places that are usually out of reach for financial or logistical reasons as a commonly mentioned benefit of VR.

A meta-analysis by Kaplan et al. (2020) showed that the performance outcome of VR was similar to that of traditional training. But given that, the additional benefits of VR solutions, such as cost, safety, and ease of implementation, make it a superior approach. They also point to the fact that the research results on virtual and augmented reality’s effect on learning outcomes vary highly, and there are significant gaps in the research, making it difficult to draw definite conclusions at that point.

While it's true that the research is limited, studies on virtual reality's effects on student performance have been gearing up over the past few years and trending upwards. In their meta-analysis, Kyaw et al. (2019) concluded that VR provides a slight improvement in knowledge and moderate to a large improvement in skills compared to traditional and other forms of digital methods. They also found that higher interaction VR applications had a more significant improvement than low interaction solutions.

Notwithstanding the latter, Çalişkan (2011) points out that it's unknown how lasting the gained knowledge is, given the lack of other senses involved in the experiences. For optimal results, VR should be combined with other learning activities outside the virtual environment, such as debriefing after VR practice (Luo et al., 2021). The highest impact can be achieved in subject areas that are abstract or conceptual or teach procedural skills (Hamilton et al., 2021).

Risks and limitations of virtual reality

Like with many new technologies, the significant current barriers to VR integration are lack of teacher training, low understanding of how to best use it in educational settings, and lack of relevant content (Fernandez, 2017; Cooper et al., 2019). Jensen and Konradsen (2018) have highlighted that the teachers are very dependent on the available content, which is still scarce, and existing content might not fit their needs. In an inquiry into higher education and virtual reality integration, Cook et al. (2019) found that the know-how to develop and integrate VR is often spread out, hindering progress, and a set of metrics needs to be developed to enable easy assessment of VRs impact on students results.

Brij and Belhadaoui (2021) found additional limits to the schools' required investment, lack of research on its effectiveness for knowledge transfer, cybersecurity, ethical issues, limited research into psychological effects, distraction, and complexity of content development. Luo et al. (2021) pointed out that several main barriers are actively being solved - lack of training, cost, usability, and insufficient realism. The significant and often-cited barrier, price, is coming down rapidly (Olmos et al., 2018).

Other barriers are likely more challenging to solve, such as the personal isolation of students immersed in virtual environments (Fernandez, 2017). Kenwright (2018) calls for adding testing and analysis of physiological and social elements into the VR development process. He says it's essential with younger kids who might not distinguish virtual experience from real and over whom virtual environments might possess more influence than in other mediums.

Technological issues can be a hurdle in using VR in the classroom by causing delays and disturbances to the learning experience, taking time away from developing assessment approaches and using VR content promptly and in sync with the curriculum (Castaneda et al., 2021).

An often-overlooked issue is an assessment or VR based learning process as increased engagement, which VR commonly provides, does not necessarily mean enhanced learning (Castaneda et al., 2021).

Theoretical Framework

As the primary aim of this article is to assess the potential teachers see in virtual reality in education, we use a technology integration framework within which to evaluate this. From our literature review, we identified several models and frameworks that have been introduced over the years that describe and support technology integration in education; the three that were most closely aligned with our needs are outlined below.

The Replacement-Amplification-Transformation (RAT) model was introduced in 2006 by Hughes et al. to support technology integration decision-making in K-12 classrooms. The framework's design was motivated by the need to help preservice and in-service teachers develop technology-enabled lessons and make informed technology choices based on the pedagogical goals instead of simply having to adopt example lessons with no context-specific strategies. In the framework, Replacement means that technology is used as an alternative way to the same end without changing the practices and processes; Amplification implies that technology is being used to amplify existing methods, increasing efficiency and productivity; and Transformation means that technology is used to change the instructional strategies and learning processes. When determining the technology's role in a particular situation, the authors provide a list of dimensions to consider. The dimensions are across the three themes of instructional methods, student learning processes and curriculum goals.

The Technology Integration Matrix (TIM), developed by Florida Center for Instructional Technology in 2005, describes the use of technology in the classroom across five types of learning environments and five levels of technology integration. The five types of meaningful learning environments are active (students are actively using the tool, not just receiving information from the technology), collaborative (students use technology to collaborate and not work alone), constructive (technology is used to connect new information to old knowledge), authentic (technology is used to connect learnings to outside classroom environments) and goal-oriented (technology is used to set and manage goals, plan activities and monitor progress). The levels of technology integration are entry (technology is used to deliver educational content), adoption (students are guided to use technology in the learning process), adaption (individual exploration and use of technology are encouraged), infusion (students get to choose the technology tools to use) and transformation (higher-order learning tasks are introduced that would not be possible without the technology). Therefore, the framework describes 25 ways technology can be used and integrated into learning across the matrix.

The Substitution, Augmentation, Modification and Redefinition (SAMR) model of technology integration in education was introduced by Puentedura in 2006. The model describes four levels at which technology can be integrated into education. Technology can be a direct substitute with no functional change (Substitution), it can be a substitute but provide functional improvements (Augmentation), it can allow for significant task redesign (Modification), or the creation of new tasks that were previously unthinkable (Redefinition). The first two are described to provide the power to enhance learning tasks and materials – for example, by substituting physical learning materials with digital and providing video lessons – and the last two have transformational powers to develop entirely new ways of teaching certain concepts and skills.

While SAMR can be looked at as a ladder of technology integration by depth, it is also a spectrum along which teachers can identify the best ways to use such technology in a specific setting and need.

In the choice of framework for this study, we looked at three key aspects – the depth spectrum of technology integration it covers, the clarity and descriptiveness of the steps, and the ease by which teachers could understand them. The goal in analysing and choosing between the frameworks across these aspects was twofold – firstly, find one that required the least additional explanation during the process, albeit we expected to provide some, should the need arise, given the different backgrounds and experience levels of teachers, and secondly, to identify the one that would provide us with most use when later analysing the results in combination with the qualitative study results.

