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RESEARCH ARTICLE

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Graduating nursing students' user experiences of the immersive virtual reality simulation in learning – A qualitative descriptive study

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Abstract

Aim: To describe nursing students' user experiences' (UX) regarding highly immersive virtual reality (VR) simulation with head mounted display used for learning.

Design: Qualitative descriptive study.

Methods: Graduating nursing students ($n = 41$). Individual interviews were held right after VR simulation. The usability was assessed using System Usability Scale (SUS).

Results: User experiences emphasized three themes about the highly immersive VR simulation: nursing care in the immersive VR simulation, technology in the immersive VR simulation, and learning nursing in the immersive VR simulation. Usability was evaluated as fair (SUS score 62.3 out of 100). Scores revealed that the VR simulation was easy to use. The support of a technical person was highlighted.

Conclusions: This study supports strongly the use of highly immersive VR simulation for nursing education. VR simulations should replicate the most authentic nursing care. Technical assistance is crucial when adopting new technologies in education. The results highlighted the importance of UX in an education context.

KEYWORDS
descriptive study, head mounted display, immersive virtual reality, nursing students, simulation, user experience

1 | INTRODUCTION

Interest in user experience (UX) research has increased rapidly, due to the technology revolution initiating a new era in healthcare education. The improvements in the quality and availability of VR technology have increased its use during recent years (Weiner & Sanchez, 2020), as well as its decreasing prices (Paíno Ambrosio & Rodríguez Fidalgo, 2020). Therefore, highly immersive virtual reality (VR) used with head-mounted displays (HMDs) and hand controls, has begun to be used more frequently in nursing education (Mandal, 2013; McEnroe-Petitte & Farris, 2020). The use of VR technology in education could be ideal for increasingly technology-competent students (Kardong-Edgren et al., 2019). The potential of highly immersive VR has been seen in healthcare training (e.g. Botha et al., 2021; Hardie et al., 2020; Kardong-Edgren et al., 2019; Salovaara-Hiltunen et al., 2019). Overall experiences of using these completely immersive VR technologies have been mainly positive (eg. Botha et al., 2021; Chang & Lai, 2021; Saab et al., 2022).

UXs involve users' internal states, the characteristics of the system, and the interaction context (Hassenzahl & Tractinsky, 2006). UXs relate to how the product works when people interact with it (Garrett, 2011) and the users' feelings when using the product

(Sáenz-de-Urturi et al., 2015). Studying UX is essential in the context of education, because different UX aspects have been shown to have a great impact on learning (Zaharias & Pappas, 2016).

Today, new ways of learning are needed, due to the different needs of the diverse learners (Foronda et al., 2017). Needs and learning experiences vary between learners, a multitude of different UXs can occur. There is no absolute single scientific consensus regarding the definition of, or a theoretical model for, UX (Zarour & Alharbi, 2017). In this study, Tcha-Tokey et al.'s (2018) model of UX in immersive virtual environments was chosen (Table 1).

Immersion, presence and interactivity are the key components of VR (Mandal, 2013; Paíno Ambrosio & Rodríguez Fidalgo, 2020), which make VR feel as real as possible for the users (North & North, 2016). Immersion can be determined as a subjective impression and psychological condition where a person interacts in the environment which provides a continuing level of stimulus such as image, and sound, creating an overall realistic experience (Dede, 2009; Freina & Ott, 2015; Witmer & Singer, 1998). Presence refers to the person's feeling of being there in the VR environment physically, even though they are located elsewhere (Johnson et al., 2009; Slater & Steed, 2000). Moreover, the element of interactivity can be defined as the user's interaction with the VR environment in real time by modifying the form and the content (Bailenson et al., 2008). A high level of immersion may increase learning (Farra et al., 2018). The more immersive the environment is, the greater the learning gains are likely to be; even low levels of immersion have been shown to relate positively to learning (Georgiou & Kyza, 2018). In addition, emotion strongly influences the ability to learn, through users' motivation and behaviour (Tyng et al., 2017). Understanding users' emotions facilitates overall understanding of their experiences of challenge and interest, which lead to increasing satisfaction and joy in learning (de Lera et al., 2013). UXs affect users' motivation and engagement, which may be the most important elements of learning experiences (Zaharias & Pappas, 2016). Previous studies have also revealed that experience of flow positively affects learning (Skadberg & Kimmel, 2004), as does engagement through concentration, interest, and enjoyment (Hamari et al., 2016). Moreover, usability affects students' learning, e.g. learning effectiveness and students' overall learning experiences (Orfanou et al., 2015).

