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Research article

# Evaluating virtual reality communication training in nursing and medical education: A multi-country cross-sectional study

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ABSTRACT

*Introduction:* Virtual reality (VR) is increasingly used in health professions education due to its rapid advancement and proven effectiveness in simulating clinical scenarios. It enhances theoretical knowledge, practical skills, communication, and emotional intelligence in a safe and immersive environment. VR also shows potential to improve communication skills among nursing and medical students, though large-scale research in this area remains limited.
*Objective:* To evaluate VR communication training in nursing and medical education.
*Methods:* A cross-sectional feasibility, usability, and acceptability study was conducted from November 2024 to May 2025. Nursing and medical students were recruited from six universities in five European countries using purposive and snowball sampling. Participants engaged with a VR scenario simulating challenging communication then completed a 35-item electronic survey. This included sociodemographic questions, the System Usability Scale, VR Feasibility Scale, satisfaction questionnaire, and open-ended items. Quantitative data were analysed using descriptive and inferential statistics, and qualitative responses underwent content analysis.
*Results:* A total of 268 students participated. Most (70%) had never used VR for education. The VR scenario was well received, with a mean usability score of 78.46/100 and feasibility score of 86.44/100. Satisfaction was high (94%). Nine percent reported issues, mostly visual or technical. Usability scores were higher for students who had used VR for leisure (+3.49 points, $p = 0.019$) and lower for those who experienced symptoms including headache, eye strain, cybersickness, dizziness, emotional upset, and physical discomfort (−7.37 points, $p = 0.021$). VR was viewed as a useful, engaging supplement to traditional communication training. Participants valued the immersive, realistic design and structured guidance. They suggested expanding VR with more scenarios and feedback, while noting it should complement real-life practice.

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*Conclusions:* VR-based communication training is feasible, usable, and acceptable, offering a promising addition to traditional methods. Addressing technical and financial barriers is key to broader adoption in health education.

## 1. Introduction

Virtual reality (VR) is a computer-generated environment that immerses users in 3-dimentional spaces, enabling interaction with virtual objects and simulating real-world experiences (Hamad and Jia, 2022; Bargeri et al., 2023; Teixeira et al., 2024). VR technology can be accessed through various devices including smartphones, portable devices, headset displays, and computers (Bargeri et al., 2023). Headset-supported VR offers the most immersive experience with 360-degree views in room-scale environments, closely replicating real life (Antón-Sancho et al., 2024).

VR is one of the most rapidly growing technologies globally (Kardong-Edgren et al., 2019). It is projected that VR could deliver around €1.7 trillion boost to the global economy by 2030, including €265 billion boost to the global Gross Domestic Product by supporting education and training (PricewaterhouseCoopers, 2019). The rapid growth and adoption of VR has led to the development of user-friendly, wireless, light, and affordable devices (Saab et al., 2023).

The COVID-19 pandemic has led to a significant increase in the use of VR in health professions education (Saab et al., 2021). Indeed, a recent bibliometric analysis revealed a substantial increase in the number of publications on VR in health professions education, with the rate of published articles rising by 51.9% between 2019 and 2021 (Guo et al., 2024).

VR can simulate clinical environments and experiences, helping to overcome the limitations of traditional hands-on training methods (Antón-Sancho et al., 2024; Papapanou et al., 2022). Using VR in nursing and medical education improves the acquisition of theoretical knowledge and enhances professional practical skills through real-world simulations (Beketov et al., 2024; Jiang et al., 2022; Kim et al., 2024). In nursing education, VR offers students a highly realistic environment to develop various skills including the management of diverse diagnoses (Liu et al., 2023), psychomotor skills (Plotzky et al., 2021a), medication management (Rossler et al., 2021), intravenous injection (Kim et al., 2024), and health assessment (Bryant et al., 2015). Similarly, VR-based medical education enhances clinical decision-making, motor skills, and critical thinking, potentially improving patient safety and clinical outcomes (Radianti et al., 2020; Mao et al., 2021; Abedi and Abedi, 2020; Saab et al., 2024; Chen et al., 2020).