As a result of our review, it was concluded that the TIM framework was too detailed, and teachers with no prior educational VR experience would have trouble imagining the potential use cases at that level of detail. The RAT and SAMR models were ranked similar in terms of our criteria, but as the structure of our study was around educational tasks, the SAMR model fit better and ended up as the preferred choice. While the SAMR model has several shortcomings (Hamilton et al., 2016), work has been done to clarify the technology integration steps further and describe their connections to learning processes (Crompton and Burke, 2020). We took such developments and clarifications into account when integrating and explaining the SAMR model in our study's context. For example, Hamilton et al. (2016) had raised the issue of the original framework presenting technology integration in a hierarchical way which doesn't always take the context of the learning tasks and teachers' goals into account. It should be looked at as a dynamic framework where, based on the situation, any of the four levels could be the most desired level of application.

Method

The study used a concurrent mixed method approach. The quantitative research instrument produced numerical data that helped draw generalised conclusions and conduct correlation analysis. The qualitative research instrument lets us validate the quantitative data and gather unique information about the participants' views, opinions, and insights that couldn't be acquired through a quantitative instrument. A mixed approach helps to understand better the context in which quantitative data is provided in; it limits the impact of the researcher's personal biases in interpretation and provides a more complete picture that would not be possible by using a standalone quantitative or qualitative study (Creswell and Plano Clark, 2018).

The instruments and research process were designed specifically for this study to be able to gather data in a situation where the majority of the sample did not have prior knowledge about and experience with virtual reality technologies and needed to be provided with an introduction to the technology as well as direct hands-on examples of how the technology would be used in an educational setting.

Sample

Purposeful sampling was used to gather a varied group of teachers. The sample was collected based on teaching experience, taught subjects, and taught grades. Since the study required a physical engagement from each participant, convenience played a role in selecting the sample. Most study participants were all within or around the city of Tartu. The sample identification and collection were conducted through existing contacts in the educational sector and relevant email lists, and suitable times for participation agreed on over email and phone calls.

Discussions about participating in the study were reached with twenty-five teachers, and suitable times and places were agreed upon with twenty of them, which gave us a participation rate of 80%. Two of the teachers were used to pilot the instruments, and 18 were part of the study's research sample. The reasons for not being able to participate were lack of time (three cases), location (one case) and previous negative experience with virtual reality due to health reasons (one case). Six additional teachers showed interest in participating in the study after the sample was completed and data collection had started.

The final sample included eighteen teachers with teaching experience ranging from 1 to 42 years, and 39% had some prior experience with VR (see Table 1). Two of the teachers were male (11%), and sixteen were female (89%) (see Table 2). The taught subjects by the participants included Estonian, Finnish, Russian, German and English language, literature, music, chemistry, maths, physics, communications, human studies, biology, and IT. The mean self-assessed level of digital literacy was 4.5 out of 7.

Table 1: Overview of study participants by teaching experience and prior VR experience

Count

		Previous VR experience		Total
		No	Yes	
Teaching experience	1-15 years	4	1	5
	16-30 years	2	5	7
	31-50 years	5	1	6
Total		11	7	18

Table 2: Age and gender breakdown of participants

Count

		Gender		Total
		Male	Female	
Age Group	20-30 years old	1	1	2
	31-40 years old	0	2	2
	41-50 years old	0	6	6
	51-60 years old	1	3	4
	61-70 years old	0	4	4
Total		2	16	18

Training of participants

As the level of prior experience with virtual experience was very different across the sample and most participants had not used an educational VR application before (most prior experiences had been either observational VR entertainment or VR games), the study included an introductory session.

Before administering the instruments, participants were given a selection of educational virtual reality applications to use, which gave them the necessary and relevant experience to fill out the questionnaire and answer the interview questions. The training was conducted in three steps, and the meetings for participant training and data collection happened in groups of 2-5 teachers.

The steps were as follows:

1. Overview of the research study's structure and process, the goal of the VR experiences and description of the research instruments to follow.
2. Orientation and introduction to the technology – participants were provided with the necessary background and overview of the functionality of the VR equipment (Oculus Quest 2), including how to use the controllers, how to adjust the HMD to fit well on the head and how to adjust it for good vision. Participants were also asked to describe their previous VR experiences if they had one, and whether they had felt comfortable using VR equipment. In case participants felt unsure or had previously felt dizzy in virtual reality, it was noted, and the experiences were provided in a sitting position. The research study overview and technology orientation took 3-6 minutes, depending on the participants' prior experience with virtual reality equipment.
3. Virtual reality experiences – participants used four different educational virtual reality experiences ranging by the interactions and subjects to give a broad understanding of the possibilities of the technology. The experiences were commercially available educational and gaming applications developed for the Oculus Quest 2 devices. Each experience lasted 5-10 minutes, depending on how quickly the participant got used to the primary dynamic. The apps were:
    - Ecosphere by PHORIA (https://www.phoria.com.au) - the participants watched a 180-degree immersive video on African elephants or orangutans. It was an observational experience with no interactions or controls needed by the user. It

was a conscious choice to start with a low-interaction experience to help the participants get used to the gear and the medium. After the experience, the participants were asked if they felt comfortable and if the image was clear or if the headset needed to be adjusted to improve the experience.

- Futuclass Reaction Balancing by Futuclass (https://futuclass.com) - the participants stepped into a virtual chemistry lab and had to use hand controllers to balance chemical reaction formulas. The participants had to pick up and place molecule models correctly onto a virtual table to ensure both sides of the formula were equal. It was an interactive experience requiring the use of controllers.
- Mondly by ATi Studios (https://www.mondly.com) - the participants completed a conversational language lesson talking to a Finnish speaking taxi driver – introducing themselves, telling them where to take them and negotiating over price. It required the participants to listen to the taxi driver speak (English translation was provided by text), choose a suitable response and say it aloud. The app then provided feedback on whether the person said it correctly. Hand controls were needed to navigate the experience and record the answer. The key dynamic experienced was the use of voice and conversation as part of a virtual learning experience.
- Smash Drums by PotamWorks SAS (http://smashdrums.com/) - the participants played a beat-based rhythm game. It required hand controls and rhythm coordination. It was chosen to be a more active and gamified experience as the last one in the selection.

