Nursing Students’ Views Regarding the Use of Virtual Reality: A Qualitative Exploration

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Abbreviations ........................................................................................................... 1
Acknowledgements ................................................................................................. 2
Nurses and Nursing Students’ Attitudes and Beliefs Regarding the Use of Technology in Patient Care: A Mixed-Method Systematic Review .......................................................... 3
  1.1 Introduction ...................................................................................................... 3
  1.2 Methods ......................................................................................................... 5
    1.2.1 Design ..................................................................................................... 5
    1.2.2 Eligibility criteria ................................................................................... 5
    1.2.3 Information sources and search ............................................................. 5
    1.2.4 Study selection and data collection ....................................................... 6
    1.2.5 Quality appraisal .................................................................................... 6
    1.2.6 Synthesis of results ................................................................................ 7
  1.3 Results ........................................................................................................... 7
    1.3.1 Study selection ....................................................................................... 7
    1.3.2 Study characteristics ............................................................................. 8
    1.3.3 Quality appraisal .................................................................................... 9
    1.3.4 Attitudes and beliefs regarding smartphones ....................................... 3
    1.3.5 Attitudes and beliefs regarding web-based information ....................... 4
  1.4 Discussion .................................................................................................... 4
    1.4.1 Limitations ............................................................................................ 7
  1.5 Conclusion .................................................................................................... 7
Exploring Nursing Students’ Views of Using Virtual Reality in Healthcare and Nursing Education: A Qualitative Descriptive Study ................................................................. 9
  2.1 Introduction .................................................................................................... 9
    2.1.1 Virtual reality in healthcare delivery .................................................... 9
    2.1.2 Virtual reality in nursing education ...................................................... 11
  2.2 Methods ...................................................................................................... 13
    2.2.1 Design .................................................................................................. 13
    2.2.2 Participants ......................................................................................... 13
    2.2.3 Data collection ..................................................................................... 14
    2.2.4 Ethical considerations .......................................................................... 15
    2.2.5 Data analysis ....................................................................................... 16
    2.2.6 Trustworthiness .................................................................................. 17
Abbreviations

CT  Cannot Tell
E-MAT  Enhancing Men’s Awareness of Testicular Diseases
FG  Focus Group
GAA  Gaelic Athletic Association
GP  General Practitioner
I  Individual Interview
IT  Information Technology
M  Mean
MMAT  Mixed Methods Appraisal Tool
N  No
PRISMA  Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD  Standard Deviation
SPIDER  Sample, Phenomenon of Interest, Design, Evaluation, and Research type
SRQR  Standards for Reporting Qualitative Research
UCC  University College Cork
UK  United Kingdom
USA  United States of America
VR  Virtual Reality
Y  Yes
Acknowledgements

The authors would like to thank The Sigma Theta Tau International Honor Society of Nursing for the Sigma Foundation for Nursing/Joan K. Stout, RN, Research Grant. A special thank you to the nursing students who contributed to this project and gave of their valuable time.
1.1 Introduction

The application of technology rich information systems is considered by service providers to be at the core of global health and a positive means of enhancing the quality of patient care (Darvish et al., 2014; Huryk et al., 2010; Oliveira et al., 2011). Recent advancements in information technology and computer science have resulted in the development of computerized information systems across a wide range of healthcare delivery systems (Moghaddasi et al., 2017). According to Kuwabara et al. (2020), technology has redefined the way patients and healthcare providers communicate and exchange information. Internet-based patient support systems are now widely assumed to play a significant role in patient education initiatives (Anttila et al., 2012; Gilmour et al., 2012).

Nurses are often at the initial point of care and are aware of the importance of communicating with patients regarding their health status on a regular basis (Darvish et al., 2014; Loan et al., 2018). Nurses also play a key role in empowering patients with chronic conditions to enhance their self-management skills (Coates, 2017). Currently, digital technologies provide great opportunities for nurses to develop patient health-related literacy skills to support the efficacious use of online health information (Gilmour et al., 2014; Krick et al., 2019; Tubaishat, 2014). Specifically, Darvish et al. (2014) are of the view that information technology can optimize the nursing management of patient care situations by providing immediate e-education regardless of time or place. Therefore, accurate and easily accessible information is a pre-requisite for the provision of safe patient-centered care (Krick et al., 2019).

Traditionally, healthcare providers have used paper-based formats such as articles, written messages, and pamphlets as means of providing health-focused information and education to patients (Alotaibi & Federico, 2017; Kuwabara et al., 2020). However, more
recently, a wide array of multimedia such as emails, group texting (VanDusen, 2017), video, audio (Kuwabara et al., 2020), and interactive patient care technologies (Rao-Gupta et al., 2018) are being integrated into a number of clinical practice settings. Healthcare professionals are beginning to see evidence of the potential use of such technologies in enhancing patient education (Moore & Jayewardene, 2014; VanDusen, 2017). Indeed, a survey by Moore and Jayewardene (2014) found that nurses and doctors recognized the benefits of devices such as smartphones and healthcare applications in helping improve patient access to information, decision-making, and efficiency of care. Of the nurse respondents, 58% used their smartphones in practice; this figure was 81% for doctors.

Nursing students are also important contributors to the healthcare workforce and thus important users of information technology in the clinical setting. In a cross-sectional study, Tubaishat (2014) measured fourth year nursing students’ attitudes towards the use of technology in healthcare. This study highlighted the need to provide further education on technology to final year nursing students to help prepare for their future role as registered nurses. Tubaishat’s (2014) findings demonstrate that nursing students hold a generally positive attitude toward technology.

According to Kuwabara et al. (2020), technological devices will continue to develop in their capacity to efficiently monitor, educate, and support individual patients to practice health-related behaviors. Thus, Holden et al. (2016) contend that it is important to explore the perceptions of nurses towards novel technologies in order to use such technologies in clinical practice. Nurses’ attitudes can be a pivotal point upon which successful health-related technology implementation hinges. To this end, the aim of this mixed-method systematic review was to synthesize evidence from studies which explored nurses and nursing students’ attitudes and beliefs regarding the use of technology in patient care. In particular, this systematic review aimed to answer the following questions:

i. What are the different technologies used in patient care within the included studies?

ii. What are nurses and nursing students’ attitudes and beliefs regarding these technologies?

iii. What are patients and family members’ attitudes and beliefs regarding these technologies?
1.2 Methods

1.2.1 Design

Mixed-method systematic reviews allow for the inclusion of qualitative, quantitative, and mixed-method studies; therefore, combining the strengths of quantitative and qualitative research and accounting for design limitations (Pluye & Hong, 2014). This review was conducted according to the Joanna Briggs Institute Manual for Evidence Synthesis (Aromataris & Munn, 2020) and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page et al., 2021).

1.2.2 Eligibility criteria

Study eligibility criteria were pre-determined according to the review aim and questions using the SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, and Research type) framework (Cooke et al., 2012). Studies were considered for inclusion if they included nurses, nursing educators, nurse managers, and nursing students; used any empirical design; and primarily explored participants' attitudes, beliefs, feelings, and perceptions regarding the use of any technology in patient care in general and education in particular (primary outcome). Studies exploring the way nurses and nursing students use the technology and studies reporting on patient outcomes as a result of using technology (secondary outcomes) were also considered for inclusion.

Studies with healthcare professionals other than nurses and studies where findings from nurses could not be isolated were excluded. Studies which have solely evaluated participants' knowledge, awareness, and behaviors regarding the use of technology in patient care were also excluded. Literature reviews, editorials, opinion pieces, abstracts, dissertations, and theses were not considered for inclusion.