Authenticity has been proved to be the most motivating factor in VR simulations in healthcare education (Koivisto et al., 2018). Additionally, the better the simulation replicates the interaction between a patient and a nurse, the more realistic and engaging the learning experience is for the students (Koivisto et al., 2017). Simulation sickness is the term used to describe the temporary side effects caused by immersive VR, which may include symptoms such as nausea, dizziness or eyestrain. (Yildirim, 2020). Experienced simulation sickness may affect users' interest in using VR products (Davis et al., 2014). However, previous studies deemed VR-related simulation sickness to be mild or rare (Bracq et al., 2019; Samosorn et al., 2020). Studies investigating UXs of the most immersive VR technologies in the healthcare field remain quite limited (Mäkinen et al., 2022). The most user-centred technologies provide the best opportunities for learning; therefore, studying the experiences of nursing students is essential.

To the best of our knowledge, there cannot be found studies exploring UXs of the fully immersive VR technologies used in nursing education. In general, some studies focusing on students' overall experiences using VR can be found (eg. Botha et al., 2021; Chang & Lai, 2021), but this is the first study investigating nursing students' UXs of the most immersive VR simulation with a specific UX model. The purpose of this study was to describe graduating nursing students' user experiences of the immersive virtual reality simulation with Head Mounted Display (HMD) used for learning. The aim was to analyse user experiences to enable development of the most user-centered technology for nursing education. Ultimately, enhanced learning outcomes may have a positive impact on patient care and safety practices.

2 | METHOD

2.1 | Study design and data collection

This was qualitative descriptive study enriched with quantitative data (SUS). The data were collected on March 4th–19th, 2019 in a

TABLE 1 UX components in immersive virtual environment by Tcha-Tokey et al. (2018)

Presence	The user's "sense of being there" in the virtual environment.
Engagement	The connection between the user and the user's activity, consisting of behavioural, emotional, and cognitive forms.
Immersion	Illusion that the virtual environment technology replaced the user's sensory stimuli with the virtual sensory stimuli.
Flow	A pleasant psychological sense of control, fun, and joy. State where skills and the given challenge were balanced. The focus was on the current activity.
Usability	Easy to learn and easy to use the virtual environment.
Skill	The user gained knowledge by managing their own activity.
Emotion	The user's feelings when using the virtual environment.
Experience consequence	The symptoms (e.g. simulator sickness) the user experienced in the virtual environment.
Judgement	The overall experience of the virtual environment.
Technology adoption	The user's actions and decisions regarding future use or intention to use the virtual environment.

one university of applied sciences, as implementing a VR simulation into nursing education is time consuming and requires significant resources from the institution and research team. The simulation was integrated into teaching, but participation in the study was voluntary. Integration was conducted as follows: before the VR simulation, students took theory classes and participated in a classroom simulation of resuscitation. In addition, students had a chance to play a computer version of the game at home. A purposive sample of graduating nursing students (n = 41) participated in the simulations, over the course of 7 days. Each playing session took about 40 min. The students received a tutorial on the use of the VR technology and practiced controlling the equipment. The HMD settings were adjusted individually. The researcher was available throughout the session if any problems arose. All students played the scenario once (Figure 1). Moreover, the participants' psychological safety was ensured by one researcher being present throughout the simulation. Participants had an opportunity to talk about their immediate feelings during the simulation. In addition, they had an opportunity to stop the simulation at any time. The researcher was observing the situation sensitively, ready to react rapidly.

First the students participated in the VR simulation, which after they were interviewed. Second, students answered to the electronic questionnaire about the usability. Semi-structured individual interviews (see Table 2) addressed nine themes using the model of UXs in immersive virtual environments. The interview did not include question about the usability, because the usability of the VR simulation was assessed using 10-item The System Usability Scale (SUS) (Brooke, 1996) with a five-point Likert scale (1 = totally disagree, 5 = totally agree). SUS scores are ranged 0–100, where 100 is the best possible score (Brooke, 2013). In this study, Finnish positive version of the SUS was used (Jokela, 2013; Strandell-Laine, 2019; Vierula et al., 2021). The interview was pilot tested with one graduating nursing student and no changes were made based on the test. The total duration of the interviews was 6 h 42 min. Three of the researchers acted as interviewers. Interviews were audio-recorded with the participants' permission.