Instruments

For quantitative data collection, we used a questionnaire (the questions are included in Appendix 1) to record teachers' thoughts on VRs potential role in education following their direct experience of educational VR applications. The primary question in the instrument followed the SAMR framework's structure and descriptions of its steps, as this was the basis for our analysis. In the first question, the participants were presented with the four descriptions of SAMR levels, and they had to rank them from most likely to least likely to be the primary level of integration for VR. In addition, the questionnaire asked for participants' details on their teaching experience in years, their age, the subjects they taught, the grades they taught, their self-assessed digital literacy on a 7-point scale and whether they had any prior experience with VR. The questionnaire was set up using Google Forms. It used a multiple-choice grid for the first question on VRs potential, short answer text fields for age, grades taught, subjects taught and work experience questions, a multiple-choice field for the VR experience question, and a linear scale field for the self-assessed digital literacy question. The answers were saved within Google Forms and later exported to SPSS for analysis.

Qualitative data were collected through open-ended questions immediately after completing the questionnaire to ensure all the answers were provided while the VR experiences were still "fresh" in participants' minds. The interview included three questions about the opportunities and benefits they saw in VR, the risks and problems they saw in VR, and whether they would use VR in their lessons should relevant material exist (the questions are included in Appendix 2).

The instruments were designed and data recorded so that it was possible to link participants' questionnaire responses and interview answers later on, should it be necessary and valuable in the data analysis process and for discussion purposes.

The instruments were prepared in English and then translated into Estonian as that was the native tongue of all participants. After data collection and before analysis, all the answers were translated back into English by the author. The translation accuracy was tested during the pilot when the pilot participants were asked to describe how they understood the questions, which were then compared against the original meaning in English. No adjustments were required in translation as the meaning was confirmed to be correct.

Piloting the Instruments

The instruments were piloted to ensure their reliability and integrity (Creswell, 2008). The pilot was conducted with two teachers whose profile was comparable to the rest of the sample. They were purposefully selected to represent a variety of potential participants on the age, work experience and digital literacy scales. They were provided with the orientation and technology introduction; they used the initial selection of four educational virtual reality experiences. They were administered both instruments – the questionnaire and the interview.

After that, a separate interview was held to understand if all the steps of the process were clear and understood as expected or if anything needed to be clarified or changed, and how the subject felt in terms of health aspects such as vision and balance while using the applications.

The feedback from the pilot helped to improve the instrument before being used in primary data collection. The key improvements were related to the timing and length of the training and instrument administering, the selection of the VR educational applications that participants used, and the questionnaire's wording and interview questions.

Data Collection

The data was collected from May 9-18, 2022, at a location of convenience for the participants, which in most cases was at their workplace. Before data collection, the equipment was set up and tested. Enough space was secured to safely provide the VR experiences (most of the time this was a space of about 2x2 meters with a chair on the side for the applications used while sitting). When the setup was complete, the participants were invited to join. Depending on the session and number of participants, either one or two VR headsets were prepared for use. If two headsets were being used, the applications were used by two participants concurrently; if one was used, they took turns, but the order of the applications remained the same for everybody.

At the beginning of the meeting, the author introduced to the participants the study protocol, the target data to be collected, and data treatment for the research purpose. After the participants used the VR applications described above, the questionnaire (see Appendix 1) was administered using a laptop computer. No time constraints were applied to the questionnaire, and it took between 5 and 15 minutes per participant to complete. In the first part of the questionnaire, participants relied on their VR experiences and views formed based on them. The second part of the questionnaire collected data on the participants' professional and personal profiles and previous VR experience. When participants had questions about the questions or the tool used to administer the instrument, help was provided. Once the answers were submitted, the participant notified the researcher, the successful submission of data was checked, and the researcher introduced the next instrument.

The questionnaire was immediately followed by an interview with open-ended questions about the potentials and risks of VR in educational settings and whether and how the participants would integrate VR into their lessons, should relevant content for their subject and grades exist (see Appendix 2 for the interview's questions). Before answering, the participants were informed that their answers would be recorded via audio for later transcription and that the recordings would be then permanently deleted. After the disclaimer, an audio recording was initiated on a mobile app. After reading each question, the interviewer let the participant answer them with minimal interruption. Probing questions were used to occasionally ask the participant to expand on what they were saying. When participants finished answering or said they had nothing else to add, a follow-up question of “Does anything else come to mind?” was asked, which usually yielded additional thoughts or extensions to previous answers. When all questions were administered, the recording was stopped.

On average, participants provided 3-5 items per question in the interview, and the interview took about 5 minutes to complete. After the interview, the participants were thanked for their participation. The total time spent per participant from orientation to the end of the interview took 40 minutes on average.

Data Analysis

Before quantitative data analysis could begin, the data was first exported from Google Forms, cleaned and structured. Then, the dataset’s structure and required variables were prepared in the statistical analysis software SPSS. This included variables that were direct answers from the questionnaire and recoded variables based on them – for example, age and work experience ranges.

Following the data preparation and entry, a range of descriptive statistics was produced and validated to ensure that the data had been adequately treated. Data analysis was conducted using descriptive statistics (frequency analysis and crosstabulation) and bivariate correlation analysis. The resulting tables and figures were recorded in separate output files in SPSS, applied with the appropriate styling and numbered according to their appearance on the paper.

Qualitative interview recordings were manually transcribed by audio playback and spreadsheet software. Following the transcription, inductive coding was conducted to narrow the interview answers to be represented by a single central keyword – so that approximately 9-15 keywords then characterised each interviewee's responses. These keywords were then analysed across all participants to identify common topics across the interviews and clustered based on similarity.

Finally, each cluster was summarised by a common descriptive phrase. See table 3 for an example of how four answers were first represented by a keyword through inductive coding and then grouped based on a common theme. In this case, the answers initially represented by keywords “travel” and “remote visit” were combined into a theme for “[VR] makes it possible to visit remote places”, and answers with keywords “expensive” and “limited budget” were combined into a common theme for “It’s expensive”. While the two answers in the latter approached the theme from different angles (cost and budget constraints), they fit under the same theme based on the context in which the answers were provided.

