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Nursing students' views of using virtual reality in healthcare: A qualitative study

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Abstract

Aims and Objectives: This study explored nursing students' views of using virtual reality in healthcare.

Background: The popularity and use of virtual reality in healthcare delivery and education is on the rise. Yet, the views of future nurses regarding this technology remain underexplored.

Design: This is a qualitative descriptive study guided by a naturalistic inquiry and reported using the Standards for Reporting Qualitative Research checklist.

Methods: Nursing students (n = 26) were recruited using convenience and snowball sampling. They were first exposed to a virtual reality intervention aimed to enhance men's awareness of testicular diseases. This was attempted to familiarise participants with the technology and initiate conversations around its use in healthcare. Participants were then interviewed face-to-face, either individually or within focus groups. Data were analysed using thematic analysis.

Results: Four themes were identified: (i) positive experiences of virtual reality; (ii) challenges to using virtual reality; (iii) settings where virtual reality can be implemented; and (iv) blue-sky and future applications of virtual reality. Participants described this technology as novel, enjoyable, immersive, memorable and inclusive. They questioned, however, the suitability of virtual reality for older adults, reported minor technical difficulties and stressed the importance of prior preparation in the use of the technology. Virtual reality was recommended for use in outpatient healthcare settings, schools and the community. Participants suggested using virtual reality in health promotion, disease prevention and management, and to promote nurses' empathy towards patients.

Conclusions: Findings highlight the potential role of virtual reality in assisting nurses in promoting health and managing disease. Future research is needed to establish the long-term effect of virtual reality interventions among more diverse participants.

Relevance to clinical practice: Virtual reality can be implemented in outpatient, educational and community settings in order to promote health, prevent disease, enhance disease and self-management, and increase nurses' empathy towards patients.

KEYWORDS

delivery of health care, nursing, nursing students, qualitative research, technology, virtual reality

1 | INTRODUCTION

In recent years, the growing number of technological advancements has led to a paradigm shift in healthcare delivery (Moerenhout et al., 2018). Virtual reality (VR) is one of the rapidly growing technologies in healthcare (Kardong-Edgren et al., 2019). It is defined as 'a wide variety of computer-based applications commonly associated with immersive, highly visual, 3D characteristics that allow the participant to look about and navigate within a seemingly real or physical world' (Lopreiato et al., 2016; p. 40). In other words, VR serves as a digital representation of real-life scenarios which operates on the basis that a virtual world, real or imagined, can be created for users to visualise and interact with (Radianti et al., 2020). The total number of active VR users worldwide in 2018 was 171 million, as compared to 200,000 in 2014 (Vailshery, 2021). PwC economists in the United Kingdom (UK) stated that VR and augmented reality could deliver a 294 billion USD boost to global Gross Domestic Product by supporting education and training (PwC, 2019). The rapid growth of VR has led to significant price drops and the development of user friendly, wireless, light and affordable devices. Therefore, it is safe to assume that the VR technology is not merely a fad (Rizzo, 2019).

One example of using VR in healthcare is an intervention entitled E-MAT (Enhancing Men's Awareness of Testicular diseases) which proved successful in raising men's awareness of testicular diseases and increasing their intentions to seek help for symptoms of concern (Saab et al., 2018, 2019). In the current study, E-MAT was administered to study participant in order to familiarise them with the technology and spark conversations around the use of VR in various healthcare contexts.

What does this paper contribute to the wider global clinical community?

- Nursing students perceived virtual reality as novel, enjoyable, interactive and immersive. They believed that virtual reality caters for different literacy levels and learning styles and reduces embarrassment by providing the user with ample privacy.
- Virtual reality can be implemented in outpatient settings as well as educational and community settings and can be used in various health contexts including health promotion, disease prevention, disease and self-management, and to increase nurses' empathy towards patients.
- The inclusion of virtual reality in nursing education is recommended, while taking cognisance of the risk of motion sickness, the resources incurred by this technology, and the need for a priori training among students and educators.

2 | BACKGROUND

The popularity and use of VR in healthcare delivery and health education is on the rise (Jeong & Lee, 2019). In recent years, the use of VR in the international health literature has exploded. For instance, the following are only few recent examples of healthcare contexts where VR was used successfully: stroke rehabilitation (Laver et al., 2017); medical education (Izard et al., 2018); surgery training (Kim, Kim et al., 2017); chronic pain management (Jones et al., 2016); health promotion (Saab et al., 2018); and treatment of anxiety and other psychiatric disorders (Park et al., 2019).

More recently, in the context of the COVID-19 pandemic, VR became increasingly used to deliver healthcare services that could not be delivered using traditional strategies. Indeed, in their literature review, Singh et al. (2020) found that VR had several health usages during the pandemic including physical and cognitive rehabilitation; pain management; treatment of psychological disorders; surgery; healthcare professional training; VR-based mobile COVID-19 mobile application; and as a tool to distract patients.

A recent scoping review found that there is a paucity of evidence regarding the use of VR in nursing (Fealy et al., 2019). Within the nursing literature, VR is often used to educate nurses and nursing students about various skills including wound care (Choi, 2019), urinary catheterisation (Kardong-Edgren et al., 2019) and medication administration (Dubovi et al., 2017). However, it remains unclear how future healthcare professionals, including nursing students, view the VR technology and whether the use of such technology in healthcare delivery is favoured by nursing students. Therefore, this study explored nursing students' views of using VR in healthcare. Particularly, this study aimed to answer the following research questions: What are nursing students' (i) experiences of and perceptions regarding the E-MAT intervention; (ii) views around the use of VR technology in wider healthcare contexts and settings; and (iii) recommendations regarding future applications of VR in healthcare?