New nursing and medical graduates often face difficulties managing critical patients in high-stress situations, potentially leading to poor patient outcomes. This issue arises from limited clinical exposure and inadequate supervision, especially in high-risk settings, which can increase the risk of patient harm (Hainsworth et al., 2022; Raposo et al., 2023). VR simulation helps address this challenge by providing a safe environment where students can practice at their own pace, learn from their mistakes, and avoid real-world consequences; a benefit not typically available in clinical or traditional classroom settings (Radianti et al., 2020; Hill et al., 2023; Pottle, 2019).

While VR is considered a transformative tool in nursing and medical education, it also has notable drawbacks. The high cost of VR software development remains a significant barrier, particularly in resource-limited settings (Chen et al., 2020; Thomas, 2022). Additionally, technical issues such as system malfunctions and the need for specialised training can hinder effective implementation (Saab et al., 2023; Saab et al., 2021). User experience challenges, including visual discomfort and cybersickness, can detract from the learning experience (Lawson and Stanney, 2021). Moreover, the lack of standardisation across VR platforms complicates integration into various curricula (Lie et al., 2023). These factors highlight the need for careful planning and resource allocation when incorporating VR into nursing and medical education.

In line with Cognitive Load Theory, which emphasises the importance of managing learners' mental effort to optimise performance and retention, VR offers a powerful solution through its capacity for isolating and sequencing learning objectives (van Merriënboer and Sweller, 2010). One pedagogical strength of VR is its ability to support "learning one skill at a time," thereby reducing cognitive overload often experienced in high-pressure, real-world clinical settings (Fraser et al., 2012). In VR, health professions students can focus on specific competencies, such as delivering bad news or responding to emotional cues, without being simultaneously burdened by environmental stressors or competing demands. This gradual and structured skill acquisition aligns with best practices in health professions education and fosters deeper learning and confidence before transitioning to real clinical environments (Cook et al., 2011).

VR has the potential to enhance nursing and medical students' communication skills and emotional intelligence (Plotzky et al., 2021a; Casler et al., 2024). Virtual patients provide a safe, reproducible, and cost-effective environment for students to practice difficult conversations without risking patient harm (Jiang et al., 2022; Raposo et al., 2023). VR simulation improves communication skills and is comparable in effectiveness to traditional methods involving standardised patients (Collingwoode-Williams et al., 2024; Kang, 2024). VR also allows learners to repeat and self-assess their performance, enhancing self-reflection and empathy (Khodabakhshian et al., 2024).

While the use of VR in health professions education is growing, there remains a research gap regarding its acceptance and successful integration into existing training programmes, particularly from the student perspective. Several studies have explored the technical and pedagogical potential of VR (Kyaw et al., 2019; Brown et al., 2022), yet few have focused on how students perceive its relevance, usability, and fit within established curricula. Moreover, current research on the use of VR in communication training such as delivering bad news or managing emotional responses remains limited with calls for more large-scale studies to refine VR design and integrate it effectively into nursing and medical curricula (Kang, 2024; Khodabakhshian et al., 2024). Addressing this gap not only highlights the importance of student-centred evaluations but also supports the inclusion of emotionally complex scenarios as a core objective of VR-based training interventions. Therefore, the overall aim of this study was to evaluate VR communication training in nursing and medical education. The study's specific objectives were to:

i. Evaluate the usability and acceptability of VR communication training in nursing and medical education.
ii. Assess the feasibility of VR communication training in nursing and medical education.
iii. Examine nursing and medical students' satisfaction with VR communication training.
iv. Explore nursing and medical students' overall experience of VR-based communication training.

## 2. Methods

### 2.1. Study design

This cross-sectional usability, feasibility, and acceptability study is the key output from a European project titled "Virtual Reality Communication Tool for Application and Evaluation with Key

Stakeholders (VR-TALKS)" (VR-TALKS, 2022). The overall project protocol and the needs assessment guiding the current study have been published elsewhere (Röwer et al., 2025; Skvortsova et al., 2025).

Usability, feasibility, and acceptability studies are essential for evaluating new technologies. Usability refers to the ease of use, user engagement, and overall programme use (Sandars, 2010; Brooke, 1996; Brooke, 2013); feasibility assesses whether an intervention can be implemented successfully (Saab et al., 2019); and acceptability evaluates users' satisfaction, intention to use, and perception of appropriateness (Zhong et al., 2023; Regan et al., 2024). The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) checklist was used to report this study (von Elm et al., 2008). The dataset for this study can be accessed at https://zenodo.org/records/17405402 (Saab, 2025).