While a number of the topics and keywords were frequent across many participants (for example travelling to places and cost), there was also a range of topics that only appeared once. In such cases, the keyword was simply expanded to a theme by itself without combining it with others’ answers. Frequency analysis was conducted at the theme level.

Table 3: Example of inductive coding and themes

Answer, verbatim	Keyword, inductive coding	Identified theme
“I usually show students videos of museums and cities, but I could take them there"	Travel	Makes it possible to visit remote places
"You might never be able to visit a jungle or other remote places, but with this, you can take students there"	Remote visit	Makes it possible to visit remote places
"It would serve its purpose if it's accessible to everybody and widely used, not a one off event. But as it's expensive, I'm not sure it will reach schools."	Expensive	It's expensive
"The key question from the school's standpoint is that where does the money come from to buy it? What do we need to give up?"	Limited budget	It's expensive

Data analysis was conducted on quantitative and qualitative data sets separately at first. Then they were viewed collectively to answer the research questions and prepare the discussion of the results. The results were visualised and presented using tables and figures. (Creswell & Plano, 2007)

Results

Quantitative Data

Research Question 1: What role do teachers see VR could have in primary and secondary education?

Descriptive statistics were obtained through the quantitative instrument for the first research question. Each teacher was asked to rank the four levels of VR integration – Substitution, Augmentation, Modification and Redefinition, from least likely to most likely based on their perception following the use of the educational applications.

For this study, our primary interest was to explore what would the teachers identify as the most likely level of integration for virtual reality in education. 66.67% of teachers (n = 12) said that VR has the potential to redefine learning tasks, 16.67% of teachers (n = 3) said that VR has the potential to allow for a significant redesign of learning tasks, 11.1% (n = 2) of teachers said that VR would allow for learning task augmentation, and 5.56% (n = 1) of teachers said that VR would be a substitution for existing tasks with the same substance (See Table 2).

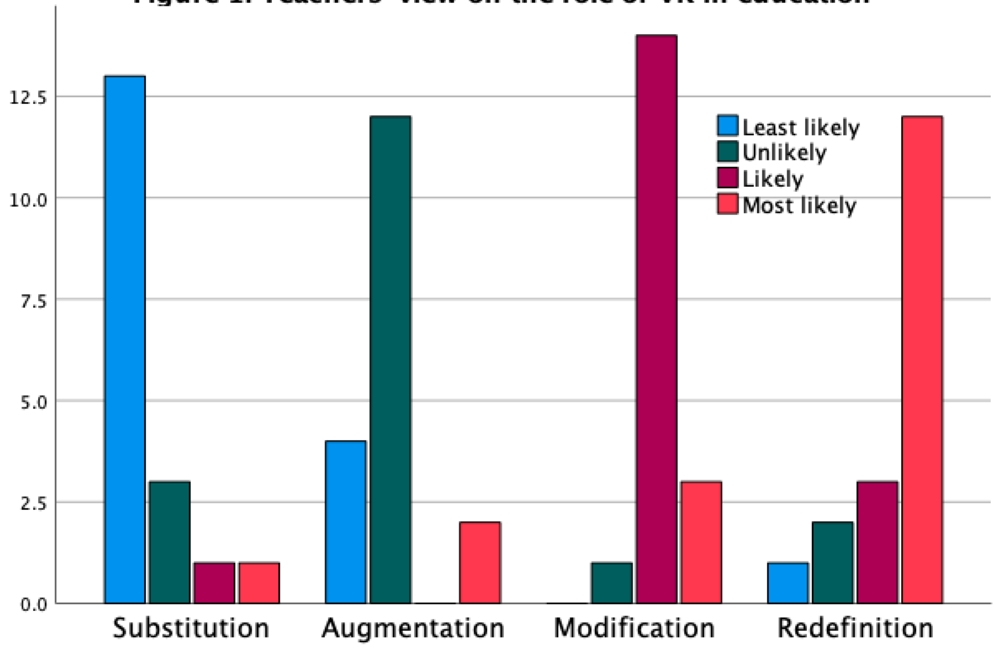
Our secondary interest was in how the other levels of integrations were ranked. The data shows that the most common ranking was a hierarchical one – Substitution being the least likely and Redefinition being the most likely. But there was a range of different combinations, and only two ranking selections – Augmentation as likely and Modification as least likely, did not receive any selections. And in contrast with the most popular choices, Substitution was selected as most likely in one case and Redefinition was selected as least likely once.

Table 4: Teachers' perspective on the potential role of VR in education

	Likelihood				
	Least likely	Unlikely	Likely	Most likely	Total
Substitution	72.2%	16.7%	5.6%	5.6%	100.0%
Augmentation	22.2%	66.7%	0.0%	11.1%	100.0%
Modification	0.0%	5.6%	77.8%	16.7%	100.0%
Redefinition	5.6%	11.1%	16.7%	66.7%	100.0%

Figure 1 visualises the results of each stage based on absolute numbers, each bar representing the number of answers for each likelihood.

Figure 1: Teachers' view on the role of VR in education



Research Question 2: Is there a relationship between teachers' age and their view on virtual reality's role or teachers' work experience and their view on virtual reality's role?

We used our collected qualitative data to review the bivariate correlation between the variables. Table 5 describes the direction, strength, and level of significance of the relationship between teachers' age and their view on VR's most likely role in education. In terms of direction and strength, 0.009 indicates no relationship. Also, at 0.973, r is statistically insignificant (r = .05).

Table 5: Correlation between teachers' age and view on VRs potential

			VR potential	Age
Spearman's rho	VR potential	Correlation Coefficient	1.000	.009
		Sig. (2-tailed)	.	.973
		N	18	18
	Age	Correlation Coefficient	.009	1.000
		Sig. (2-tailed)	.973	.
		N	18	18

Based on this, there is no reason to believe that teachers' age is a factor in perceiving the potential role of VR in the classroom. The qualitative data confirmed this finding as teachers provided positive answers in this study's case. While there were apparent differences in the frequency and depth at which teachers mentioned that they would use virtual reality in their classroom, there weren't any noticeable age-based differences identified. They appeared to be more connected to the subjects being taught and the individual's personal preference for various teaching methods.