1.2.3 Information sources and search

A systematic search of electronic databases was conducted in Academic Search Complete, CINAHL, MEDLINE, Education Full Text, PsycARTICLES, Psychology and Behavioral Sciences Collection, PsycINFO, and ERIC. The search was conducted on August 28, 2020 and was limited to studies published in English between January 2010 and August 2020. Of
note, the 10-year limit helped source the most up-to-date evidence regarding the latest technologies used in healthcare.

Keywords were truncated to maximize retrieval, combined using Boolean operators “OR” and “AND,” and searched based on title or abstract as follows: Nurs* AND (attitude* OR percep* OR perspective* OR opinion* OR thought* OR feeling* OR belie*) AND (technolog* OR comput* OR tablet* OR “mobile phone*” OR smartphone* OR “smart phone*” OR cellphone* OR “cell* phone*” OR app* OR “virtual realit*” OR “VR” OR “augmented realit*” OR “AR” OR “artificial intelligence*” OR “AI” OR simulat* OR internet* OR web* OR electronic*) AND (“patient* educat*” OR “patient* teach*” OR “patient* inform*” OR “health* educat*” OR “health* promot*” OR “health* teach*” OR “health* behavio*”).

1.2.4 Study selection and data collection

Records identified from the database search were exported to Covidence, an online software package used to produce systematic reviews. Duplicates were deleted and the title and abstract of all records were screened. Following the exclusion of irrelevant records, the full texts of potentially eligible records were obtained and screened for eligibility. Two independent reviewers conducted title, abstract, and full text screenings at random. A third independent reviewer resolved all screening conflicts.

Data from the included studies were extracted by one reviewer using a standardized data extraction table (Saab et al., 2017) which was cross-checked for accuracy by the review team. The following data were extracted from each of the included studies: reference; country; design; theoretical underpinning; sample; setting; technology used; data collection; and relevant results.

1.2.5 Quality appraisal

The methodological quality of the reviewed studies was assessed using the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018). The design of the included studies guided the choice of the MMAT quality appraisal items. In total, seven items assessed the methodological quality of cross-sectional studies, qualitative studies, and non-randomized studies. These items related to the clarity of the research question, suitability of the data collection process to the research question, sampling and sample representativeness, appropriateness of outcome measures, presentation and clarity of findings, and the presence
of confounders (Hong et al., 2018). Each item was voted on a “yes,” “no,” or “can't tell” basis. Quality appraisal was conducted by one author and cross-checked for accuracy by a second author. Voting discrepancies were resolved by consensus.

1.2.6 Synthesis of results

Data synthesis in mixed-method systematic reviews is conducted either sequentially (i.e., sequential exploratory synthesis) or concurrently (i.e., convergent synthesis; Coffey et al., 2019; Pluye & Hong, 2014). In the present review, convergent integrated synthesis was conducted whereby quantitative data were “qualitized” (Aromataris & Munn, 2020). This involved transforming statistical evidence into narrative descriptions according to the review aim. Qualitized quantitative data and qualitative data were then assembled, thematized, and pooled together based on similarity in meaning to produce a set of integrated findings. Therefore, findings in the current review were synthesized and presented according to the type of technology used in the included studies.

1.3 Results

1.3.1 Study selection

A total of 2,417 records were identified through database searching. Following deletion of duplicates, the title and abstract of 1,169 records were screened and 1,110 irrelevant records were excluded. Full texts of the remaining 59 articles were obtained for further screening. Of those, 51 were excluded, mainly due to wrong outcomes (n=23) and wrong study design (n=14). Therefore, eight studies were included in this systematic review. The study identification, screening, and selection process is presented in Figure 1.
1.3.2 Study characteristics

Almost half of the studies were conducted in the United States of America (USA) (n=3) and used a cross-sectional survey design (n=3). Half of the studies (n=4) were conducted in hospitals. Three studies were underpinned by theory including elements from Jean Watson’s Theory of Human Caring (Chick et al., 2012), the Technology Acceptance Model (Collins, 2019), and the Integrative Model for Explaining Behavioral Change (Emond et al., 2013). Most studies were conducted among nurses (n=6) with some studies comprising mixed samples of nurses, nursing students, and other healthcare professionals. Sample sizes ranged between 12 (Burkoski et al., 2019) and 130 (Emond et al., 2013) participants. Technologies used in the reviewed studies include smartphones and smartphones applications (n=4) and web-based information and educational resources (n=4). The full study characteristics are presented in Table 1.
Table 1. Study characteristics (n=8)

<table>
<thead>
<tr>
<th>Country</th>
<th>United States of America (n=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Australia (n=1)</td>
</tr>
<tr>
<td></td>
<td>Canada (n=1)</td>
</tr>
<tr>
<td></td>
<td>Finland (n=1)</td>
</tr>
<tr>
<td></td>
<td>India (n=1)</td>
</tr>
<tr>
<td></td>
<td>The Netherlands (n=1)</td>
</tr>
<tr>
<td>Setting</td>
<td>Hospital (n=4)</td>
</tr>
<tr>
<td></td>
<td>University (n=2)</td>
</tr>
<tr>
<td></td>
<td>Hospital and community (n=1)</td>
</tr>
<tr>
<td></td>
<td>Mental health service user associations and laboratory (n=1)</td>
</tr>
<tr>
<td>Study design</td>
<td>Cross-sectional survey (n=3)</td>
</tr>
<tr>
<td></td>
<td>Explorative descriptive design (n=1)</td>
</tr>
<tr>
<td></td>
<td>Pre-post survey (n=1)</td>
</tr>
<tr>
<td></td>
<td>Prospective study (n=1)</td>
</tr>
<tr>
<td></td>
<td>Qualitative survey (n=1)</td>
</tr>
<tr>
<td></td>
<td>Semi-structured focus group and interviews (n=1)</td>
</tr>
<tr>
<td>Theoretical underpinning</td>
<td>Elements from Jean Watson’s Theory of Human Caring (n=1)</td>
</tr>
<tr>
<td></td>
<td>Integrative Model for Explaining Behavioral Change (n=1)</td>
</tr>
<tr>
<td></td>
<td>Technology Acceptance Model (n=1)</td>
</tr>
<tr>
<td></td>
<td>None/not reported (n=5)</td>
</tr>
<tr>
<td>Population</td>
<td>Nurses (n=3)</td>
</tr>
<tr>
<td></td>
<td>Nurse academics (n=1)</td>
</tr>
<tr>
<td></td>
<td>Nurses and medical specialists (n=1)</td>
</tr>
<tr>
<td></td>
<td>Nurses, nursing students, and service users (n=1)</td>
</tr>
<tr>
<td></td>
<td>Nurses, pharmacists, and doctors (n=1)</td>
</tr>
<tr>
<td></td>
<td>Nursing students (n=1)</td>
</tr>
<tr>
<td>Sample size (min-max)</td>
<td>12–130 participants</td>
</tr>
<tr>
<td>Technology</td>
<td>Smartphones and smartphones applications (n=4)</td>
</tr>
<tr>
<td></td>
<td>Web-based information and educational resources (n=4)</td>
</tr>
<tr>
<td>Data collection</td>
<td>Survey (mode of delivery not specified) (n=3)</td>
</tr>
<tr>
<td></td>
<td>Electronic survey (n=2)</td>
</tr>
<tr>
<td></td>
<td>Electronic and paper-based survey (n=1)</td>
</tr>
<tr>
<td></td>
<td>Paper-based survey (n=1)</td>
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<td></td>
<td>Semi-structured in-depth interviews (n=1)</td>
</tr>
</tbody>
</table>

1.3.3 Quality appraisal

All the quantitative descriptive studies (n=5) had clear and appropriate research questions, data collection process, sampling strategies, and data analysis. A major methodological issue, however, was the low response rate which ranged between 36% (Emond et al., 2013) and 43.3% (Nasser et al., 2012) resulting in concerns around sample representativeness and the risk of nonresponse bias.