FIGURE 1 Student playing in the game studio.

2.2 | Virtual reality simulation

In the VR simulation the learning goal was to practice clinical reasoning skills in a resuscitation situation (Koivisto et al., 2018). The used VR hardware was the HTC VivePro system. The VR simulation included an urgent life support scenario which based on guidelines created by the European Resuscitation Council (ERC) (Soar et al., 2015). The simulation environment was developed using a design-based research methodology using Unity3D development platform (Koivisto et al., 2018). The development process followed the theoretical framework of the clinical reasoning process, which includes collecting and processing information, identifying problems and issues, establishing goals, taking action and evaluating outcomes (Levett-Jones et al., 2010). The VR simulation is a single-player game, in which the player took the role of the nurse in a 3D environment (Koivisto et al., 2018). Players were able to learn how to assess a critically ill patient using the systematic ABCDE (airway, breathing, circulation, disability, exposure) approach (Smith & Bowden, 2017) (Figure 2). All of the actions were performed by choosing from multiple-choice menus. In addition, information and immediate feedback were given to the participants after every answer.

2.3 | Ethical considerations

This research adhered to the ethical guidelines provided by the National Advisory Board on Research Ethics. Permission for the study was obtained from the university of applied sciences. Ethical approval was obtained from the Ethics Committee of Satakunta Higher Education Institution. Participants were informed orally and with an information sheet about the research study. The participants were advised that taking part in the research was voluntary, that they could withdraw from participation at any time and that participating in the research would not affect their grades. Written informed consent was obtained from all participants and the data was processed anonymously.

2.4 | Data analysis

Deductive and inductive content analysis was conducted by two researchers (HM, JMK), which included preparation, organizing, and reporting (Elo & Kyngäs, 2008). The audio recordings were transcribed verbatim by a professional transcription company. First, the transcripts were read several times to obtain a full understanding of the data. Second, a categorisation matrix was developed deductively. Third, all the significant expressions from each interview were identified, coded, and entered into the matrix. Thereafter, an inductive content analysis was performed for every component. The codes were synthesized into subcategories and then into nine categories. The category of technology adoption from the original framework was merged into other categories, since the research data did not warrant keeping it as a separate category. Finally, three main categories were derived inductively by combining the categories. Ultimately, a high

TABLE 2 The interview guide

At first, please describe your very first feelings after the VR simulation.	
1.	How natural did nursing the patient feel in the VR simulation? Did you feel presence while playing? (**presence**)
2.	How compelling was the VR simulation? Describe what kind of interaction you felt? (**Engagement**, interaction with the patient, equipment and environment)
3.	How did the playing feel? Did you feel immersed? (**Immersion**)
4.	How did your own skills and challenge of the VR simulation match? What kind of feelings did you have about that? (**Flow**)
5.	Describe how you felt your own actions (using the hand controllers/ grabbing an object etc.) in the VR simulation? (**Skill**)
6.	Explain what kind of emotions you felt while playing? (**Emotion**)
7.	Describe if you experienced any physical symptoms while playing? Describe the symptoms? (**Experience consequence**)
8.	How do you feel about the VR simulation as a teaching method? (**Judgement**)
9.	How likely are you to use the VR simulation in the future? (**Technology adoption**)

FIGURE 2 Screenshot of the VR simulation.

level of agreement was reached in the research group regarding the content and definitions of the created categories.

The SUS score was calculated by scoring each of the ten items on a scale from 0 to 4 (most negative – most positive) and multiplying the total sum of individual scores by 2.5 to obtain an overall score from 0 to 100. (Brooke, 1996).

3 | RESULTS

3.1 | Demographics

In this study, most of the students were women (85%) and over half (60%) of the participants were aged 21–25 years (Table 3). Most of them had no previous experience of VR technology (Table 4).