Table 6 describes the direction, strength, and significance of the relationship between teachers' working experience in years and their view on VR's most likely role in education. In terms of direction and strength, -0.083 indicates no relationship. Also, at 0.742, r is statistically insignificant (r = .05).

Similarly to the analysis of the relationship between teachers' age and their view on VR's role, the correlation does not exist. The qualitative study confirmed this, which showed a relatively positive reception of the technology across the board with no apparent difference in answers based on how long teachers had been working.

There was a slight difference in the way teachers framed technologies based on their work experience – newer teachers seemed to approach technology evaluation more from the technological capabilities and personal experiences, and teachers with more extended work history tended to more actively connect the technology's capabilities and risks to their pedagogical methods and experiences.

Table 6: Correlation between teachers' teaching experience in years and view on VRs potential

			VR potential	Teaching experience in years
Spearman's rho	VR potential	Correlation Coefficient	1.000	-.083
		Sig. (2-tailed)	.	.742
		N	18	18
	Teaching experience in years	Correlation Coefficient	-.083	1.000
		Sig. (2-tailed)	.742	.
		N	18	18

Research Question 3: Is there a relationship between a teacher's previous VR experience and view on virtual reality's role?

We looked at a crosstabulation (see Table 7) to compare the responses on VR's most likely role based on teachers' previous VR experience to answer the research question. Eleven participants did not have prior experience in our sample, and seven had some. However, it must be considered that in most cases, this did not include educational VR experiences, as confirmed during the qualitative data collection.

While teachers with no prior VR experience saw most likely roles in all four categories (although only one in each of the lower steps), 72.7% of the group saw virtual reality as having a redefining role in education. Of the teachers who had previous VR experience, 57.1% saw virtual reality as having a redefining role, and the rest saw either augmenting or modifying roles. While the percentage difference seems large between the two groups, the sample size of the study is a small sample, and hence such a difference does not play a major role and shouldn't be considered a significant difference.

Qualitative interviews made it evident that some people who had had a prior experience came with pre-existing fears of either health concerns or discomfort. However, none of them seemed to actualise during the study. In some of those cases, people had used previous generation equipment, which was likely to have a higher negative impact on people's bodies and senses due to lags between movement and image delivery.

Table 7: Crosstabulation of previous VR experience and view on VR potential

			VR potential				
			Substitution	Augmentation	Modification	Redefinition	Total
Previous VR experience	No	Count	1	1	1	8	11
		% within Previous VR experience	9.1%	9.1%	9.1%	72.7%	100.0%
	Yes	Count	0	1	2	4	7
		% within Previous VR experience	0.0%	14.3%	28.6%	57.1%	100.0%
Total		Count	1	2	3	12	18
		% within Previous VR experience	5.6%	11.1%	16.7%	66.7%	100.0%

Research Question 4: Is there a relationship between teachers' self-assessed digital literacy and view on virtual reality's role?

Teachers' comfort with technologies and their assessment of how literate they are with digital devices was identified when designing the study as a potential variable that could impact the way teachers evaluate technologies and predict their role in education. The numbers did not provide strong support for that. Table 8 describes the direction, strength, and level of significance of the relationship between teachers' self-assessed digital literacy and their view on VR's most likely role in education, and in terms of direction and strength, 0.160 indicates a weak positive relationship. Also, at 0.527, r is statistically insignificant (r = .05).

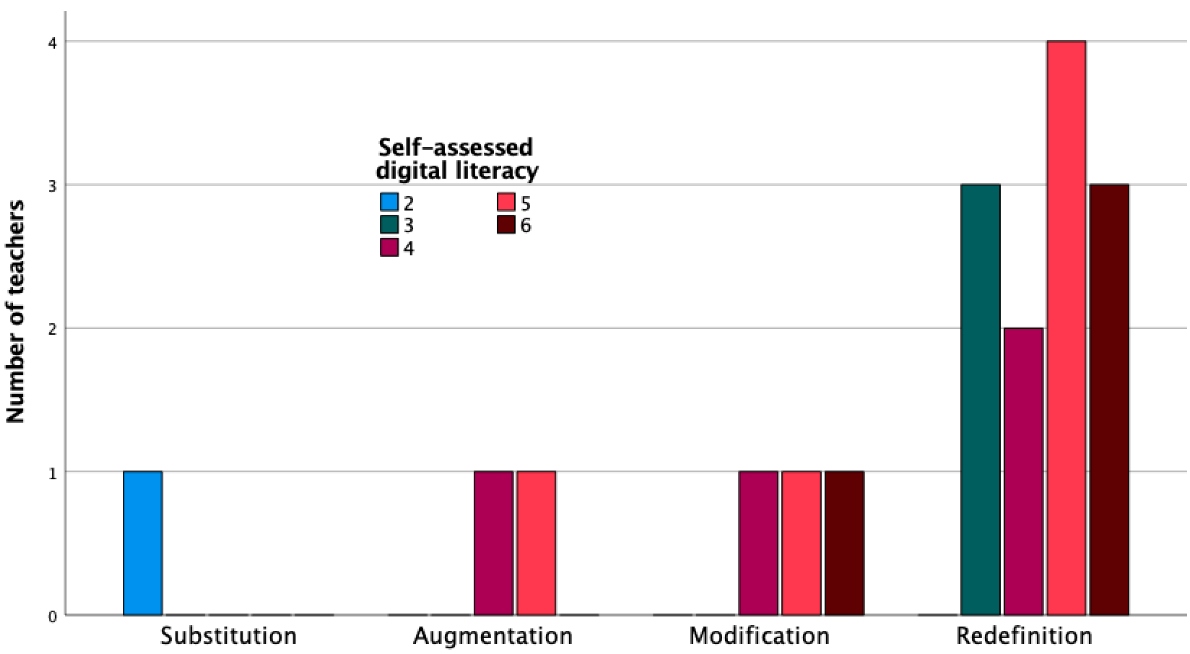
Table 8: Correlation between teachers' self-assessed digital literacy and view on VRs potential