3 | METHODS

3.1 | Design

A qualitative descriptive design was used. Qualitative description is considered to be the least theoretical in comparison to other qualitative approaches (Kim et al., 2017; Sandelowski, 2000). This enables researchers to explore participants' unadorned views in their natural state, without committing to pre-existing theories or philosophies (Sandelowski, 2000). Qualitative description is also appropriate for eliciting poorly explored nursing-related phenomena, and helping answer questions such as: 'What are the concerns of people about an event? What are people's responses (e.g. thoughts, feelings and attitudes) towards an event? What reasons do people have for using or not using a service or procedure? Who uses a service and when do they use it?' (Sandelowski, 2000; p. 337). This type of questioning is in line with the aim of the current study.

This study is reported according to the Standards for Reporting Qualitative Research checklist, which helps enhance transparency and maintain an audit trail of the qualitative study process (O'Brien et al., 2014; Appendix S1).

3.2 | Participants

Third year undergraduate nursing students over the age of 18 years from two large undergraduate nursing programmes (i.e., General Nursing, and Children's and General Nursing Integrated) were eligible for inclusion. Participants were recruited from a university located in the south of Ireland using convenience sampling. Snowball sampling was also used, whereby eligible participants were asked to refer their classmates and invite them to participate in the study.

VR can trigger motion sickness, which is mainly associated with sudden movements and extreme gaming such as shooting games (Fernandes & Feiner, 2016). This was not the case in the current study. However, in order to safeguard the safety of participants, students with a history of severe motion sickness were not eligible for inclusion.

3.3 | Data collection

A designated researcher who had no previous relationship with the students advertised the study using a brief PowerPoint presentation during class time on two occasions: at the beginning and 2 weeks into the study. Students were also provided with an invitation letter with information about the study and the researchers' contact details. Over 100 students were registered for this class. Recruitment was conducted on an 'first come, first served' basis whereby students who were interested in participating contacted the researchers directly to arrange for a mutually agreeable data collection date and time.

Data were collected between January–February 2020 in a private venue located on campus. Participants completed a sociodemographic questionnaire with nine questions on age; gender; employment; course of study; computer use; hours of computer use; hours of internet use; experience with video gaming; and prior VR use. They were then exposed to the E-MAT intervention (Figure 1). This VR-based serious game was developed using the Medical Research Council framework (Craig et al., 2013) following several reviews of the empirical and theoretical literature on men's awareness of testicular diseases, qualitative interviews and co-design sessions with at-risk men (Saab et al., 2017; Saab et al., 2018, 2019). The usability, feasibility and effectiveness of E-MAT were established elsewhere (Saab et al., 2018, 2019).

E-MAT is delivered using a VR headset with embedded voiceover and handheld controllers with haptics (i.e., vibrational feedback) designed to raise men's awareness of the normal look and feel of the testes, common testicular symptoms and diseases, and the importance of feeling one's own testes and seeking medical help for symptoms of concern. This intervention uses simple and light-hearted approaches such as representing the testes using walnuts and referring to testes using colloquial language (i.e., nuts; Figure 1(a)). E-MAT is comprised of three interactive serious gaming levels with self-representation using hand avatars (Figure 1(b)). Level 1 involves a 3D space with two walnuts. Participants were encouraged to explore the virtual walnuts and to 'walk' around them using the handheld controllers while the voiceover provided information on the normal look and feel of the testes. Next, a lump, swelling, and pain appeared consecutively (Figure 1(c,d)) and were accompanied with light-hearted responses from the voiceover such as 'ouch!' and 'that escalated quickly!' Participants were asked to find and 'touch' each of the abnormalities using the hand avatars. This triggered a response from the voiceover and haptic feedback (i.e., vibrations) from the handheld controllers indicating that participants have successfully identified each of the three abnormalities/symptoms. Participants then progressed to Level 2, which involved 'walking' on the surface of a 3D model of a testis. During this level, the voiceover linked the symptoms seen in Level 1 to structures like the spermatic cord and epididymis (Figure 1(e)). Moreover, a purple lump appeared to indicate a growth (e.g. testicular cancer) (Figure 1(f)). After finding and identifying the anatomical structures, participants were transported to Level 3. This final level aimed to reiterate the key messages from the E-MAT intervention using three icons: (i) a snowflake to indicate the uniqueness of the testes and the importance of familiarity with one's own testes; (ii) an infographic about testicular self-examination; and (iii)