TABLE 3 Demographic variables ($N = 41$)

Students' characteristics	%	*n*
Gender		
Female	85	35
Male	15	6
Age		
21–25	61	25
26–30	20	8
31–35	12	5
36–40	5	2
41–45	2	1
Work experience in social and health services		
No work experience at all	10	4
<1 year	34	14
1–5 years	46	19
6–10 years	10	4

3.2 | Nursing students' user experiences of the immersive virtual reality simulation

Based on the qualitative data analysis, UXs of the nursing students emphasized three themes considering the highly immersive virtual reality simulation with HMD: nursing care in the immersive VR simulation, technology in the immersive VR simulation, and learning nursing in the immersive VR simulation. The main categories included nine categories (Figure 3). Usability of the VR simulation was assessed separately.

3.2.1 | Nursing care in the immersive virtual reality simulation

Feeling of presence in the nursing care, included the subcategories of the *natural nursing care* and *visual view of the VR environment*. Ability to move in the environment and the availability of the necessary nursing equipment affected the feeling of natural nursing care. However, some felt that the patient seemed more like a virtual character than a real person. Some students criticized the view as unclear.

> The room was around me and then I saw the patient monitor … It was like, I could physically move in the patient room….
>
> (VR0025)

> I could not see clearly what the text was saying. It was somehow so close, and my hand also trembled….
>
> (VR0016)

Engagement in the nursing care included the subcategories of *interaction with the patient and the VR environment*, *participation in the nursing care*, and *concentration on the nursing care*. Interaction with the patient and VR environment was reported as easy. Students

TABLE 4 Students gaming experience ($N = 41$)

Gaming experiences	%	*n*	Gaming experiences	%	*n*
Gaming activity			*Experience of VR during past year*		
Non-digital games			Gaming		
Weekly	10	4	Weekly	8	3
Occasionally	85	35	Occasionally	26	10
Not at all	5	2	Not at all	62	24
			Missing		4
Digital games			Films		
Weekly	37	15	Weekly	23	9
Occasionally	44	18	Occasionally	26	10
Not at all	19	8	Not at all	54	19
			Missing		3
Educational games			Music videos		
Weekly	4	2	Weekly	21	8
Occasionally	62	25	Occasionally	23	9
Not at all	34	14	Not at all	54	21
			Missing		3
*Previous experience of VR**			Cultural experience		
HTC Vive	8	3	Weekly	0	0
Oculus Rift	3	1	Occasionally	44	17
PlayStation VR	15	6	Not at all	54	21
Samsung Gear VR	10	4	Missing		3
Other mobile	10	4	Documentary experience		
Other technology	10	4	Weekly	0	0
Missing		2	Occasionally	21	8
			Not at all	77	30
			Missing		3
			Nature experience		
			Weekly	3	5
			Occasionally	28	11
			Not at all	56	22
			Missing		3

* indicates participants could choose multiple options.

appreciated the communication with the patient. Additionally, many students mentioned receiving feedback and information from the nurse facilitator, although some felt that interaction was poor, mainly because lack of voice. Nevertheless, many students felt they could truly participate in nursing care by observing and examining the patient and the numeric vitals. Some complained that they missed touching the patient and physically attaching the patient to the monitor.

> There were the interview questions, but it is not the same as if you could ask questions using your own voice and the patient could answer using a real voice.
>
> (VR0024)

Immersion in the nursing care included the subcategories of *realistic nursing care* and *a realistic VR environment*, *engrossment in nursing care and the VR environment*, and *perceptions of time and place*. VR environment and the nursing situation were described as authentic. In addition, some students pointed out that there are no menus or pre-prepared answer options in real-life nursing situations. Most reported that the 3D view facilitated the engrossment. Many of the students reported that they felt that they were so completely "in the game" that they forgot where they really were:

> The environment and everything was so realistic.
>
> (VR002)