			VR potential	Self-assessed digital literacy
Spearman's rho	VR potential	Correlation Coefficient	1.000	.160
		Sig. (2-tailed)	.	.527
		N	18	18
	Self-assessed digital literacy	Correlation Coefficient	.160	1.000
		Sig. (2-tailed)	.527	.
		N	18	18

Figure 2 shows the 'most likely' responses by each of the four categories across the different digital literacy rates (as nobody in the study rated themselves as "1" or "7", the literacy rates range from 2 to 6.). While one participant with the lowest self-assessed digital literacy rate also chose Substitution as the most likely role for VR, all who self-assessed at "3" thought that VR would most likely play a redefining role.

While there were sometimes significant differences during the initial stages of using the virtual reality applications that reflected the digital literacy levels, they would largely disappear when the primary game dynamic was acquired. The subject understood how the controls worked and how to interact with the experience. Some barriers existed in completing the tasks. Still, those were mainly related to a limited understanding of the underlying subject and were not considered in the context of this study.

Figure 2: VRs most likely role, by teachers' self-assessed digital literacy level



Qualitative Data

As part of qualitative data collection, interviews comprised of three questions were conducted with the 18 teachers. The goal of the interviews was to expand on the quantitative data to understand the opportunities and risks that teachers see in using VR. Some of the findings have been already presented alongside quantitative data next to the research questions above for the reader's convenience.

Interview Question 1: What use cases and opportunities do you see for using VR in education?

As described in the data analysis section, the answers were processed first to be represented by keywords and then clustered into common themes. Table 9 shows the themes brought up and the number of teachers who mentioned them. The range of topics was quite broad, with 13 themes being brought up by at least two different teachers. There were 65 answers provided for this question; on average, 3,61 answers per participant.

The most popular theme was the excitement it causes by being a unique and different tool, mentioned in some form by eight teachers. It was followed by the fact that it's a novel and modern tool. While these sound somewhat similar, the latter answers were more focused on technological development and its potential in the teaching process and less on the simple excitement it creates as a medium. The third most prevalent theme, mentioned by five teachers, was the ability to use virtual reality to visit different locations – in a few cases, this was explained in a language learning context. Also, it's worth keeping in mind that the participants had just before the instruments received an experience that did precisely that. This might have been an influence on having it mentioned so often.

The fourth most popular answer that received four mentioned was gamification and how it supports learning by making the learning fun and interactive. The same number of mentions were given to the idea that it makes it easier to understand abstract concepts through visualisation, interaction and immersion. The themes mentioned three times were student activation, support in acquiring practical skills, variety, and the fact that it feels like reality.

Table 9: Benefits and opportunities teachers identified

	Frequency
It causes excitement about learning	8
It's a novel and modern tool	6
Makes it possible to visit remote places	5
It gamifies learning	4
It makes learning abstract concepts easier	4
It activates students	3
It helps to acquire practical skills	3
It provides variety to traditional tasks	3
It's like reality	3
Easy to test and try new things	2
It's memorable	2
It's very visual	2
Learning at individual pace	2
Great for dialogue practice in language lessons	1
It creates an emotional connection with the task	1
It has a lot of flexibility	1
It helps to both introduce and practice knowledge	1
It helps to create connections between subjects	1
It helps to keep students focused on the task	1
It increases engagement	1
It lowers stress in some learning tasks	1
It makes expensive learning activities affordable	1
It provides full immesion into the learning task	1
It shows new potential career paths to students	1
It's an individual experience for each student	1
It's complementary to other learning methods	1
It's familiar environment for students	1
Makes certain tasks more accessible	1
Provides direct feedback to students	1
Teacher's are excited about it	1
Teacher's workload decreases	1
Total	65

Interview Question 2: What risks and problems do you see in using VR in education?

The risks were much more difficult for participants to come up with, which is reflected in the number of answers and themes presented. The top-mentioned themes had a very similar mention frequency compared to the benefits and opportunities. There were 50 answers provided for this question, on average, 2,77 answers per participant.

The most common theme, mentioned by eight teachers, was that it might feel too much like a game for students, and they fail to pick up the desired knowledge or skill while being engaged with the game elements. The second most popular answer, also with eight mentions, was health risks that might impact the way students could and would use VR. The more specific health cases mentioned included eyesight, balance, and trauma inflicted on oneself and others due to not being able to see the real world within VR. The third most common answer was the loss of interest in the physical world, and in a few cases, teachers mentioned the risk that they worry students don't care about real-world learning exercises once VR is introduced. Four teachers mentioned the cost of virtual reality equipment and maintenance-related issues. The lack of VR skills of teachers and tech reliability were mentioned three times.

Table 10: Risks and problems teachers identified

	Frequency
It feels like a game	8
It has health risks	8
Loss of interest in physical world	6
It's expensive	4
Teachers might not have appropriate tech skills	3
Tech reliability might be an issue	3
Lesson preparation is tougher	2
Loss of connection with reality	2
The hardware ages quickly	2
All senses can't be used in learning	1
Content is scarce and expensive to develop	1
It might be addictive	1
It requires software updates	1
It requires space and modifications to the learning environment	1
It's dependent on internet connection	1
It's use needs to be balanced	1
Safety measures required	1
Students need to have appropriate tech skills	1
Teachers need better control and overview of what's going on	1
Teachers need to believe in it	1
The skills might not be transferable to real world	1
Total	50

An aspect to note when looking together at the results of the last two questions is that similar themes are mentioned in a few cases as a benefit or opportunity as well as a problem or risk. For example, this goes for games and gamification, the reality of it and the risk of losing touch with the "real", and lesson preparation requirements.

Interview Question 3: If the materials existed, would you use VR in your classes?