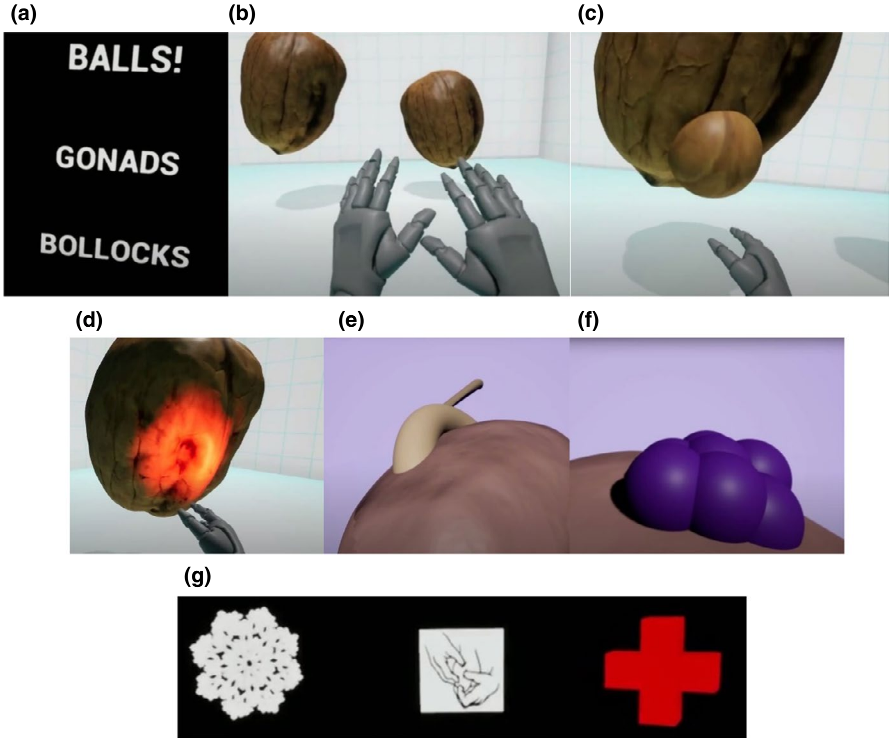

FIGURE 1 The virtual reality intervention that participants were exposed to, comprising: (a) Series of scrolling words/slang used to describe the testes. (b) Level 1: Walnuts representing the testes with virtual hands operated using the controllers. (c) Level 1: A testicular lump discovered by the user. (d) Level 1: Flashing light to represent pain discovered by the user. (e) Level 2: Participants 'land' on a 3D model of a testis where they are introduced to testicular structures like the epididymis and spermatic cord. These are linked to Level 1 symptoms. (f) Level 2: Representation of a testicular mass/tumour. (g) Level 3: Three floating icons reminding the user about the importance of knowing what is normal for him and the uniqueness of testes (snowflake); the method for testicular self-examination (infographic); and the importance of seeking medical attention for abnormalities and the urgency of sudden/sharp pain (red cross)

a red cross to emphasise the importance of timely help-seeking for testicular symptoms, with emphasis on the urgency of sudden and severe testicular pain.

Current study participants remained seated during testing of E-MAT which took around 6–10 min to complete. A designated researcher with a postgraduate qualification in computer science administered the E-MAT intervention and was available for troubleshooting and ensuring participants' safety. Following exposure to the intervention, participants partook either in individual interviews or in focus groups. The combination of both qualitative interview strategies is known to enrich qualitative data (Lambert & Loiselle, 2008) and allows for flexibility, particularly for nursing students who did not wish to discuss their views in front of their classmates and those who had busy university and/or work schedules.

Interviewers were doctorally prepared and had extensive expertise in conducting qualitative research. All interviews were audio-recorded and conducted face-to-face. A bespoke semi-structured interview guide explored participants': (i) experiences of and perceptions regarding E-MAT; (ii) views around the use of VR technology in different healthcare contexts and settings; and (iii) ideas and recommendations regarding future applications of VR in healthcare. Open-ended probing was used to explore participants' responses in greater depth. Interviews and focus groups lasted on average 50 min. Data were collected until no new themes emerged.

3.4 | Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was secured from the university's Social Research Ethics Committee and permission to access students was granted by the Research Access Committee. Participation in this study was voluntary. All participants received a study information leaflet and provided written informed consent.

3.5 | Data analysis

Data collection and analysis were concurrent. Interviews were transcribed verbatim by professional transcription services. Transcripts were cross-checked for accuracy by the first author.

Data were analysed using Braun and Clarke's (2006) six phases of thematic analysis. Transcripts were first read and re-read, and researchers' initial thoughts were written down. Relevant data were then coded systematically and transferred to a coding sheet with three columns. The first column contained the question/context where the excerpt was mentioned, the second column contained the full unedited excerpt, and the third column comprised the code corresponding to the excerpt. Similar codes were then collapsed and searched for potential sub-themes which were reviewed to check whether they aligned with the codes as well as participants' excerpts. Sub-themes were then refined to generate themes. Finally, vivid and compelling excerpts were selected to support the identified sub-themes and themes. A sample coding sheet is presented in Table 1. Participants' socio-demographic characteristics were inputted into IBM® SPSS® software platform and analysed using descriptive statistics such as frequencies, means, and standard deviations.

3.6 | Trustworthiness

The coding process was conducted by the first author and cross-checked by the second, sixth, and last authors to enhance credibility and dependability, and to minimise coding errors (Holloway & Galvin, 2016). Credibility was also enhanced by using excerpts to support and illustrate the various themes and sub-themes (Noble & Smith, 2015). Constant dialogue between the researchers was maintained during data collection and analysis in order to ensure that interpretations and findings truly derived from the data. This is known to improve confirmability (Noble & Smith, 2015). Auditability was ensured through providing a thick and transparent description of the full research process (Noble & Smith, 2015; Saldaña, 2021). Transferability was enhanced by fully describing the data collection process and sample characteristics (Saldaña, 2021). Finally, authenticity was ensured by using icebreakers prior to data collection such as asking participants about their studies and university life in general (Holloway & Galvin, 2016).

4 | RESULTS

4.1 | Participant characteristics

Data saturation was deemed achieved at participant 22. One additional focus group was conducted to confirm data saturation. In total, 26 nursing students participated in two individual interviews and five focus groups. Each focus group comprised of four to five participants. Participants' mean age was 23.6 years (standard deviation [SD] = 6.1). The majority were female (92.3%, n = 24), worked part-time (61.5%, n = 16), and were general nursing students (80.8%, n = 21). All participants reported having access to a computer and spending on average 2.5 h (SD = 1.3) using a computer and 4.2 h (SD = 2.1) using the internet per day. None of the participants mentioned using video gaming and the majority (69.2%, n = 18) reported having never used VR in the past. The full characteristics of study participants are presented in Table 2.

Four themes were identified from the interviews: (i) positive experiences of VR; (ii) challenges to using VR; (iii) settings where VR can be implemented; and (iv) blue-sky and future applications of VR. Themes, sub-themes and sample codes are presented in Table 3.

4.2 | Theme 1: Positive experiences of virtual reality

Overall, participants perceived VR as novel and enjoyable. They highlighted the interactive, and immersive nature of the technology, stating that VR is more memorable than conventional educational methods. Participants also believed that VR caters for different literacy levels and learning styles and provides the user with ample privacy. This was perceived as important, particularly while learning about sensitive health subjects.