The two qualitative studies met almost all criteria of the MMAT. However, coherence between qualitative data sources, collection, analysis, and interpretation was not clearly addressed (Burkoski et al., 2019; Kuosmanen et al., 2010).
The reviewed pre-post study had a clear research question and appropriate data collected methods (Chick et al., 2012). Yet, it was unclear whether measurements were appropriate, confounders were accounted for, and whether the intervention was administered as intended. Moreover, threats to complete outcome data reporting and sample representativeness related to not reporting the total sample size as well as a low response rate pre-test (45%) and post-test (34%) (Chick et al., 2012). Quality appraisal results from the eight included studies are presented in Table 2.
Table 2. Quality appraisal of the included studies using the Mixed Methods Appraisal Tool (MMAT)

<table>
<thead>
<tr>
<th>Study designs</th>
<th>Methodological quality criteria</th>
<th>Quantitative descriptive</th>
<th>Qualitative</th>
<th>Quantitative non-randomized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening questions (all designs)</td>
<td>• Clear research questions</td>
<td>Y Y Y Y Y Y Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Data collected address research question</td>
<td>Y Y Y Y Y Y Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantitative descriptive</td>
<td>• Sampling strategy relevant to research question</td>
<td>Y Y Y Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Representative sample</td>
<td>N N CT N CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Appropriate measurements</td>
<td>Y Y Y CT Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low risk of nonresponse bias</td>
<td>CT CT Y N CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Appropriate statistical analysis</td>
<td>Y Y Y CT Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualitative</td>
<td>• Appropriate design</td>
<td>Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Appropriate data collection methods</td>
<td>Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Findings adequately derived</td>
<td>Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Results sufficiently substantiated by data</td>
<td>Y Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Coherence between data sources, collection, analysis, and interpretation</td>
<td>CT CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantitative non-randomized</td>
<td>• Representative sample</td>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Appropriate measurements for outcome and intervention</td>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Complete outcome data</td>
<td>N</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Confounders accounted for</td>
<td>CT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Intervention administered as intended</td>
<td>CT</td>
<td></td>
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</tbody>
</table>

CT = can’t tell; N = no; Y = yes.
Findings were synthesized and presented below according to nurses and nursing students’ attitudes towards two key technologies namely (i) smartphones and (ii) web-based information. Data extraction with findings from individual studies are available in Table 3.
<table>
<thead>
<tr>
<th>Reference &amp; Country</th>
<th>Design &amp; Theory</th>
<th>Participants</th>
<th>Setting</th>
<th>Technology</th>
<th>Data collection</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burkoski et al. (2019) Canada</td>
<td>Semi-structured focus group and interviews</td>
<td>n=12 nurses</td>
<td>Hospital</td>
<td>Integration of smartphones into the call bell system</td>
<td>Semi-structured in-depth interviews with observation notes</td>
<td>- Improved time management, convenience, prioritization, patient safety, and nurse-patient relationship. - Smartphone issues: poor call quality, interference, glitches, battery life, stress of multiple notifications, and patients not knowing how to use a smartphone. - Improvements: option to text the interprofessional team, adding a phone directory to reach staff across the hospital, and linking the camera feature to the electronic medical records.</td>
</tr>
<tr>
<td>Chick et al. (2012) USA</td>
<td>Pre-post survey Elements from Jean Watson’s Theory of Human Caring</td>
<td>n=not reported nurses (pre-test: 45% response rate; post-test: 34% response rate)</td>
<td>Hospital</td>
<td>Patient education brochures, electronic system, and video-on-demand education channel (tailored)</td>
<td>Electronic researcher-designed survey administered pre- and post-test</td>
<td>At pre-test, 74% perceived it was very important to document education. This increased to 83% post-test (p=not reported).</td>
</tr>
<tr>
<td>Collins (2019) USA</td>
<td>Cross-sectional survey Technology Acceptance Model</td>
<td>n=24 nurses (40% response rate)</td>
<td>Hospital</td>
<td>Secure password-protected texting application</td>
<td>Online survey</td>
<td>Out of a maximum score of 7: perceived usefulness: M=4.30; perceived ease of use: M=4.88; trust: M=5.70; personal initiatives and characteristics: M=3.60; context: M=4.32; and intention to use: M=4.89.</td>
</tr>
<tr>
<td>Emond et al. (2013) The Netherlands</td>
<td>Cross-sectional survey Integrative Model for Explaining Behavioral Change</td>
<td>n=130 (76 medical specialists and 54 nurses) (36% response rate)</td>
<td>Hospital</td>
<td>Internet to educate patients with cancer</td>
<td>Online and written research-designed questionnaires</td>
<td>In comparison to medical specialists, nurses reported greater: self-efficacy (p&lt;0.001); recognition of patients' need for internet guidance (p=0.09); beliefs that websites give patients greater sense of control (p=0.02); encouragement and conviction that colleagues find it important to refer patients to online information (p&lt;0.05); and intentions towards structural referral (p=0.06, marginally significant).</td>
</tr>
<tr>
<td>George et al. (2017) USA</td>
<td>Qualitative survey</td>
<td>n=71 nursing students (91% response rate)</td>
<td>University</td>
<td>Smartphone applications for students to utilize point-of-care</td>
<td>Researcher-designed survey with</td>
<td>Improved: comfort when taking patient history and providing patient education; communication skills; cultural competence; patient education skills; ability to translate didactic knowledge to real-world application;</td>
</tr>
<tr>
<td>Reference &amp; Country</td>
<td>Design &amp; Theory</td>
<td>Participants</td>
<td>Setting</td>
<td>Technology</td>
<td>Data collection</td>
<td>Results</td>
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</tr>
<tr>
<td>Kuosmanen et al. (2010) Finland</td>
<td>Explorative descriptive design</td>
<td>n=76 (35 nurses, 21 service users, and 20 nursing students)</td>
<td>Mental health service user associations and laboratory</td>
<td>Web-based educational tool for people with schizophrenia spectrum psychosis</td>
<td>Researcher-designed questionnaire</td>
<td>Over 90% agreed that the target group has been defined and the content of the website was reliable. Over 85% agreed that the website was easy to use and navigate.</td>
</tr>
<tr>
<td>Nasser et al. (2012) Australia</td>
<td>Cross-sectional survey</td>
<td>n=109 (53 pharmacists, 40 doctors, and 16 nurses) (43.3% response rate)</td>
<td>Hospital and community</td>
<td>IT-based warfarin education resources</td>
<td>Paper-based researcher-designed questionnaire</td>
<td>50 (45.9%) of participants reported having access to IT-based sources. Of those, 19 (38%) (including 10 doctors, 8 pharmacists and 1 nurse) had never used such resources for patient education. The most important considerations to identify suitable IT resources were good information quality (68.8%), images relevant to warfarin therapy (62.5%), and information in multiple languages (62.5%).</td>
</tr>
<tr>
<td>Sinha and Thankachan (2012) India</td>
<td>Prospective study</td>
<td>n=52 nursing academics</td>
<td>University</td>
<td>eHealth application in patient care, research and education, public health, and administration</td>
<td>Researcher-designed questionnaire</td>
<td>Over 90% agreed that online information sources add knowledge regarding healthcare professionals and their location, and that electronic health record and computerized health information system improve the sharing and real time access of patient information. Over 80% agreed that eHealth applications maintain secure patient information, quality decision-making in patient care, and evaluation.</td>
</tr>
</tbody>
</table>

IT = information technology; M = mean.
1.3.4 Attitudes and beliefs regarding smartphones

Smartphones and smartphone applications were used in four of the reviewed studies (Burkoski et al., 2019; Collins, 2019; George et al., 2017; Sinha & Thankachan, 2012). This involved integrating smartphones into the call bell system (Burkoski et al., 2019); sending health information securely using a smartphone application (Collins, 2019); using smartphone applications to implement point-of-care (George et al., 2017); and using an eHealth application to help with patient care (Sinha & Thankachan, 2012).