The question received an unanimous positive response as all teachers indicated their readiness, at different amounts and functions, for VR technology in their classes. When we clarified the potential frequency of use, the answers ranged from daily use to a few times a month. One teacher said she would use it as a bonus for students doing well in traditional learning tasks.

A few examples of the answers:

- "I would find a use for it, at the minimum, to introduce learning activities. If the equipment were there, I would certainly use it."
- "Yes, that would be wonderful. Especially for literature lessons, I would love to have it, as well as for language teaching. It could make learning grammar fun for kids."
- "I would use it but would explore first what would engage the kids most. It's probably interesting for kids when they get a good grasp of it."
- "I would certainly use it, especially in language lessons. It could lower the stress students experience in conversational exercises, which they are usually afraid of. I think it's memorable and has a big benefit in visualising things, especially in more abstract topics."
- "Yes, I would use it if there were materials for my subjects. Absolutely would use it."
- "I would use it. A few times a month, not more. Otherwise, students would become addicted to it and lose interest in regular class activities."
- "For sure. But the applications need to provide maximum interaction to be interesting for the kids."
- "I would use it in biology to introduce abstract concepts at the micro-level."
- "Yes, I've been dreaming about this. It's new and different, very visual."

In most cases, the answers were given instantly and without hesitation, reflecting a general openness for virtual reality integration, given that they are provided with the required equipment and content. But in the analysis, the answers need to be looked at together with the previous question to understand it in the context of the barriers and problems teachers see, should the technology reach the classroom environment.

Discussion

Findings from the study, both in the quantitative and qualitative data, indicate a strong general interest in virtual reality applications for education regardless of teachers' age, teaching experience and previous virtual reality experience among primary and secondary level teachers in Estonia. While the general level of prior VR experience was low (only 39% of participants had previously tried any form of virtual reality in some form), the openness to explore the use of VR in the classroom was high. Every participant said they would do it if relevant content for their subject existed.

Based on the interviews, we also saw some differences in the motivations for using the technology. Some teachers would see it being used to introduce new concepts, some for practice and some as a bonus for well-performing students. The latter answer was interesting as it implied the use of VR as a reward instead of a direct educational tool. The differences in the aims of using it seemed to be more related to personal preferences of teaching methods and the taught subject than the teacher's background.

While the openness to use virtual reality generally was uniformly positive, there was quite a significant gap in the number of risks and problems teachers saw in VR – some couldn't at first think of any dangers VR posed or problems its implementation could face. Some were on the other hand able to identify all the commonly mentioned barriers and risks. It indicates that to start using VR in classrooms effectively; there needs to be quite an extensive training program to make sure teachers know how to develop effective learning experiences with the help of VR and that they are also able to support and identify students who might be having trouble with the technology, either in terms of learning progress, health or any other reason.

Our key research question (RQ1) was about the role teachers see VR having in education, using the SAMR technology integration framework as a basis. While the framework can be used to plan and execute a gradual introduction of specific technologies into education - starting with using them as a substitution for existing methods, our goal was to identify which stage of the framework teachers see the highest potential for VR. This, in turn, would also translate into what sort of demand is there for certain kinds of VR experiences and how much it would change the existing teaching methods. A large share of teachers (66.67%) in the study believed that VR has the potential of being a redefining technology, allowing to create new tasks that were previously not possible, with only one of the teachers thinking it will simply act as a direct substitute to current ways with no functional change. The qualitative interviews confirmed the views as the benefits teachers mentioned described educational opportunities related to task redefinition (for example, visiting remote places, holding microscopic things, and visualising abstract concepts).

In addition to the general view of VR’s role in education, we also explored if variables such as teachers' age, work experience, previous VR experience, and digital literacy influenced teachers' views on the potential role of VR (RQ2 - RQ4). We did not find any notable correlation for any of the variables, which was also confirmed by the interviews. We saw equal interest and excitement about the VR educational solutions from teachers of all ages and experiences. While not a massive difference with this sample size, the share of teachers with prior VR experience that saw VR in the refining category was lower than those, who did not. Part of the effect could be explained by the novelty of the technology and medium, which is more exciting to first-time users. The novelty and exciting form factor were also one of the top factors mentioned in the interviews, albeit mainly on the positive side; conversely, only one teacher commented that novelty tends to go down over time and, therefore, the technology’s initial appeal will likely fade.

It was interesting to observe that even teachers who had low self-assessed digital literacy were eager and successful in acquiring the critical skills for navigating and using the VR applications, supporting the findings of Baylor and Ritchie (2002) that the use of new technologies can be a driver of motivation and technological competence. It’s possible that as the technology is considered new across the board, teachers keep a more open mind than with more common technologies where it is easier to see the different skill and experience levels. As self-efficacy has been found to positively affect teachers’ technology use (Siyam, 2019), this could be a strong driver for further exploration.

We identified that teachers saw gamification and game-like dynamics both as an opportunity and a risk with VR. On the one hand, they saw that gamification could help make complex topics more easily understood and increase students’ interest in learning the material. On the other hand, they acknowledged that if game mechanics overshadow the educational goals, the student might complete the game without acquiring the knowledge and skills. One of such issues is “wheel-spinning” (Beck and Gong, 2013), where the student repeatedly tries and fails at a task to complete it without mastering the underlying skill. These kinds of cases need to be considered by the developers of VR educational content to optimise the educational impact.

The opportunities were all primarily connected to educational goals; the risks covered a much broader range of topics such as health risks, loss of interest in the physical world, cost of equipment and content, lack of necessary skills by both students and teachers and technology reliability and ageing. For example, some teachers voiced concern over what would happen if the devices broke. They would always need to have a backup plan in an alternative medium available as no easy direct substitute exists. One theme that also appeared in different forms was the already widespread use of electronic devices. VR could add to that problem and create another medium that would be addicting to students, causing loss of interest and further distancing from face-to-face interactions.

A finding that could indicate the infancy of the area is the fact that a range of topics was mentioned both as benefits or opportunities and risks or problems. For example, the fact that virtual reality feels "real" – we are yet to see if this is something we should be afraid of or if this is a crucial benefit of the medium and should be embraced.