TABLE 1 Sample coding sheet

Context where excerpt was mentioned (question/probe)	Excerpts (relevant direct quotes only, unedited)	Codes (short statements capturing the essence of the excerpts)
How did you find the intervention?	I noticed that the virtual reality is like different way of learning.	VR is a different way of learning
	The only thing I did find about it was I did feel like very nauseous after the virtual reality, which I wasn't expecting because I don't usually get like motion sickness or anything like that, but yes, it was very good.	Felt very nauseous despite not having motion sickness.
	You could grab the person's attention and keep it for longer than a doctor reading off the notes.	VR grabs and maintain attention vs doctor reading notes.
	I suppose it depends on what kind of learner you are, but I would be kind of very much a visual learner, and I feel like if I don't see pictures or kind of have a way of like transferring like words on a page to reality, then it's a lot more difficult. So, I suppose it really helps for people like that.	VR helps people who are visual learners.

Abbreviation: VR, virtual reality.

TABLE 2 Characteristics of study participants (n = 26)

Characteristic	*n* (%)
Age (years)	
Range	20–42
Mean (SD)	23.6 (6.1)
Gender	
Female	24 (92.3)
Male	2 (7.7)
Employment	
Student (not employed)	9 (34.6)
Student and employed (part-time)	16 (61.5)
Student and employed (full-time)	1 (3.8)
Course of study	
General nursing	21 (80.8)
Integrated (children's and general) nursing	5 (19.2)
Daily computer use	
Yes	26 (100)
Hours of daily computer use	
Range	1–6
Mean (SD)	2.5 (1.3)
Hours of daily internet use	
Range	2–12
Mean (SD)	4.2 (2.1)
Previous experience with video gaming	
No	26 (100)
Previous experience with VR	
Never	18 (69.2)
Once	4 (15.4)
Several times	4 (15.4)

Abbreviations: SD, standard deviation; VR, virtual reality.

4.2.1 | Novel, simple and enjoyable way to learn

The novelty, uniqueness, simplicity and enjoyability of the E-MAT intervention and the VR technology in general were discussed at length in all the interviews. Participants described VR as 'fun' (I1) and 'kind of different…you haven't really seen it done much…people would pay more attention to it and be like, "Oh, like what's that about?"' (FG3). Similarly, participants in FG5 perceived VR as:

> Really effective because it's so unusual for everyone to do virtual reality…you will tell someone else like oh, I did this. This is what I learned, and you will pass it on. So even if someone that did not do virtual reality, they will still gain some of the knowledge that we looked at today.

The simplicity of the technology was also addressed in the interviews. Participants believed that 'once people use it [VR] once or twice, it's so easy to do they'll get used to it' (FG2), especially that none of the participants had any gaming experience: 'As someone who's not from a gaming background, you didn't have to have that experience going in. It was just "turn this way and scroll that way"' (FG5).

The simple language and light humour used in the E-MAT intervention appealed to participants, specifically those who were not native English speakers:

> I think the voice, the conductor's voice [voiceover] was really nice for me, like very plain English, if you are not English speaker, and very funny in a way that he was very enjoyable [laughter].
>
> *(I1)*

4.2.2 | Interactive and immersive technology

Participants discussed at length their experience of using VR, stating how interactive, immersive and engaging the technology was. For instance, one participant said: 'like you were just there, actually physically there…it grabs your attention' (I2). This was echoed in several focus groups, whereby VR 'kept the attention for the full length of time' (FG4) and participants 'weren't drifting off thinking about anything else' (FG2). Moreover, participants mentioned 'paying attention to everything' and 'did not find [themselves] zoning out. Because you couldn't really. You saw something you had to do it' (FG3). The use of voiceover to give feedback and directions during the intervention also added to the engaging nature of the technology:

> I found it very nice, the recorded voice. For me, that makes the experience great, because I really engaged with that voice and oh yes, he is nice, I said, I felt to myself [laughs].
>
> *(I1)*

4.2.3 | More memorable than conventional educational methods

Unlike conventional educational strategies, the 'informality' (FG1) of VR was perceived to 'put the person using it at ease' (FG1). Consequently, participants perceived VR as more memorable than traditional health education strategies including posters, leaflets, diagrams, TV programmes and face-to-face health education which were perceived to 'go over someone's head' (FG5). Below are two excerpts echoing this finding:

> There's so many different posters and leaflets and they're there all the time and sure you don't read half of it! whereas you're actually involved here [VR], so you have to listen, and you have to do in order to keep it [VR] going.
>
> *(I2)*

TABLE 3 Study themes, sub-themes and sample codes

Themes	Sub-themes	Sample codes
Positive experiences of VR	Novel, simple and enjoyable way to learn	• A lot of people would like to try VR. It is cool. • Simple and easy to use among non-gamers. • Fun/using colloquial language would stick (e.g. nuts)
	Interactive and immersive technology	• 'Like you were physically there'. • Having to look for information rather than being told. • More likely to grab/maintain attention.
	More memorable than conventional educational methods	• Having a doctor telling someone what to look for face-to-face is likely to go over someone's head. • Posters, videos and TV are common. VR is new. • Targeting fewer people with VR is better than distributing 100 leaflets that one person would read.
	Catering for various literacy levels and learning styles	• Educational level does not matter, anyone can understand E-MAT. • Prevents overloading people with information beyond their level of understanding. • Suitable for different learning styles (e.g. kinetic).
	Providing privacy and reducing embarrassment	• Answers questions that men have but are too embarrassed to ask. • Can walk around in the virtual world without feeling embarrassed about asking questions. • No one else is watching or listening.
Challenges to using VR	Potentially limited to younger demographics	• Might be confusing/complex for the older adults. • More difficult for older persons to follow instructions/ move in VR. • Suitable for younger to middle-aged men.
	Technical difficulties	• Could not focus on voiceover/ distraction caused by learning how to use technology and controllers. • Struggling to hear. Need to enhance the volume. • Need for prior training/practice/tutorial in VR use.
	Side effects of VR	• Felt nauseous/dizzy despite not having motion sickness. • Sweating and feeling a bit sick. • Walking around triggered nausea.