### 2.2. Sample and setting

This study was conducted between November 2024 and May 2025, involving seven faculties from six major universities across five European countries: The Czech Republic, Germany, Ireland, Portugal, and The Netherlands. Participants were recruited from nursing and medical schools using purposive and snowball sampling. This involved asking participants to encourage their peers to participate. Eligible participants were: (i) nursing and medical students, (ii) aged ≥18 years; (iii) participating in an undergraduate or postgraduate/graduate degree; and (iv) attending courses that involve communication training.

To maintain participants' safety, students who suffer from severe motion sickness were not eligible to participate as VR can induce motion sickness, also referred to as cybersickness, which has been commonly associated with prolonged or intense gaming experiences (Fernandes and Feiner, 2016). Students with a history of motion sickness were informed of their ineligibility in the study information leaflet. The consent form also included an item asking participants to indicate whether they had a history of motion sickness. Those who responded "yes" would have been excluded, informed of their ineligibility, and thanked for their time and interest; however, no participants reported a history of motion sickness at the consent stage.

The study was advertised using presentations in the identified courses, flyers, posters in the classroom, and/or posters sent electronically to students. Posters and flyers included study details, researchers' contact information, and a quick response (QR) code/link that students could scan/click to provide their contact details and availability for data collection.

There is no consensus on the optimal sample size for usability, feasibility, and acceptability studies, although sample sizes as small as 20 participants have been recommended (Alroobaea and Mayhew, 2014; Cazañas et al., 2017; Faulkner, 2003). Increasing the sample size in such studies tends to decrease the variability in the proportion of identified usability issues (Cazañas et al., 2017). In addition to evaluating usability, feasibility, and acceptability, potential issues and adverse effects of VR were assessed. The study incorporated a quantitative measure of usability – the system usability scale (SUS) (Brooke, 1996) – which was factored into the sample size considerations (Saab et al., 2023; Bland, 2013; Sharma et al., 2020). For a desirable margin of error of ±2 points on the SUS, a total of 181 participants would be needed (Skvortsova et al., 2025), assuming it has a standard deviation of 13.7 points as in a previous study (Saab et al., 2023). For detecting adverse events, a total of 230 participants would be needed to have a power of 90% for detecting an event with prevalence of 1% and a power of 99% for an event with a prevalence of 2%, assuming a binominal distribution (Sandars, 2010). Thus, the plan was to recruit at least 230 participants.

### 2.3. Data collection

The research team, comprising senior academics, clinicians, communication specialists, and VR experts, iteratively developed two VR scenarios for delivering bad news to an avatar over a period of 10 months. The process began with joint discussions to select situations and define their educational purpose, including virtual patient characteristics. A professional screenwriter expanded the scenarios, ensuring realism and pedagogical value. Draft scripts were tested in an interactive text-based format via a custom-made web application, which enabled the research team to provide continuous feedback and refine the content.

The final English scenarios were produced in VR by a graphic designer and two information technology developers using motion capture (Movella Xsense Mo-cap suit with Reallusion software) to create avatars with realistic emotional responses. Following validation, the scenarios were translated and dubbed into Czech, German, Dutch, and Portuguese by the participating universities to ensure cultural and linguistic adaptability. The VR content was integrated into a Unity-based application optimised for Meta Quest headsets.

Scenario development followed the International Nursing Association for Clinical Simulation and Learning's Healthcare Simulation Standards of Best Practice (INACSL Standards Committee, 2021), namely Outcomes & Objectives, Simulation Design, and Prebriefing/ Preparation & Briefing. Facilitation principles guided scenario flow and learner orientation. Because the virtual patients emulate standardised patients, scenario development also aligned with the Association of Standardised Patient Educators Standards of Best Practice (Lewis et al., 2017), particularly in case development, emotional authenticity, and ensuring a safe learning environment.

The two resulting scenarios involved the delivery of bad news to an avatar. In Scenario A, participants informed the patient's husband about postponing his wife's planned hospital discharge. This scenario was underpinned by the NURSE (Name, Understand, Respect, Support, Explore) communication framework (Childers et al., 2023). In Scenario B, participants communicated the cessation of the patient's current curative cancer treatment using the SPIKES (Setting, Patient's perception, Invitation, Knowledge, Exploring/empathy, Strategy/summary) protocol for delivering bad news (Baile et al., 2000). More details of the two scenarios can be found in Supplementary Table S1 and screenshots from the two scenarios are presented in Fig. 1.