Overall, nurses and nursing students’ attitudes and experiences of using smartphone applications were positive. For instance, the use of smartphones in the call bell system was believed to enhance time management, convenience, prioritization, patient safety, and nurse-patient relationship (Burkoski et al., 2019). Similarly, the use of a smartphone application while implementing point-of-care was perceived to enhance nursing students’ communication with patients, patient education skills, comfort while taking patient history, and cultural competence (George et al., 2017). Nursing students also reported a greater ability to translate didactic knowledge to real-world situations as well as an increase in their level of confidence (George et al., 2017).

Information security was a key discussion point in two of the reviewed studies (Collins, 2019; Sinha & Thankachan, 2012). Electronic health records and computerized health information systems were perceived to improve the sharing and real time access to patient information whilst maintaining security and quality decision-making in patient care and evaluation (Sinha & Thankachan, 2012). Likewise, Collins (2019) found that secure texting applications were perceived by nurses as useful, easy to use, and trustworthy.

Nurse- and patient-related limitations of using a smartphone were addressed in one study (Burkoski et al., 2019). For nurses, limitations pertained to poor call quality, interference, system glitches, poor battery life, and stress among nurses caused by having multiple notifications. In addition, nurses reported that smartphones were not favored by patients and family members, particularly those who did not know how to use this technology (Burkoski et al., 2019). Some nurses also mentioned that patients mistakenly believed that the smartphone was the nurse’s personal cellphone and that the nurse seemed distracted as a result.
1.3.5 Attitudes and beliefs regarding web-based information

The remaining four studies used web-based information and educational resources for patients, including a video-on-demand educational channel with updated online patient information material (Chick et al., 2012); internet-based information for patients with cancer (Emond et al., 2013); a web-based educational tool for people with schizophrenia spectrum psychosis (Kuosmane et al., 2010); and information technology-based warfarin education resources (Nasser et al., 2012).

Having clinical nurse specialists create a video-on-demand educational channel and update online patient information material yielded an increase in the perceived importance of such tools among nurses (Chick et al., 2012). Kuosmanen et al. (2010) evaluated a password-protected web-based educational tool for people with schizophrenia spectrum psychosis which can be used in inpatient and outpatient settings. It was found that service users, nurses, and nursing students perceived the content of the website as reliable and agreed that the website was user friendly and easy to navigate.

When compared to other healthcare professionals, nurses were more likely to have access to web-based resources and to appraise the importance of such resources in patient education (Emond et al., 2013; Nasser et al., 2012). For instance, in the context of cancer education, nurses were more likely than medical professionals to recognize patients’ need for internet guidance, were more convinced that the use of cancer information websites gives patients a greater sense of control, reported greater self-efficacy in the use of such information, and found it important to refer patients to online information (Emond et al., 2013). Similarly, nurses were more likely than doctors and pharmacists to have access to IT-based warfarin educational resources, provided that the information was of good quality, images relevant to warfarin therapy were used, and the information was available in multiple languages (Nasser et al., 2012).

1.4 Discussion

This mixed-method systematic review focused on synthesizing evidence from studies which explored nurses and nursing students’ attitudes and beliefs regarding the use of technology in patient care with a focus on patient education. From an analysis of the data, participants’
attitudes and beliefs were explored in relation to two key technologies namely (i) smartphones and smartphone applications and (ii) web-based information and educational resources.

A key finding from this review showed that smartphones and smartphone applications were commonly used technologies in patient care (Burkoski et al., 2019; Collins, 2019; George et al., 2017; Sinha & Thankachan, 2012). Indeed, the use of smartphones in healthcare is not unusual, especially that smartphones help healthcare professionals download a wide range of health-related applications which can be readily used in patient care and education (Flynn et al., 2018). In the present review, nurses’ use of smartphones in patient care can be grouped under six broad categories: communicating (Burkoski et al., 2019); directing healthcare information (Collins, 2019); implementing point of care; securing healthcare information; imparting education (George et al., 2017); and helping provide quality healthcare to patients (Sinha & Thankachan, 2012). The above findings were corroborated in the study by Moore and Jayewardene (2014) whereby nurses and doctors showed that smartphones and healthcare applications assisted healthcare professionals to improve access to information, decision-making, and efficiency of care to improve access to information. Indeed, an online survey of 735 nurses found that almost all participants (98%) used a smartphone in acute care settings in order to access information on medications and procedures, and over 75% indicated using smartphones to seek patient education information (Flynn et al., 2018).

In relation to nursing students, the current review highlighted the value of smartphones as learning tools for nursing students and the role of smartphone applications in enhancing students’ ability to translate theoretical knowledge to the clinical setting (George et al., 2017). According to Honey (2018), knowing the technological device that nursing students use and have access to has the potential to guide the development of transformative and innovative teaching and learning initiatives. However, a key limitation that was not addressed in the reviewed studies relates to distractions caused by using smartphones for personal reasons (Honey, 2018; Zarandona et al., 2019). For instance, a survey of 234 nursing students in Spain found that smartphones were not widely used for professional purposes, with a number of students using their smartphones for personal reasons during their practicum (Honey, 2018).

While the use of smartphones in clinical settings was perceived favorably by most participants, some limitations to using such technology among nurses and patients are worthy
of note. For instance, nurses in the study by Burkoski et al. (2019) believed that the poor call quality, interference, system glitches, poor battery life, and stress caused by having multiple notifications were key limitations to using a smartphone in the clinical setting. These challenges are not uncommon and have been reported elsewhere (Aguilera-Manrique et al., 2018). Interestingly, however, one study found that the use of smartphones in healthcare delivery was favored by nurses as a means to reduce work-related stress and enhance communication with colleagues and patient care (Pal et al., 2015). Another limitation identified in our current review relates to patients not knowing how to use a smartphone and falsely believing that nurses were carrying smartphones for personal use, thus distracting them from patient care (Burkoski et al., 2019). In keeping with distraction, when used for personal reasons in clinical settings, smartphones can lead to missing important patient information which negatively affects patient care and patient safety (Coates, 2017). Of note, nurses’ and patients’ positive and negative experiences with smartphones are well documented in the wider literature. For instance, a review of the effect of nurses’ use of smartphones in patient care found that smartphones enhanced interprofessional communication, were perceived by nurses as easy and quick, improved time-management, and reduced work-related stress (Katz-Sidlow et al., 2012). Nevertheless, smartphones distracted from work and made the nurse seem unprofessional.