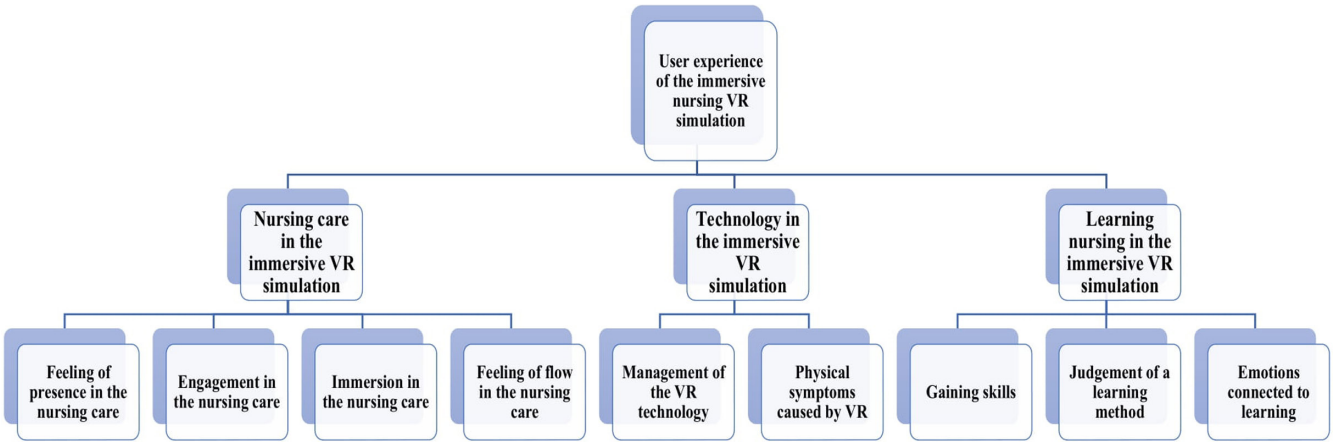

FIGURE 3 Nursing students' UXs of the immersive VR simulation with HMD.

Feeling of flow in the nursing care, included the subcategories of *the level of competence* and *a compelling virtual nursing environment*. Most of the students stated that their level of competence was sufficient, and the VR simulation was not overly challenging. Some students reported that they did not know how to progress in the simulation. Most described the VR environment as compelling and said that they would like to play more. A few students considered the most compelling scene to be the resuscitation situation:

> I think that my skills were in balance with the requirements of the game; it did not feel too hard, but not too easy either.
>
> (VR0020)

3.2.2 | Technology in the immersive virtual reality simulation

Management of the VR technology consisted of the subcategories of *the usability of the controls* and *operations in the VR environment using VR technology*. Most of the students described the controls as easy to use. They said that they learned to use the VR technology quickly and elaborated by, for example, they felt confident while moving in the VR environment and selecting objects.

> Yes, it was quick to learn what each button does.
>
> (VR0024)

Physical symptoms caused by VR simulation, included the subcategories of *symptoms caused by the VR equipment* and *symptoms caused by VR vision*. Most experienced no physical symptoms at all, but a few reported eye strain, headache, nausea or a "weird feeling." Some mentioned they became disoriented and suffered vertigo or balance problems. Some reported sweating of the hands or the VR helmet becoming hot, while a few reported trembling or numbing of the hands.

> At first, it was kind of funny because you are not familiar with the virtual glasses and I started to feel little bit nauseous or something, but the feeling disappeared very quickly. That it was like my first experience of virtual classes—just weird.
>
> (VR004)

3.2.3 | Learning nursing in the immersive virtual reality simulation

Gaining skills, included the subcategories of *VR simulation supported learning of the content* and *VR simulation supported maintaining skills*. Most felt that VR simulation supported their development of advanced skills.

> Personally, I learn much better when the method is, like, more interactive and fun to do.
>
> (VR0020)

The second category, *judgement of a learning method*, included the subcategories of *the usage as a learning method* and *usage in the different contexts*. Almost all liked the VR simulation and described it as fun, fascinating and modern way to learn. However, some thought that the VR simulation was unpleasant and did not like the idea of using it as a teaching method. Some pointed out that a VR simulation could be used in nursing practice in orientation or training, even though it might take time and resources. The potential of the VR simulation for nursing education was seen, such as for testing knowledge or rehearsing skills in different phases of education:

> This could be one learning method, or an alternative method for something, or a supplementary method. I think that it might be very useful.
>
> (VR0011)

TABLE 5 SUS scores of the immersive VR simulation ($N = 39$)

SUS items (0–4)[a]	Mean	SD
1. I think that I would like to use this system frequently	2.33	1.30
2. I found the website to be simple	2.85	1.09
3. I thought the website was easy to use	2.97	1.11
4. I think that I could use the website without the support of a technical person	1.72	1.23
5. I found the various functions in this website were well integrated	2.56	1.02
6. I thought there was a lot of consistency in this website	2.74	0.68
7. I would imagine that most people would learn to use this website very quickly	3.13	0.83
8. I found the website very intuitive	2.49	1.14
9. I felt very confident using the website	2.13	1.34
10. I could use the website without having to learn anything new	2.00	1.28

Abbreviation: SD, Standard deviation.
[a]Positive SUS by Jokela, 2013.