To standardise recruitment and data collection across the six universities, the research team developed two detailed training manuals: one outlining VR software and hardware requirements, and another detailing study procedures, participant pre-briefing and debriefing guidelines, and a QR code linking to the online survey. Pre-briefing, data collection, and debriefing were conducted on campus by dedicated researchers or trained educators (hereafter referred to as 'data collectors'), either with individual students or with groups of students. The choice of conducting individual versus group data collection was left entirely to the participating universities, in accordance with logistical and local needs.

Participants first reviewed the study information leaflet and provided written informed consent. They were assured that their participation would not be used to formally evaluate their performance. Data collectors then conducted a 20-minute pre-briefing session. This involved promoting psychological safety by fostering a friendly, supportive environment that encouraged questions, idea sharing, and open discussion without judgment. Participants were oriented to the room where data collection took place and introduced to the VR technology that would be used during the session. The VR experience was entirely stationary, with participants remaining seated throughout, and the tasks did not require the use of controllers. Consequently, no prior training in the use of VR technology was deemed necessary.

During pre-briefing, participants were presented with a fictional contract explaining that VR simulations are designed to develop skills, including judgment and reasoning, in preparation for real patient care. Although the realism of the simulated environment may vary and it cannot fully replicate real life, participants were encouraged to adopt

**Fig. 1.** Screenshots from Scenario A (left) and Scenario B (right)

the professional behaviour of a healthcare professional interacting with a real person. Participants then received verbal and written briefs of the two VR scenarios, including the NURSE and SPIKES communication frameworks (Supplementary Table S1), and were asked to choose one. In the two German universities, however, educators selected the scenario a priori to align with learning outcomes and local needs, with one university using Scenario A and the other using Scenario B.

Data were collected immediately following pre-briefing. When data were collected in groups, headphones were used alongside VR headsets to minimise disruptions and prevent students from overhearing one another. Data collectors powered on the VR headset and selected the VR scenario and language. They were always available for troubleshooting. Participants engaged with the scenario twice. During the first run, a virtual assistant provided prompts to guide their responses to the avatar. The second run was unguided, allowing participants to communicate freely with the avatar. The avatar's reactions, whether positive or negative, were based on participants' questions and responses. Artificial intelligence (AI) enabled the avatar to respond appropriately to inquiries, helping ensure a realistic experience. Each scenario took approximately 10 min to complete. Data collectors kept a record of any participants who ended the VR experience early, along with their reasons for doing so.

Immediately following the scenario, participants took part in a 15-minute debriefing session facilitated by the data collector. Debriefing was conducted using the 3D Model of Debriefing – Defusing, Discovering, and Deepening – a structured framework designed to enhance learning from simulation (Zigmont et al., 2011). The process began with 'Defusing,' where participants were asked to reflect on their emotional reactions and experiences following the VR scenario. This was followed by 'Discovering,' where participants analysed their actions, decisions, and thought processes while delivering the bad news to the avatar. Finally, during the 'Deepening' phase, participants consolidated insights from the VR experience and explored how these could be applied to real-world clinical practice, ensuring the simulation translated into meaningful learning outcomes. They were encouraged to record these insights in the designated section of the subsequent survey.

After debriefing, participants scanned a QR code to complete an online survey and then received a nominal gift voucher as a token of appreciation. Vouchers were provided by five of the six participating universities, in line with local policies and procedures.

### 2.4. Instruments

Participants completed a 35-item electronic survey comprising a sociodemographic questionnaire (Saab et al., 2023; Saab et al., 2021; Saab et al., 2022), the SUS (Brooke, 1996; Brooke, 2013), the VR feasibility scale (Saab et al., 2024; Saab et al., 2019), the satisfaction questionnaire (Saab et al., 2023; Saab et al., 2024), and open-ended questions (Saab et al., 2023; Saab et al., 2024; Coe and Scacco, 2017).

#### 2.4.1. Sociodemographic questionnaire

The 10-item sociodemographic questionnaire included questions about participants' age, gender, country of study, programme of study, degree type, the VR scenario they engaged with, previous VR experience (both for leisure and educational purposes), and any issues/adverse events encountered during VR testing (Saab et al., 2023; Saab et al., 2021; Saab et al., 2022). An additional item was included for participants who reported experiencing issues while using VR.