The risks are essential to consider when implementing VR in the classroom, but as our study showed, teachers did not seem to be deterred from using VR. While the potential VR integration was being seen as high, it was clear that teachers envisioned using it alongside other learning activities outside the VR, as recommended by Luo et al. (2021).

Limitations and future research opportunities

We recognise that there were several limitations to the study, potentially providing opportunities for future research projects. The sample in the study was relatively small and composed of teachers from a limited number of schools due to cost and time reasons. This might have impacted the results as access to technologies can differ across regions.

Also, as our sampling relied in some part upon teachers' interest in the topic of virtual reality, it is likely that it more likely attracted individuals who have a higher interest in new technologies and educational technology.

The study was conducted in Estonia, which has a relatively high national internet penetration and technology use, so the results might differ in other countries. A similar analysis could be undertaken in different regions to develop comparable results for a broader view of the similarities and differences in how educators see virtual reality technologies being implemented.

Another limitation and potential for further research lie in the selection of applications and their relevance to the participants' subjects they teach. This study was designed to provide the teachers with an overview of different dynamics and content available in virtual reality without trying to match the content to the teachers' subjects. Further studies could use the same structure and instruments but select a sample and virtual reality applications that are subject-specific and match.

As virtual reality equipment prices decrease, the equipment's capabilities and functionalities evolve, and more content gets developed, the know-how about it as well as active use cases are bound to increase in schools. In such case, instead of exploring teachers' views about VR based on the SAMR framework, which made sense in our case as most participants were new to the technology and a very detailed approach would not have been appropriate, similar studies could be conducted in the future using a more granular framework such as the Technology Integration Matrix (TIM).

Conclusion

Based on this study, the potential of virtual reality as a source of immersive and interactive learning experiences that extend existing educational methods is seen by teachers mainly in a positive or very positive way. The general openness to using it exceeded our expectations. The study showed that teachers strongly agreed that it has the potential to redefine learning tasks and bring about activities that are not conceivable with current methods and technologies. Regardless of their age, professional experience, digital literacy, and prior VR experience, the view was shared.

A general readiness to implement and use virtual reality exists, which is an important first step toward broader applications. Although many questions remain related to expenses, content, tech support and relevant training for both teachers and students, the barriers are coming down quickly, and they don't seem to impact teachers' views on its potential.

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Author's Declaration

I hereby declare that I have written this thesis independently and that all contributions of other authors and supporters have been referenced. The thesis has been written in accordance with the requirements for graduation theses of the Institute of Education of the University of Tartu and is in compliance with good academic practices.

Taavi Raidma
/Digitally signed/
03.06.2022

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Appendix 1. Questionnaire questions

1. What do you expect the role of virtual reality be in education? Rank the following statements from most likely to least likely.
    - VR acts as a direct substitute, with no functional change
    - VR acts as a direct substitute, with functional improvement
    - VR allows for significant task redesign
    - VR allows for the creation of new tasks, previously inconceivable
2. Age
3. Which subject/s do you teach?
4. Which grades do you teach?
5. How many years have you worked at a school?
6. How do you rate your digital literacy?
7. Do you have previous experience with virtual reality?
8. The second section of the questionnaire asked participants to provide information on

Appendix 2. Open-ended interview questions

In your opinion, what are the opportunities and benefits of VR in an educational setting?

In your opinion, what are the risks and problems of VR in an educational setting?

If the content existed, would you integrate VR into your lessons?

Appendix 3. Consent to Act as a Participant in a Research Study

Study title: VIRTUAL REALITY IN PRIMARY AND SECONDARY EDUCATION: A STUDY ON TEACHERS' PERSPECTIVES

Principal Investigator: Taavi Raidma

Introduction: As a participant of the study, you are invited to complete a questionnaire and a short interview following the use of four educational virtual reality applications

Content of the study: This study is conducted as an MA Thesis at the Institute of Education of the University of Tartu (Estonia). The questions cover basic demographic information, teaching experience, previous virtual reality experience, self-assessed digital literacy and a task based on the virtual reality application use.

Participation requirements: Teachers from primary and secondary schools can participate and must be at least with 18 years old or older.

The expected duration of the study: The participation, including the use of virtual reality applications, the questionnaire, and the interview takes about 40 minutes of your time.

Risks and Benefits: The risks that are associated with this research are no greater than those ordinarily encountered in daily life. There is no material benefit for participating in the study, but participants may enjoy gaining the experience in using the virtual reality applications.

Privacy and Confidentiality: The researchers will follow the following procedure to protect participants' identities during this study: The original audio/video files will remain on the original recording device or a hard drive for safety storage, which is only accessible to the Principal Investigator. The audio/video files will be transcribed, potential identifiers will be removed or aggregated and the original audio/video files will be used for the purposes of this study.

Your data and consent form will be kept separate. Your consent form will be stored securely and will not be disclosed to third parties.

By participating, you understand and agree that the data and information gathered during this study may be used by the University of Tartu for publication purposes. However, any identifiable information will not be mentioned in any such publication or dissemination of the research data and/or results.

Questions about the Study: If you have any questions, comments, or concerns about the study either before, during, or after participation, please contact Taavi Raidma (taavi.raidma@ut.ee)

Voluntary Participation: Your participation in this research is voluntary. You may discontinue participation at any time during the research activity. Your decision regarding whether to participate in this study will not result in any loss of benefits to which you are otherwise entitled.

Participant: The above information has been explained to me and all of my current questions have been answered. I understand that I am encouraged to ask questions, voice concerns or complaints about any aspect of this research study during the course of this study, and that such future questions, concerns or complaints will be answered by a qualified individual or by the investigator listed on the first page of this consent document.

Study outcome:

I _____________________ teacher of/at ______________________________. I confirm that I am (age)________ old. I have read and understand the information above. I want to participate in this research and continue with enrollment in the study

☐ Yes ☐ No

Participant__________________________________

Contact information:

Taavi Raidma
MA Candidate
University of Tartu
Institute of Education
taavi.raidma@ut.ee

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Taavi Raidma
03/06/2022

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