One limitation that was not addressed in our current review pertains to the transmission of nosocomial pathogens. Pal et al. (2015) swabbed mobile phones and hands of 386 healthcare workers and found that 316 mobile phones (81.8%) and 309 hand swab samples (80%) showed growth of bacterial pathogens including “Coagulase-negative Staphylococcus, Staphylococcus aureus, Acinetobacter species, Escherichia coli, Klebsiella pneumoniae, Pseudomonas species and Enterococcus species” (Pal et al., 2015; p.1).

In the current review, online educational resources such as an automated video (Chick et al., 2012); internet-based information on cancer (Emond et al., 2013); web-based education on schizophrenia spectrum psychosis (Kuosmanen et al., 2010); and information technology education focusing on warfarin (Nasser et al., 2012) were offered as novel opportunities for patient education in four studies. It was interesting to note that nurses were the healthcare professionals who were most likely to access and evaluate patient-related educational web-based resources when compared to other healthcare professionals including doctors (Emond et al., 2013; Nasser et al., 2012). Thus, it was not surprising that,
while nurses were more aware of patients’ requirements for internet support, they were also sensitive to the need of patients for information relating to their cancer diagnosis. This can be interpreted as nurses’ commitment to providing optimal person-centered care (Holden et al., 2016).

In the current review, one quantitative study highlighted the sense of autonomy and self-efficacy felt by patients in being able to access and use online information (Emond et al., 2013). Nurses have a central role to play in helping patients with chronic conditions to augment their self-management skills (Coates, 2017). Accordingly, Anttila et al. (2012) called for a greater focus on web-based patient education during hospitalization to help patients self-manage their care on discharge. It is important therefore, that nurses’ positive attitudes towards technology be reinforced, to increase the use and application of web-based technology in clinical practice.

1.4.1 Limitations

This review is not without limitations. While rigorous processes were used to screen and select studies, only eight studies were included in this systematic review. Therefore, review findings cannot be considered generalizable. The search was limited to studies published within the past 10 years. While the year limit would help highlight the latest technologies used in patient care, it might have led to omission of important records published before the year 2010. Most of the reviewed evidence consisted of descriptive data with very little evidence relating to the effect of technological interventions on nurses’ attitudes. Another key methodological issue related to the low response rate in quantitative studies, which ranged between 36% (Emond et al., 2013) and 43.3% (Nasser et al., 2012); this serves as another threat to generalizability.

1.5 Conclusion

There is a dearth of high-quality research investigating nurses and nursing students’ attitudes towards technology. Nonetheless, the evidence gleaned from the reviewed studies makes an important contribution to understanding nurses and nursing students’ views on the use of technology in patient care in general and education in particular. Overall, nurses and nursing students’ attitudes towards the use of smartphones and online educational resources were positive with some studies finding that nurses used such technologies more than other
healthcare professionals. This highlights the importance of reinforcing such positive practices. Limitations to using such technologies, however, must be considered. These include but are not limited to: system glitches and failures; poor battery life for smartphones; stress caused by multiple notifications; distractions; risk of infection transmission; and misbeliefs among patients regarding the reason behind nurses’ use of smartphones at the bedside.
2.1 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 visualize 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 (Statista, 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).

2.1.1 Virtual reality in healthcare delivery

One example of using VR in healthcare is an intervention entitled E-MAT (Enhancing Men’s Awareness of Testicular diseases) (Saab et al., 2019). 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., 2019).

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E-MAT is delivered using a VR headset with embedded voiceover and handheld controllers with haptics (i.e., vibrational feedback). It is comprised of three interactive levels aimed to raise men’s awareness of: (i) the normal look and feel of the testes; (ii) common testicular symptoms and diseases, and (iii) the importance of feeling one’s own testes and seeking medical help for any abnormalities. The E-MAT intervention uses simple and light-hearted approaches such as representing the testes using walnuts and referring to testes using colloquial language (i.e., nuts) (Saab et al., 2019). The different levels of E-MAT are illustrated and summarized in Figure 2. The development, usability, feasibility, and effectiveness of E-MAT were established elsewhere (Saab et al., 2018; 2019). In the current study, E-MAT was administered to study participant in order to familiarize them with the technology and spark conversations around the use of VR in healthcare.

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 et al., 2017b); 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 (Feasly 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 catheterization (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 favored by nursing students.
Figure 2. 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/tumor.
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).

2.1.2 Virtual reality in nursing education

Nurse educators are constantly being challenged to source accessible and innovative methods of teaching and learning that transition students through each stage of their
educational journey (Fealy et al., 2019). Over the last decade and more recently in the context of the COVID-19 pandemic, online education has emerged as an important educational platform in higher education (Benham-Hutchins & Lall, 2015; Bao, 2020). Consequently, there has been considerable development in the number of online and hybrid nursing programs at both, undergraduate and postgraduate levels. The increase in online education paves the way for novel technologies such as VR (Foronda et al., 2017; Mendez et al., 2020). Published literature has also focused on the potential use of virtual learning and game-based learning in many of the science-based disciplines (Felszeghy et al., 2019; Radianti et al., 2020). Currently, this technology is being considered for inclusion in nursing curricula at undergraduate level (Farra et al., 2018; Lange et al., 2020).

VR operates on the premise that a virtual world, real or imagined, can be created, which allows users not only to visualize the content but also to interact with it (Vlachopoulos & Makri, 2017). Specifically, VR allows the visualization of and interaction with digital representation of real-life scenarios (Padilha et al., 2019; Radianti et al., 2020). VR has the potential to change the way in which educational content at undergraduate level is delivered (Zackoff et al., 2020). The application of such technology in undergraduate nursing education enhances the transfer of theoretical and clinical learning in a more engaging and meaningful way (Foronda et al., 2017). The potential for immersion in a learning activity promotes a greater understanding and consolidation of knowledge and skills. Thus, VR can facilitate the link between theory and practice for students, through repeated exposure to content and related clinical skills (Jenson & Forsyth, 2012).

Emerging studies have uncovered some of the benefits of online learning at undergraduate nursing level. These benefits include the provision of an interactive learning opportunity in a safe non-threatening environment (Zackoff et al., 2020), the increased access and flexibility afforded to the learner (Mendez et al., 2020), the provision of a platform for presentations/lectures, and the opportunity to ask questions (Benham-Hutchins & Lall, 2015). Additional benefits were identified in a recent randomized controlled trial which highlighted that VR promoted knowledge retention, clinical reasoning, self-efficacy, and greater satisfaction with the learning experience among nursing students (Padilha et al., 2019).

Despite the evidence regarding the effectiveness of VR, this technology remains a new experience for nursing students. There is a dearth of research exploring in-depth the
potential use and application of VR in undergraduate nursing education from the perspective of nursing students. This is key to potentially integrating and sustaining this technology in nursing curricula. Therefore, the aim of this study is to explore nursing students’ (i) views of using VR in various healthcare contexts and (ii) perspectives of incorporating VR in nursing education.

2.2 Methods

2.2.1 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., 2017a; 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, attitudes) toward 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 aims 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).

2.2.2 Participants

Third year undergraduate nursing students were recruited from a university located in the south-west of Ireland using convenience sampling. Snowball sampling was also used, whereby 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.
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 two 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.