> Personally, I do not feel that this learning method is suitable for me, perhaps because I am not a 'game person'. (VR001)

Emotions connected to learning, consisted of the subcategories of *emotions connected with competence*, *emotions connected with ignorance*, and *emotions connected with the new situation*. Many students described that the feeling of satisfaction arose mostly when they succeeded in the simulation and the patient survived. Frustration or disappointment were also experienced, which typically occurred when they did not know how to proceed in the simulation or when answers were incorrect. Students felt uncertain of their knowledge. In addition, incorrect answers made some feel embarrassment. Most stated that they felt excited during the simulation, because of the new situation and the game sounds.

> I felt satisfaction when I knew what to do … and when I answered right. (VR0038)

> I was kind of embarrassed. I should really know these things … (VR0023)

3.2.4 | Usability of the immersive VR simulation

The usability of the VR simulation was ranged as fair (mean SUS score 62.3) (Bangor et al., 2009). SUS scores indicated that learning to use the VR simulation would be quick (highest mean score 3.13, SD = 0.83). In addition, students reported the VR simulation as easy to use (mean score 2.97, SD = 1.11) and simple (mean score 2.85, SD = 1.09). However, using the VR simulation without the support of a technical person presented the lowest mean score (1.72, SD = 1.23). (Table 5.)

4 | DISCUSSION

The purpose of this study was to describe graduating nursing students' UXs regarding immersive VR simulation with HMD used for learning. The results from the interviews showed that the UXs of the immersive VR simulation emphasized three themes: nursing care in the immersive VR simulation, technology in the immersive VR simulation, and learning nursing in the immersive VR simulation. Moreover, the SUS determined the usability of the immersive VR simulation as fair.

First main category, *nursing care in the immersive VR simulation*, highlighted the realism of the highly immersive virtual simulation, because it enables the interaction in the VR environment. (Koivisto et al., 2017; Salovaara-Hiltunen et al., 2019). The lack of voices in the interactions caused weakness in the realism (Bracq et al., 2019). Another result concerned participants' reports about communication. The ready-made options guided students' choices, and it would be more realistic if they could conduct nursing actions fully independently. Students also wished that they could actually perform nursing actions, such as attaching the patient to the monitor, rather than simply choosing options from the text menu. These findings indicated that the VR simulations used in nursing education should replicate the most authentic nursing care. The more realistic the simulation is, the more satisfied students are. Our findings suggested that communication and participation in scenarios should be developed as responses to highly realistic nursing care. This could be accomplished by giving the "patient" a real voice and gestures, as well as allowing the user to perform different nursing interventions, such as attaching the patient to a monitor and taking the patient's pulse.

The second main category, *technology in the immersive VR simulation*, revealed that the use of the VR technology was easy, or that participants quickly learned to use the equipment and operate in the VR environment, even though most of the participants did not have any former experience of VR technology. This finding was consistent to those reported in SUS which indicated that

learning to use the VR simulation would be quick. Moreover, the SUS scores confirmed the finding, where the overall usability was rated fair (mean SUS score 62.3). Hence, the finding suggests further development of the VR simulation to accomplish even better usability. The reason for this ease might have been due to every participant receiving individual instruction in the use of the VR equipment. However, some of the students said that they had to concentrate on using the VR technology, which disturbed the simulation. This also accords with the results from the SUS, which presented the lowest mean score to using the VR simulation without the support of a technical person. These findings suggested that technical assistance is essential when adopting new teaching strategies and technologies for education purposes. Most of the students did not experience any physical symptoms, which was consistent with earlier studies (Bracq et al., 2019; Samosorn et al., 2020). A possible explanation for this might be that the technology has developed enormously during recent decades (Kardong-Edgren et al., 2019).