(Continues)

TABLE 3 (Continued)

Themes	Sub-themes	Sample codes
Settings where VR can be implemented	Outpatient preferred over inpatient healthcare settings	• No time for VR in hospital • Infection control issues in hospitals. • More suitable for outpatient settings: pop-up stall in a hospital near reception, VR in waiting rooms.
	Schools and universities	• VR use in schools: younger people are interested in the technology. • Spread it out: college bathrooms. • Quiet place on campus: there will be a queue to try VR.
	Various community settings	• Health youth service (e.g. sexual health). • More time in the community rather than acute care: have a community nurse promote VR. • VR in areas frequented by men: gyms, shower rooms, after work, clubs, street, shopping centres.
Blue-sky and future applications of VR	Health promotion and disease prevention	• Can promote early detection of abnormalities and results in early help-seeking/early detection. • Can be used in mental health topics for men to answer questions about stigmatised topics. • VR can be used in promoting reproductive health.
	Disease and self-management	• Education about and coping with a new diagnosis. • Disease management: insulin injections, asthma, glaucoma. • Explaining treatments (e.g. chemotherapy and physiotherapy).
	Promoting empathy among nurses	• People talk to people with dementia like children. VR enables you to put yourself in their shoes and see how people treat you. • Lying in a trolley: how people look down at you. Nurses do not understand why people on a trolly are anxious.

Abbreviations: E-MAT, enhancing men's awareness of testicular diseases; VR, virtual reality.

> I liked that it was kind of like 3D, so instead of just looking at diagrams of "oh, this is like a growth and this would be a pain, or this would be that" I think that the fact that you could see it [testes is E-MAT] from all angles, like you'd quickly spot something.
>
> *(FG4)*

4.2.4 | Catering for various literacy levels and learning styles

The VR technology was often viewed as equitable, since individuals would receive the same information using the same medium, thus putting 'everyone on the same playing field' (FG1). To that end, participants believed that VR was suitable for individuals, regardless of their preferred learning styles including 'kinetic' (FG2) and 'visual learners' (FG3). Others stressed the fact that VR 'prevents overloading people with information which is past their actual level of knowledge' (I2) and that VR is 'open to anybody' (FG5). One participant added:

> I think maybe if someone was illiterate, we'll say: "why don't you give that a go?" You don't need to read or write…I just think it [VR] reaches everyone.
>
> *(FG5)*

4.2.5 | Providing privacy and reducing embarrassment

The privacy afforded in VR was perceived as another positive aspect to this technology. VR was repeatedly described as 'a hands-on experience without actually having to be hands-on with someone else' (FG2) since 'no one knows what you're listening to. No one knows what you're doing' (FG3), and 'nobody's watching you and if they are watching, you can't even tell if they're watching you' (I2).

As aforementioned, the E-MAT intervention is aimed at raising men's awareness of a rather sensitive subject, namely testicular diseases. This sparked conversations around the importance of having a private medium like VR to educate the public, particularly men, about sensitive health topics. Participants were of the view that 'VR answers a lot of questions that maybe men would have but are too embarrassed to ask their GP [General Practitioner] or friend' (FG5), especially that:

> Not everyone wants to talk about testicular cancer… people wouldn't be comfortable talking about it, so I thought it [VR] was a really good way of giving a lot of information that people will definitely find helpful.
>
> *(FG4)*

4.3 | Theme 2: Challenges to using virtual reality

Despite the many positive aspects of VR, participants highlighted challenges to using this technology. Some believed that VR was potentially limited to younger rather than older demographics, while others reported technical difficulties and side effects like dizziness while navigating the virtual environment.

4.3.1 | Potentially limited to younger demographics

While several participants described VR as inclusive and equitable, others believed that this technology was more suitable for younger and middle-aged users rather than older adults. In fact, words like 'difficult' (FG1), 'confusing' (FG5) and 'scary' (FG2) were used to describe how older adults would potentially perceive VR:

> The only fault that I found personally was that I couldn't see it [VR] covering too many age demographics. I can see it very good for younger generations who are interested in gaming and but maybe for older adults, it might be a bit difficult.
>
> (FG1)

> VR can be confusing to older people since they're not used to even the phone sometimes, so this is a massive jump from phones and TVs to this. So maybe that's probably the only people who aren't able to access VR.
>
> (FG5)

This was echoed by FG2 participants who stated that 'VR might be scary for older adults' and that 'technophobia more than the technology itself' might impair the use of VR among older people.

4.3.2 | Technical difficulties

Some participants reported technical difficulties while navigating the VR intervention, particularly those who were first-time VR users and those who were not into video gaming. One of the difficulties involved the voiceover since some participants reported 'struggling to hear the voiceover' (FG2) and stated that 'the voice was low' (I2). The main technical difficulty, however, related to the use of the handheld controllers in order to navigate the virtual environment:

> At the beginning, I was a little bit lost because I did not know how to use the joysticks [controllers]. I did before a virtual reality experience, but it was a tour around a castle, so it was not the same. So, at the beginning, it [VR] was difficult to use, to see myself into that space and to use the joysticks and to go forward or backwards.
>
> (I1)

In order to overcome this hurdle, participants recommended having 'a little kind of a test so people could know how to move forward and backward' (FG2). Others highlighted the need for 'a bit more training at the start in order to figure out how to get around the walnut [testis]' as opposed to 'being there for ages trying to get to the right or get to the left' (FG1).