2.2.3 Data collection

Data were collected between January and February 2020 in a private venue located on campus. Participants completed a socio-demographic 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. The socio-demographic questionnaire can be found in Appendix 1. They were then exposed to the E-MAT intervention (Figure 2). Participants remained seated during testing which took around six minutes. 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’ experiences of and perceptions regarding E-MAT, views around the use of VR technology in different healthcare settings, and ideas and recommendations regarding future applications of VR in healthcare. Participants' thoughts around using VR in nursing education, perceived advantages, and disadvantages of using VR in nursing education, and blue sky thinking about the future of VR in nursing education were also explored (Table 4). Open-ended probing was used to explore participants' responses in greater depth. Data were collected until no new themes emerged.
### Table 4. Semi-structured interview guide and sample probes

<table>
<thead>
<tr>
<th>Main questions</th>
<th>Probes</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did you find the intervention?</td>
<td>• What worked for you?</td>
</tr>
<tr>
<td></td>
<td>• What did not work for you?</td>
</tr>
<tr>
<td></td>
<td>• What would you change?</td>
</tr>
<tr>
<td>What are your thoughts about using this intervention in healthcare settings</td>
<td>• What are the potential healthcare settings where this intervention can be used?</td>
</tr>
<tr>
<td>(e.g., clinical setting, community etc.)?</td>
<td>• What are the barriers to using this intervention in healthcare?</td>
</tr>
<tr>
<td></td>
<td>• What are the facilitators for using this intervention in healthcare?</td>
</tr>
<tr>
<td>Think blue skies about the future of virtual reality, can you imagine it being</td>
<td>• If yes, can you give examples of health topics where virtual reality can be used effectively?</td>
</tr>
<tr>
<td>used to promote men’s health in the future?</td>
<td>• If not, why not?</td>
</tr>
<tr>
<td></td>
<td>• Could you imagine situations where you would recommend the use of virtual reality as a health promotion tool?</td>
</tr>
<tr>
<td></td>
<td>• Please elaborate</td>
</tr>
<tr>
<td>What are your thoughts around using virtual reality in the education of nursing</td>
<td>• What are the potential subjects/topics/courses where virtual reality can be used?</td>
</tr>
<tr>
<td>students?</td>
<td>• What are the barriers to using virtual reality in nursing education?</td>
</tr>
<tr>
<td></td>
<td>• What are the facilitators for using virtual reality in nursing education?</td>
</tr>
<tr>
<td>In comparison to current teaching methods (e.g., face-to-face, simulation,</td>
<td>• What are the advantages of using virtual reality in nursing education?</td>
</tr>
<tr>
<td>blended-learning, clinical skills):</td>
<td>• What are disadvantages of using virtual reality in nursing education?</td>
</tr>
<tr>
<td></td>
<td>• Can virtual reality be incorporated with other teaching and learning methods? If yes, how? If no, why not?</td>
</tr>
<tr>
<td>Think blue skies about the future of virtual reality, can you imagine it being</td>
<td>• If yes, how?</td>
</tr>
<tr>
<td>used as a tool in the education of future healthcare professionals including</td>
<td>• If not, why not?</td>
</tr>
<tr>
<td>nurses?</td>
<td></td>
</tr>
</tbody>
</table>

### 2.2.4 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.
2.2.5 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 analyzed 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 5. Participants’ sociodemographic characteristics were inputted into IBM® SPSS® software platform and analyzed using descriptive statistics such as frequencies, means, and standard deviations.
Table 5. Sample coding sheet

<table>
<thead>
<tr>
<th>Context where excerpt was mentioned (question/probe)</th>
<th>Excerpts (relevant direct quotes only, unedited)</th>
<th>Codes (short statements capturing the essence of the excerpts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did you find the intervention?</td>
<td>I noticed that the virtual reality is like different way of learning.</td>
<td>VR is a different way of learning.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>Felt very nauseous despite not having motion sickness.</td>
</tr>
<tr>
<td></td>
<td>You could grab the person's attention and keep it for longer than a doctor reading off the notes.</td>
<td>VR grabs and maintain attention vs doctor reading notes.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td>VR helps people who are visual learners.</td>
</tr>
</tbody>
</table>

VR = virtual reality.

2.2.6 Trustworthiness

The coding process was conducted by the first author and cross-checked by the second and last authors to enhance credibility and dependability, and to minimize 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).
2.3 Results

2.3.1 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 lasting on average 50 minutes. 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 hours (SD=1.3) using a computer and 4.2 hours (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 6.

Table 6. Characteristics of study participants (n=26)

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

SD = standard deviation; VR = virtual reality.
Two major themes were identified namely VR in healthcare delivery and VR in nursing education. Themes, sub-themes, and sample codes are presented in Table 7.

Table 7. Study themes, sub-themes, and sample codes

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-themes</th>
<th>Sample codes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VR in healthcare delivery</strong></td>
<td>Positive experiences of VR</td>
<td>• Novel, simple, and enjoyable way to learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Interactive and immersive technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• More memorable than conventional educational methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Catering for various literacy levels and learning styles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Providing privacy and reducing embarrassment</td>
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<td>Challenges to using VR and ways to overcome them</td>
<td>• Potentially limited to younger demographics</td>
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<td>• Technical difficulties</td>
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<td>• Side effects of VR</td>
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<td></td>
<td>Settings where VR can be implemented</td>
<td>• Outpatient preferred over inpatient healthcare settings</td>
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<td>• Schools and universities</td>
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<td>• Various community settings</td>
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<td></td>
<td>Blue-sky and future applications of VR</td>
<td>• Health promotion and disease prevention</td>
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<td>• Disease- and self-management</td>
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<td>• Promoting empathy among nurses</td>
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<td><strong>VR in nursing education</strong></td>
<td>Captivating, innovative, and empowering nature of VR</td>
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<td>• Consolidating and complementing existing teaching and learning approaches</td>
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<td>Contextual transfer</td>
<td>• Learning human anatomy and physiology</td>
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<td>• Developing practical and clinical decision-making skills</td>
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<td>• Emphasizing the patient experience and enhancing empathy</td>
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<td>Challenges and threats to actualization</td>
<td>• Resources incurred by the technology</td>
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<td>• Potential side effects and safety concerns</td>
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VR = virtual reality.

2.3.2 Virtual reality in healthcare delivery

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.

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 humor 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).

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).

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 programs, 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).

“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).

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).

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).

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.

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 in 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.

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).

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).

**Settings where virtual reality 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 centers) 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).

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).
In addition to outpatient and educational settings, participants recommended using VR in the community: “awareness weeks at work” (I1); “vans outside shopping centers like the blood pressure ones” (FG1); “Men’s Sheds [Irish organization 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).

Blue-sky and future applications of virtual reality

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.

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 stigmatized 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 organization]” (FG3).

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).

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] program 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).

2.3.3 Virtual reality in nursing education

Captivating, innovative, and empowering nature of virtual reality

Participants believed that “VR keeps learning interesting and adds a little bit of fun” (FG1). They also perceived that the novelty of VR makes it more memorable and “grabs the attention” (I2), particularly when compared to traditional learning strategies:
“…Everyone sees posters and videos on the Internet or TV and they just move on. But in VR, you will tell someone else ‘oh, I did this, this is what I learned,’ and you will pass it on” (FG5).

Several participants believed that “doing” rather than “seeing” or “hearing” (FG2) using VR grabs the attention and makes the experience more memorable:

“I was paying attention to everything and I was really interested. I didn’t find myself zoning out, because you couldn’t. You saw something you had to do it…you’re definitely going to remember what was said” (FG3).

VR was perceived to promote equity among students by delivering the same information through the same means, particularly when exposure to certain clinical experiences is limited:

“On placement, I might never see a grade four pressure sore, but then someone else might see one. This might be putting me at a disadvantage, whereas if I was able to see that on VR, it kind of puts everyone on the same playing field” (FG2).

VR was also perceived to “cater for various types of learners” (FG1) and provide individualized “one-to-one education and very individualized” (FG4) teaching and learning experiences.