The third main category, *learning nursing in the immersive VR simulation*, revealed that VR simulation supported learning of content and maintaining of skills, which are in line with previous studies (e.g Hardie et al., 2020; Kardong-Edgren et al., 2019; Salovaara-Hiltunen et al., 2019) Moreover, the VR simulation showed great potential for use as a learning method, which was consistent with Bracq et al.'s (2019). The VR simulation was described as a fun and innovative way to learn, which agreed with Kardong-Edgren et al.'s (2019). VR simulation was seen as a potential addition to healthcare training, which was consistent with Salovaara-Hiltunen et al.'s (2019). However, some of the students did not enjoy the experience and claimed that the use of computer-based education has expanded too far. Therefore, VR simulation should be considered as supplementary to other methods, to ensure versatile learning opportunities for diverse learners.

The study results have many practical implications for healthcare education: new highly immersive VR simulations can be developed, or existing ones improved. In general, the results of these kinds of UX studies reveal the benefits and disadvantages of different technologies in the field of education. This may help educators to choose the most user-friendly methods for teaching, for different learners and situations. VR simulations can provide opportunities for traditional education but also distance education, when face-to-face practice is not an option. These highly immersive VR simulations could prepare students for experiencing challenging situations and for situations which occur rarely in healthcare contexts, such as resuscitation, other unusual actions or stressful situations, which require knowledge and fast decision making. It is important to practice such stressful situations in a safe environment without the risk of harming real patients and with the possibility to rehearse. Better UXs lead to better learning outcomes, which ultimately may improve safety, clinical practice, and patient care. The study results also highlight the need for further study of the complex concept of UX in healthcare contexts.

5 | LIMITATIONS

The study was conducted in one university of applied sciences in a single country, and students were recruited from a single bachelor's degree nursing programme with specific characteristics. However, the study sample was large. Three interviewers interviewed students, which may have caused some bias. However, same interview guide was used to ensure that each interview was carried out in the same way. The concept of UX may have been unfamiliar to the participants; hence, some of the students might have experienced difficulty in answering the interview questions. Nevertheless, all the interviewers were familiar with the concept and could explain it if necessary.

6 | CONCLUSIONS

This study strengthens support for the potential use of highly immersive VR simulations with HMD for nursing education, learning content, and practicing and maintaining skills. Students' attitudes towards the VR simulation were mainly positive. The VR simulation showed fair usability, and still further development is suggested. The results confirmed that immersive VR simulations used in nursing education should replicate the most authentic nursing care. Especially communication, participation and technical initiatives of the patient were the main areas for further development in this certain VR simulation. The data highlighted the importance of technical assistance when adopting new technologies in education. In addition, VR simulation should be considered as a supplement method, to ensure versatile opportunities for diverse learners to learn. The results of the study may help educators to choose the most user-friendly methods for teaching. In conclusion, the results highlighted the meaning of UXs in an education context. Further study of UXs of different applications in healthcare contexts is vital and research is also needed to determine UXs' effects on learning.

AUTHOR CONTRIBUTIONS

Henna Mäkinen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation, Writing - original draft, Visualization. Elina Haavisto: Conceptualization, Methodology, Validation, Formal analysis, Writing - Review & Editing, Supervision. Sara Havola: Conceptualization, Methodology, Validation, Investigation, Data Curation, Writing - Review & Editing. Jaana-Maija Koivisto: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing - Review & Editing, Supervision, Project administration.

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of data, in the writing of the report, or in the decision to submit the article for publication.

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CONFLICT OF INTEREST

All the authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

The research data remains confidential and will not be shared to ensure participants' anonymity.

ETHICAL APPROVAL

This research adhered to the ethical guidelines provided by the National Advisory Board on Research Ethics. Permission for the study was obtained from the university of applied sciences. Ethical approval was obtained from the Ethics Committee of Satakunta Higher Education Institution in January 2019. Participants were informed orally and with an information sheet about the research study. The participants were advised that taking part in the research was voluntary, that they could withdraw from participation at any time and that participating in the research would not affect their grades. Written informed consent was obtained from all participants and the data was processed anonymously.

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