4.3.3 | Side effects of virtual reality

All 26 participants completed the intervention. However, a few participants complained of dizziness and motion sickness which subsided within a few minutes to one hour following the intervention. For instance, below is a conversation between two participants (A and B) who experienced nausea:

> A: The only thing I did find about it [VR] was I did feel very nauseous after the virtual reality, which I wasn't expecting because I don't usually get motion sickness…it actually lasted for about an hour afterwards… there was one stage when I did actually have it [VR headset] on when I was using virtual reality that I thought I'd have to take it off.
>
> B: That happened to me as well! I was sweating up and then I felt a bit sick, but it went then after a while though, but during it, I did feel a bit sick, yes.
>
> *(FG4)*

4.4 | Theme 3: Settings where VR can be implemented

Overall, participants believed that VR was more suitable for use in outpatient rather than inpatient settings. They also recommended using VR in a variety of educational (e.g. schools and universities) and community (e.g. gyms and shopping centres) settings.

4.4.1 | Outpatient preferred over inpatient healthcare settings

Participants questioned the practicality of using VR in hospitals and acute care settings, primarily due to time constraints, understaffing and concerns around infection control:

> I don't think it's not useful in hospitals. I just feel like maybe it's gone past the point if they're already in hospital…the time also, you kind of want them [patients] in and out. Infection control comes into it as well.
>
> (FG5)

Instead, they believed that VR was more suitable for outpatient healthcare settings where ‘people could come and go as they please’ (I2). This was also perceived as a cost-effective strategy: ‘cost-wise probably, the fact that you would be able to have maybe two [VR headsets], instead of trying to have one in 50 different places in the hospital’ (FG3). The following are examples of outpatient settings where participants recommended placing the technology: ‘BreastCheck [Irish breast cancer screening] clinics’ (FG1); ‘youth health services’ (FG1); ‘pop-up stalls near the hospital reception area’ (FG2); ‘outpatient clinics’ (FG4); and ‘waiting areas’ (FG5).

4.4.2 | Schools and universities

The VR technology in general and the E-MAT intervention in particular were recommended for use in educational settings such as schools and universities. Several participants believed that pupils would benefit from the E-MAT intervention, especially those who are in their transition year. This refers to the fourth year in Irish secondary schools where students are given the option to engage in community/social activities and work experience:

> Maybe transition year students, you could either come into the school or they could go on a trip to the hospital and try it [VR] out because then if they're able to know themselves what's normal, then like they'll cop it straight away when something feels abnormal. They won't wait months and months until it gets too bad.
>
> (FG1)

Others believed that VR could be incorporated into university events or in pop-up locations on campus:

> Freshers' week [week of events designated to first year university students], those kind of types of events because it's [VR] fun, it's interactive, it's different and it aims towards its target audience.
>
> *(FG3)*

> If you brought that [VR] out onto main campus, if you had like a little gazebo just for the quietness so you could hear the audio. There are always people looking to kill a bit of time and try something fun. There will be a queue to try VR. It [E-MAT] is so short as well, it's in and out. Like it's not a chore to do it.
>
> *(FG5)*

4.4.3 | Various community settings

In addition to outpatient and educational settings, participants recommended using VR in the community: ‘awareness weeks at work’ (I1); ‘vans outside shopping centres like the blood pressure ones’ (FG1); ‘Men's Sheds [Irish organisation which provides information, resources and support to men in the community]. There's like 5,000 of them around the country’ (FG2); ‘gyms because there's not a lot of health promotion around that area’ (FG3); and ‘community halls’ (FG5).

4.5 | Theme 4: Blue-sky and future applications of VR

All participants recommended using VR in the future, mainly in health promotion and disease prevention and as a means to encourage people to seek help for health concerns and learn about sensitive health subjects. VR was also recommended for use in disease and self-management. Interestingly, participants were of the view that VR can be used to promote empathy towards patients by showing nurses the world from the patient's perspective.

4.5.1 | Health promotion and disease prevention

The use of VR in health education was a key discussion point in all the interviews. For example, one participant suggested using VR to learn about ‘breast checks, examining your breasts. Going through a model, a virtual model and knowing what lumps need to be examined more or if they're ok’ (FG2). VR was also recommended to promote mental health and wellbeing:

> Mental health issues to answer any questions in regard to that because it is such a stigmatised topic. I think it [VR] makes it really easy for people to engage because they don't have the nervousness of having to

> sit and face an actual person and to have to see their reactions and their answers.
>
> (FG5)

Other subjects that were mentioned for future VR interventions include: 'prevention of bone fractures in children and adolescents' (FG1); 'anything to do with reproductive health' (FG2); and 'health promotion in GAA teams [Gaelic Athletic Association, Ireland's largest sports organisation]' (FG3).

4.5.2 | Disease and self-management

The use of VR in disease and self-management, particularly among patients who are newly diagnosed with a chronic illness was another point of discussion. Examples given by participant I1 included: 'diabetes…because you can educate patients on how to inject insulin or asthma on how to use the inhaler'. In keeping with treatments, participant I2 gave an example on how VR could educate patients about chemotherapy:

> From experience, I had a relative going through chemotherapy and she went to some clinic and they explained what it would be like and they put on a DVD… the video that they had used was so dated…a virtual reality thing would be helpful here.
>
> (I2)

One participant in FG5 also believed that VR can help improve compliance with physiotherapy:

> If you were going through physiotherapy, then your physiotherapist could have your exercises and you can see them actually being done in 3D…this might help with compliance, because that's a fun way of doing physio.
>
> *(FG5)*

4.5.3 | Promoting empathy among nurses

Interestingly, participants thought that VR has the potential to increase nurses' empathy towards patients, particularly nurses who 'have been working on a ward for 15 plus years' and are 'a bit more curt with people' (FG1). The example of having the nurse 'use VR while trying to make a cup of tea when [she/he/they] has Parkinson's or arthritis' (FG1) was given. Participant I1 provided detailed accounts on how VR can be used to promote empathy in dementia care and in operating rooms:

> You can work with a [VR] programme to make you like you are a patient with dementia…to put yourself in their shoes…to see how other people treat you in order to know what a dementia patient experiences. For example, when you are talking to an older person with dementia as if they are children…or in a hospital, when someone is lying on a trolley and you are looking down at them and they are looking up at you. Nurses don't know that feeling and probably with virtual reality, you can develop how a person who is going to the theatre [operating room] feels…because sometimes I think that nurses don't understand why the person in the trolley is so anxious….
>
> *(I1)*

5 | DISCUSSION

This study explored nursing students' views of using VR in healthcare following exposure to a brief intervention aimed to promote men's awareness of testicular diseases. Overall, participants reported positive experiences and emphasised the novelty, simplicity and interactivity of VR. These views were echoed by men with whom the usability and feasibility of E-MAT were established (Saab et al., 2019). Men often described VR as enjoyable, engaging and easy to use. Similarly, in their systematic review on using VR in nursing education, Fealy et al. (2019) found that this technology served as a rich, interactive and engaging educational strategy which supported experiential learning-by-doing. Our participants also viewed VR as inclusive, catering for different learning styles. This is echoed in the wider nursing literature. For instance, Mangold et al. (2018) advocated for educational approaches which use various formats to meet the individual needs of nurses, while indicating that 'sensing' and 'visualising' were nurses' preferred learning styles.

In keeping with education, nursing faculty are often the decision makers in product purchasing and are the gatekeepers for the implementation of technology in the classroom (Breitkreuz et al., 2021). This highlights the importance of exploring nursing educators' attitudes and willingness to implement VR in nursing education (Moran et al., 2018). For instance, Breitkreuz et al., (2021) found that nursing educators perceived a VR sterile urinary catheter insertion game as fun and engaging, yet they were frustrated with the technology and reported difficulty navigating the virtual environment. Similarly, VR-based communication skills training was perceived by nursing educators as potentially effective, yet the use of the technology proved challenging (Shorey et al., 2020). Findings from these two studies echo findings from our current study and warrant further exploration.

The VR technology was described by current study participants as memorable, especially when compared to conventional methods of information delivery. Indeed, memory plays a key role in knowledge retention, particularly when three types of memory are triggered by certain events, in this case, exposure to VR. These include: episodic memory (e.g. memorable life events such as first-time exposure to VR); semantic memory (e.g. easy-to-understand scientific information delivered by the voiceover during VR); and procedural memory (e.g. learning new skills such as using hand avatars in the virtual world [Figure 1] and controllers with haptic/vibrational feedback) (Mastin, 2010; Saab et al., 2019). In fact, men's knowledge of testicular diseases increased significantly following exposure to E-MAT and was retained one month post-test (Saab et al., 2018). Of note, the positive impact of VR on memory extends beyond the health literature, to include studies on the retention of a second language (Cho, 2018) and knowledge of aviation safety (Chittaro & Buttussi, 2015).

Many participants viewed VR as an effective strategy to educate the public about sensitive and embarrassing health subjects. They gave the example of testicular diseases addressed within E-MAT, as well as taboo subjects such as mental health disorders. This result is echoed in the mental health literature whereby VR exposure therapy provided privacy, and reduced embarrassment and information overload among patients with anxiety disorders (Bush, 2008). More recently, a review of 36 studies on the use of VR in treating psychiatric disorders found that this technology was indeed promising ‘as a simulation, interaction and distraction tool for patients with psychiatric illnesses such as PTSD [post-traumatic stress disorder], anxiety, specific phobia, schizophrenia, autism, dementia and heavy stress’ (Park et al., 2019; p. 6).

While participants described VR as a simple educational strategy, they believed that the technology was more suitable for younger demographics and that it would be cumbersome for older adults. Indeed, challenges such as the weight of the technology, lack of familiarity with the controllers, and safety concerns might occur; however, VR is often well tolerated and accepted by older adults (Brown, 2019). The use of VR with older people is quite promising, with evidence from randomised controlled trials supporting its use in improving older adults' sense of wellbeing (Lee et al., 2019), cognition (Thapa et al., 2020), executive function (Liao et al., 2019), mood (Chan et al., 2020) and balance (Sadeghi et al., 2021). For example, in their randomised controlled trial, Sadeghi et al. (2021) found that an eight-week VR balance training was more effective than traditional balance training in improving balance and functional mobility among community-dwelling older men. Similarly, a multicentre randomised controlled cross-over trial found that a VR-based cognitive stimulation activity was more effective than a paper-and-pencil activity in improving mood and reducing negative affect among older persons (Chan et al., 2020).

Difficulties manoeuvring the controllers and navigating the virtual environment were reported by current study participants. In order to address this challenge, participants recommended prior training in VR use. Indeed, in previous studies, a brief demonstration was used to familiarise participants with VR before exposing them to E-MAT (Saab et al., 2018, 2019). This demonstration was omitted from our current study due to time constraints. In hindside, the inclusion of this demonstration could have addressed technical difficulties reported by our participants. Pre-planning and training participants in VR use are indeed key to delivering VR interventions as intended (Dubovi et al., 2017).

Some participants reported feeling nauseous and dizzy for a few minutes to one hour following E-MAT. Motion sickness, also known as VR sickness, is a key barrier to the effective use of VR (Brooks et al., 2010; Patrão et al., 2020). It is often characterised by ocular (i.e., eye-strain, blurred vision and pain) and/or non-ocular (i.e., fatigue, drowsiness, dizziness and nausea) symptoms which occur among 20% of VR users (Fernandes & Feiner, 2016). However, severe VR sickness is often linked to fast-paced VR games which involve shooting or falling (Fernandes & Feiner, 2016); this was not the case in the current study.