Participants discussed how VR can help increase students’ confidence by providing them with a safe environment which allows for trial and error, an experience not afforded with real patients:

“When I’m in clinical practice, I can get quite shaky, especially if it’s the first time I’m doing something. That’s where VR would come in. It would give me that space to practice literally hands-on without actually being on clinical placement” (FG3).

VR was often compared to “putting on a mask and adopting a different persona” (FG2), which was perceived to help build students’ confidence and learn from their mistakes:

“In VR, it’s just yourself with the goggles. Nobody is going to observe you. You can feel free to make errors and increase your confidence. You can fail, you can do things wrong, you can learn from the mistakes” (I1).
Participants reported that VR can be used to consolidate pre-acquired information and skills or complement pre-existing teaching and learning approaches. They recommended using VR before lectures, between lectures and practical sessions, or after lectures to test their knowledge:

“Every lecture could have a VR element. You could, you wouldn’t say VR-ise the curricula, but you could definitely integrate a lot of what we’re learning already into VR” (FG2).

Others perceived that VR could serve as a refresher on previously acquired knowledge and skills. This was believed to help students prepare for their clinical placements:

“In practicals, we do the skills once and we don’t always get the opportunity to do them that much in clinical practice. You forget the skill a little bit when the time comes around for you to be doing it in clinical practice. Booster lessons with VR on certain skills would be very beneficial” (FG4).

**Contextual transfer**

Using VR to visualize the human body (e.g., cardiovascular system) and learn about different physiological processes (e.g., digestion) were discussed in all the interviews:

“VR will be really nice in anatomy lectures. Have a hologram and everybody can put the VR goggles on while the lecturer is delivering the lecture, you can go and dissect or touch the organs…you can with gloves [VR controllers] feel the heart or the shape of the liver” (I1).

VR was perceived to “enhance kinetic learning and skills acquire during practical labs” (FG2). All participants stated that various nursing skills can be acquired using VR including aseptic techniques; wound dressing; pressure sore care; intravenous cannulation; vital sign measurement; suturing; administering injections; catheterization; physical assessment; medications administration; stoma care; and nasogastric tube insertion. VR was also perceived to enhance decision-making skills, particularly while responding to patient deterioration and in “emergency settings like a cardiac arrest” (I2):

“If you were able to go into it [VR] and interact with a patient and if there was a random mode and their vitals change and you need to recognize them. So, you’re kept on your toes” (FG5).
Participants believed that VR can be used for nursing students to “put themselves in patients’ shoes” (I1). Examples were given on how VR can help visualize how “patients with dementia feel while being fed, or how a patient lying on a trolley feels” (I1):

“You see nurses who have been working on a ward for 15 plus years and they’re a bit more curt with people. It might be nice for them to go back to VR and be reminded of what patients are going through…grow their empathy back a small bit…if it was something where people just had their peripheral vision…or even trying to make a cup of tea when you have Parkinson’s or arthritis…you just have to go through it and see how tough it is for patients” (FG1).

**Challenges and threats to actualization**

Concerns regarding the resources incurred by VR related to the “cost of purchasing and maintaining VR headsets” (I2), whereby “getting five or 10 of them [VR headset] isn’t that easy” (FG5) as well as not having “enough resources to convert text and PowerPoint into VR” (FG2). These challenges were perceived to lead to inequities:

“If there wasn’t enough VR sets for everyone to do it at the same time, students would fall behind because they mightn’t do it, say they could do it four days after another person has done it. So, the first people would have four days of learning while the other person would be just sitting and waiting” (FG4).

While some participants recommended using VR to promote empathy, others believed that VR can be “antisocial and isolating” (FG4) and would impact negatively on human interactions and “core nursing values, caring and compassion” (FG1):

“Nursing for me is one-to-one. I need to interact with people, I need to see people’s faces, their eyes, their expressions. Even if you want to check the temperature or a person’s skin integrity, you have to touch their skin or body…It’s [VR] not for me” (I1).

Potential lack of in-person feedback was perceived as another threat posed by VR:

“You might want to ask a question in a lecture if you don’t understand completely what is in the slides. But I think with VR, you wouldn’t have the opportunity to ask a question” (FG4).
Sight problems, vertigo, dizziness, motion sickness, and risk for injury were perceived to limit the use of VR:

“You warn of motion sickness and some people would be more prone to that, so it [VR] excludes anybody who has a light stomach. And then are you excluding them from extra learning because they have motion sickness? I think the big thing also is safety…if we did do something, like panicked…you might hurt yourself by reacting since senses are shut off somewhat…cleanliness also, if there’s multiple students using it…” (FG5).

Some participants believed that being inherently uninterested in VR would cause students to become distracted and disengaged:

“When you’re in college…everyone around you is writing notes and the lecturer is looking at you, whereas when you’re at home, you’d have it [VR headset] on, you could be falling asleep and nobody would know…some people are more enthusiastic and more willing to use it, whereas others would have a negative attitude towards it” (I2).

Age was identified as another challenge to using VR, whereby “younger generations are so open to experimenting with new technologies” (I1) whereas older students might not be interested in new technologies.

Participants proposed several approaches to address the challenges surrounding VR use. Some perceived that VR “might work better in a master’s degree because in undergraduate degrees, there’s hundreds of students” (I2). When used in undergraduate education, participants proposed using VR in small tutorial groups rather than during lectures and recommended a system which allows them to “rent out VR for 10 minutes” (FG3):

“Have one or two [VR headsets] in the library to come down and practice…if they were installed in the IT lab or into one of the private rooms off the library, it would be a really good facility and resource for people” (FG5).

The need for continuous feedback was iterated on several occasions to prepare students to use VR, assist them during VR, and/or debrief them following VR:

“Like the way the VR we did for this study [E-MAT] was talking to us, if you did something wrong, it would stop you and tell you that you’ve done something wrong and explain it to you and then you could go and do it again” (FG4).
2.4 Discussion

This study explored nursing students’ views of using VR in healthcare delivery and nursing following exposure to a brief intervention aimed to promote men’s awareness of testicular diseases.

2.4.1 Virtual reality in healthcare delivery

Overall, participants reported positive experiences and emphasized 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 “visualizing” were nurses’ preferred learning styles.

The VR technology was also described 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 2] 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 randomized 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 randomized 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 multicenter randomized 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 maneuvering 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 familiarize 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 hindsight, 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 characterized by ocular (i.e.,
eyestrain, 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.

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). Learning about insulin injections was one of the examples given by our participants to enhance self-management of diabetes. In their clinical trial, Ebrahimpour et al. (2015) found that, in comparison to usual care, an interactive computer game significantly decreased behavioral 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).
2.4.2 Virtual reality in nursing education

In terms on using VR in nursing education, findings highlight the captivating, innovative, and empowering nature of VR and the various contexts where VR can be used as well as the challenges to using VR and ways to overcome them. Several positive features of VR were highlighted. In keeping with emerging research (Benham-Hutchins & Lall, 2015; Smith & Hamilton, 2015; Thompson et al., 2020), current study participants identified the engaging and novel nature of VR, which in their view increased their motivation and made learning more interesting. Similar findings were evident in a recent systematic review which found that VR provided a rich, interactive, and engaging educational context that supported experiential learning-by-doing (Fealy et al., 2019). VR can enhance the link between theory and practice for students, through repeated exposure to content and related clinical skills (Jenson and Forsyth, 2012). Similarly, current study participants reported that VR would potentially support knowledge retention and skill acquisition.

Consistent with recent research (Thompson et al., 2020), this study highlighted that VR could facilitate the consolidation of pre-acquired information and skills. Notable recommendations included using VR before lectures, between lectures and practical sessions, or after lectures to test knowledge. Others perceived that VR could serve as a refresher on previously acquired knowledge. Participants also considered VR as an important means to promote equity among students by delivering the same information through the same medium, especially when exposure to certain clinical experiences is limited and intermittent. In keeping with earlier research (Benham-Hutchins & Lall, 2015), current study participants believed that VR could help increase students’ confidence by providing them with a safe environment, which allows for trial and error, an opportunity not afforded with real patients.

The present study also highlighted that VR could accommodate diverse learning styles and provide individualized teaching and learning experiences. Underpinned by the Felder-Silverman Model (Felder & Spurlin, 2005), Mangold et al. (2018) advocated for educational approaches in various formats to meet the needs of individual nurses in an ever-changing healthcare environment. The results indicated that ‘sensing’ and ‘visual’ were the preferred learning styles among nurses regardless of gender, age, or experience.
Consistent with emerging research (Benham-Hutchins & Lall, 2015; Smith & Hamilton, 2015), current study participants indicated that VR sessions could be used to complement the learning that occurs in the skills lab and during lectures. However, in accordance with Benham-Hutchins and Lall’s (2015) findings, students believed that while VR would augment clinical skills training, it would not necessarily replace actual clinical practice. Nonetheless, our participants endorsed the use of VR simulation as a supplemental tool for teaching a range of psychomotor skills. It is the view of Benham-Hutchins and Lall (2015) that the potential benefits of VR for clinical skill acquisition and critical incident simulation allows students more practice time compared to traditional simulation methods.

A recurring theme related to using VR to supplement the teaching of complex anatomical structures and physiological processes. In keeping with earlier research, which focused on the use of 3D models to teach anatomy to medical students (Pujol et al., 2016), being afforded the opportunity to visualize anatomical models, structures, and processes was seen to be particularly valuable to nursing students in the current study. Students perceived VR to enhance decision-making skills, particularly when responding to patient deterioration and emergency settings such as cardiac arrest. Consistent with these findings, Felszeghy et al.’s (2019) quasi-experimental study suggested that the games element of their course enhanced students’ problem-solving skills.

From the perspective of the affective domain, participants saw the potential use of VR to foster empathy and help nurses visualize situations from the perspective of patients. Ouzouni and Nakakis (2012) concluded from their exploratory qualitative study that the concept of empathy is multi-dimensional and involves emotional and cognitive responses from the nurse. Thus, using VR in teaching has the potential to enhance nurses’ ability to sense another person’s feelings, become aware of their significance, and react accordingly.

Participants voiced concerns regarding the resources incurred by VR, such as the cost of purchasing and maintaining VR headsets and having adequate resources to convert text and PowerPoint into VR. In the view of some participants, these challenges could lead to inequities. While some participants recommended using VR to promote empathy, others believed that VR could be antisocial and isolating and could negatively affect human interactions. Indeed, Dean et al. (2020) argued that the use of VR to teach nurses procedures is beneficial, but not if it replaces opportunities to learn from experienced educators on how to convey caring to patients.
A finding unique to this study related to the view that a lack of interest in VR would result in some students to become distracted and disengaged. Subsequently, participants highlighted the need for feedback while using VR. Some believed that problems such as motion sickness would limit the use of VR. However, Huygelier et al. (2019) in a self-reported questionnaire identified that motion sickness was minimal and had no association with exposure to immersive VR. Of note, motion sickness is associated with extreme VR gaming which involves ‘shooting’ and ‘falling down’ rather than using VR for educational purposes (Fernandes & Feiner, 2016).

Participants proposed several approaches to deal with the challenges surrounding VR use. They recommended using VR in small rather than large classes. Some perceived that VR would work better for postgraduate students, possibly due to the smaller numbers of students. When adopted in undergraduate education, participants proposed using VR in small tutorial groups rather than during lectures and recommended having a system in place, which would allow them to hire/use VR at their own leisure in the library/computer lab. The need for continuous feedback was iterated by participants on several occasions to prepare students to use VR, to assist them during VR, or debrief them following VR.

2.4.3 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 students who were interested in the VR technology volunteered to participate in this study. This could have skewed the study findings in favor of VR. In terms of data analysis, accidental alteration of the data could have occurred. However, this was accounted for by having two experienced authors cross-check and verify the analyzed data.

2.5 Conclusion

Nursing students reported several positive aspects of VR and recommended using this technology in various healthcare settings and educational contexts. Given the predominantly positive experiences identified in this study, the development and testing of future VR experiences is warranted in healthcare and nursing education. Future VR interventions
should continue to promote health and 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. In terms of nursing education, participants recommended embedding VR in nursing curricula. VR was perceived to help students acquire several psychomotor, decision-making, and problem-solving skills and to promote equity among students, especially when exposure to certain clinical experiences is limited. Participants, however, cautioned against replacing pre-existing teaching and learning approaches with VR. Instead, they recommended using VR as an additional/supplemental resource to consolidate learning.

Educators ought to consider the value of using VR across diverse nursing curricula and help address potential threats to actualization. Educators who are committed to adopting VR as a teaching and learning tool must address issues such as technology costs as well as space and training in VR use. The VR educational experience could be adapted and delivered on a standard desktop to reduce inequity for individuals who experience motions sickness.

Future research should be cognizant of actual and potential challenges associated with the VR technology. 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 key to familiarizing 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 maneuvering the handheld controllers and moving in the virtual space.
References


Chan, J. Y., Chan, T. K., Wong, M. P., Cheung, R. S., Yiu, K. K., & Tsoi, K. K. (2020). Effects of virtual reality on moods in community older adults: a multicenter randomized
controlled trial. *International Journal of Geriatric Psychiatry, 35*(8), 926-933. doi:10.1002/gps.5314


Appendix 1. Socio-Demographic Questionnaire

1. Age: _____________ years

2. Gender
   - Female
   - Male
   - Other (Please specify): ___________
   - Prefer not to say

3. Current occupation (Tick as many as applies to you)
   - Student
   - Employed (full-time)
   - Employed (part-time)
   - Other (please specify): ______________

4. What course are you in?
   - General Nursing
   - Children’s and General Integrated Nursing

5. Do you use a computer (Desktop, Laptop, or Tablet)?
   - Yes
   - No

6. How many hours per day, on average, do you use a computer? __________ hours

7. How often do you play video games?
   - Once a day
   - Several times a day
   - Don’t know about video games
   - Never

8. How many hours per day, on average, do you use the internet? ____________ hours

9. How much experience do you have with Virtual Reality?
   - Used once
   - Used several times
   - Use a lot
   - None

10. Do you suffer from motion sickness?
    - Rarely
    - Sometimes
    - Frequently
    - Never

<table>
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<tr>
<th>Items</th>
<th>Amount</th>
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<tr>
<td>Research Assistant - Hourly pay including tax</td>
<td>€686.26</td>
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<tr>
<td>Presenting findings (oral) from current project at Sigma's Virtual International Nursing Research Congress</td>
<td>€297.95</td>
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<tr>
<td>Transcription of qualitative interviews</td>
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<td>Consumables and supplies</td>
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<td>Gift vouchers for participants as a token of appreciation</td>
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<tr>
<td>Covidence online software to conduct the systematic review</td>
<td>€536.50</td>
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| Total available to spend                                           | €3,976.69 |
| Total amount spent to date                                         | €2,852.4  |
| Balance to be sent back to Sigma                                   | €1,124.29 |