Resources incurred by VR serve as another limitation to using this technology in healthcare education and delivery. State-of-the-art immersive VR technology is ever-changing, can be expensive and requires periodical maintenance and updating. However, low-cost consumer-grade VR systems exist (Brown & Green, 2016). Such systems have proven effective in several health contexts including education (Brown & Green, 2016), balance, strength training and aerobics for children with developmental delay (Salem et al., 2012), treatment for phantom limb pain (Ambron et al., 2018), and stroke rehabilitation (Seo et al., 2016). Therefore, low-cost VR technologies have the potential to reduce inequities in access to technology, particularly in areas where economic resources are limited.

In terms of the future implementation of VR, participants advised against using VR in acute care settings due to concerns around time, staffing and infection control. Instead, they stated that outpatient clinics, educational institutions and community settings were more suitable for VR delivery. While several VR-based studies are conducted outside of the hospital bounds, there is a growing body of evidence around the use of VR in acute care. Examples include the use of VR as a distraction tool for people undergoing endoscopic urologic surgery (Moon et al., 2019), to control acute pain during medical procedures (Hoffman et al., 2019), and in children during wound dressing change (Hua et al., 2015).

Participants believed that VR has a future in healthcare delivery and recommended its use in health promotion and in disease and self-management. Indeed, in previous studies, VR was successful in promoting and restoring health; one example relates to post-stroke rehabilitation (Laver et al., 2017). In terms of disease management, evidence from clinical research (Jin et al., 2016; Jones et al., 2016), and from literature reviews and meta-analyses (Chuan et al., 2021, Mallari et al., 2019) indicates that distraction using VR interventions, inclusive of VR serious gaming, is indeed effective in managing pain associated with surgery, labour, wound dressing change and various chronic pain conditions. These findings were echoed by current study participants. In keeping with disease management and specifically self-management, learning about insulin injections was one of the examples given by our participants to enhance self-management of diabetes. For instance, in their clinical trial, Ebrahimpour et al. (2015) found that, in comparison to usual care, an interactive computer game significantly decreased behavioural distress caused by insulin injections among children with type 1 diabetes. Another example given by current study participants relates to using VR to teach patients about a new diagnosis and treatments such as chemotherapy. Similarly, a recent review highlighted that VR can be incorporated in the management of breast and colon cancers (Pareek et al., 2018).

Interestingly, VR was recommended for use, not only as an intervention among patients, but also among nurses in order to increase their empathy towards patients. The use of VR in empathy building is not uncommon and is well documented in the international literature (van Loon et al., 2018; Wijma et al., 2018). For example, a VR intervention titled 'Through the D'mentia Lens' was successful in improving empathy among informal caregivers of persons with dementia (Wijma et al., 2018).

6 | LIMITATIONS

While data saturation was deemed achieved, current study findings might not be transferrable to other nursing students in other universities and courses. This is primarily due to using convenience sampling. While widely used in qualitative research, this sampling strategy also increases the risk of self-selection bias, which further impacts on trustworthiness.

It is possible that only nursing students who were interested in the VR technology volunteered to participate in this study. Moreover, most study participants were first-time VR users. These two factors could have introduced a certain degree of friendliness and novelty bias (Acerbi & Bentley, 2014), which could have skewed the study findings in favour of VR. Indeed, novelty bias is often acknowledged in the wider health literature as a limitation to using VR among first-time users (Pulijala et al., 2018; Riches et al., 2021). In terms of data analysis, accidental alteration of the data could have occurred. However, this was accounted for by having three experienced authors cross-check and verify the analysed data.

7 | CONCLUSION

Nursing students reported several positive aspects of VR and recommended using this technology in various healthcare settings and contexts. Given the predominantly positive experiences identified in this study, the development and testing of future VR experiences is recommended in healthcare. VR is a promising novel approach to promote health messages as well as healthy behaviours, reaching potentially a different group of audiences, which traditional channels could reach. The use of VR can potentially empower individuals to cope with and manage disease. VR can also be used to educate the public about sensitive and taboo subjects such as sexual health and mental wellbeing, and to improve nurses' empathy towards patients.

Future research, however, ought to consider the actual and potential challenges associated with the VR technology. For instance, the space for VR needs to be primed beforehand. People with a history of severe motion sickness should be instructed to use VR with caution. Training in the form of a short demonstration, particularly for first-time users, is recommended to familiarise individuals with VR prior to undertaking the intended intervention. This would help users focus on the information being delivering and reduce noise caused by technical difficulties such as problems manoeuvring the handheld controllers and moving in the virtual space. In keeping with future research, given the relatively homogenous sample of participants and the monomethod used in the current study, there is a need for future mixed method and longitudinal research with a more diverse sample.

8 | RELEVANCE TO CLINICAL PRACTICE

Findings from this study demonstrate that VR can be potentially implemented in outpatient as well as educational (e.g. schools and universities) and community (e.g. community centres and sports clubs) settings. Therefore, public health and community health nurses have a key role to place in training and administering VR-based interventions in order to promote health, prevent disease, enhance disease and self-management, and increase nurses' empathy towards patients. In terms of nursing education, given the predominantly positive experiences reported by current study participants, the inclusion of VR in the education of future nurses is recommended. This, however, cannot be achieved without being cognisant of the resources incurred by VR and the need for a priori training among students and educators in VR use.

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CONFLICT OF INTERESTS

No conflict of interest has been declared by the authors.

AUTHOR CONTRIBUTIONS

Conceptualisation, methodology, formal analysis, investigation, wrote the original draft, wrote the review and editing, project administration and funding acquisition: MMS. Conceptualisation, methodology, formal analysis, investigation, wrote the original draft, wrote the review and editing: ML. Conceptualisation, investigation, wrote the review and editing: DM. Investigation, wrote the review and editing: BO'M. Conceptualisation, wrote the review and editing: EC. Formal analysis, wrote the original draft, wrote the review and editing: MO'D. Conceptualisation, methodology, formal analysis, investigation, wrote the review and editing: JH.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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