#### 2.4.2. System usability scale

The 10-item SUS is freely available for non-commercial research use (Brooke, 1996). It is used to measure the usability of a new technology (Brooke, 1996; Brooke, 2013). Each item is scored on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." To minimise response bias, the direction is alternated in each item. The odd numbered items (1, 3, 5, 7, and 9) are worded positively (i.e., favouring VR) and are scored from 0 ("strongly disagree") to 4 ("strongly agree"). The even numbered items (2, 4, 6, 8, and 10) are worded negatively (i.e., not favouring VR) and are scored from 4 ("strongly disagree") to 0 ("strongly agree").

The total SUS score is scored from 0 to 100 by taking the sum of these 10 items and multiplying it by 2.5. The SUS scores can be categorised and interpreted in a number of ways as indicated in Supplementary Table S2, including the Grade (A+ to F), typical percentile range, a narrative description ("best imaginable", "excellent", "good", "ok", "poor", "worst imaginable"), acceptability ("acceptable", "marginal", "not acceptable"), and their likely corresponding value on the Net Promoter Score ("promoter", "passive", "detractor") (Sauro, 2018). Cronbach's alpha was 0.68 (95% CI: 0.60–0.75), indicating acceptable reliability.

#### 2.4.3. Virtual reality feasibility scale

The 10-item VR feasibility scale, developed and validated by the study authors (Saab et al., 2024; Saab et al., 2019), assessed the clarity, appropriateness, and effectiveness of the VR scenario in teaching communication skills. This scale also covered the scenario's content, language, instructions, visual design, and applicability across different healthcare professions and educational levels. The items also assessed the VR scenario's relevance to real-life situations, its perceived effectiveness in teaching difficult communication skills, and the perceived learning value for participants.

Each item is scored on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." To minimise response bias, the direction was changed for the first item. The VR feasibility scale was scored using the same approach as the SUS, resulting in a range between 0 and 100. In brief, the first item was given a reversed scoring from 4 ("strongly disagree") to 0 ("strongly agree"), and the remaining nine items were scored from 0 ("strongly disagree") to 4 ("strongly agree"). The total score was then multiplied by 2.5 to give a range out of 100. Cronbach's alpha was 0.76 (95% CI: 0.66–0.87), indicating acceptable reliability.

#### 2.4.4. Satisfaction questionnaire

Participants' level of satisfaction with using VR to learn about communication and the overall quality of the VR scenario was measured using two 5-point Likert scale questions ranging from "extremely dissatisfied" to "extremely satisfied" (Saab et al., 2019).

#### 2.4.5. Open-ended questions

Three open-ended questions explored the elements of the VR scenario participants enjoyed the most, the elements of the VR scenario they enjoyed the least, and recommendations to integrate the VR scenarios into future education. Participants were asked to write their responses to these questions in the language they were most comfortable with.

### 2.5. Data analysis

Several quality control measures were used to ensure accurate data entry and analysis, maintain data integrity, and minimise missing data. The online survey was administered via Qualtrics and configured to prevent participants from skipping questions, thereby eliminating the submission of incomplete responses. To further minimise missing data, a 'prefer not to say' option was included for sensitive sociodemographic questions. To avoid conflicting results, the question on what symptoms participants experienced was set to be automatically skipped if they selected that they experienced no issues in the previous question. Moreover, prior to data collection, the research team conducted a series of pilot tests, completing the survey as participants, to identify any inaccuracies. These pilot responses were subsequently identified and removed from the dataset before data analysis commenced.

Statistical analyses were conducted in R (version 4.4.2) using code to ensure transparency and reproducibility (*R: The R Project for Statistical Computing [Internet]*, 2026). Confidence intervals (CIs) were calculated at a 95% significance level and *p*-values were two tailed. To illustrate statistical uncertainty for descriptive statistics, a Wald CI was calculated for mean scale scores (SUS and VR feasibility scale), and a Wilson CI (using "DescTools" package version 0.99.60) (Signorell et al., 2025) was calculated for the prevalence of reported issues.

Eight potential confounding variables were selected for multivariable analysis: gender (male vs female); area of study (nursing vs medicine); VR scenario chosen (Scenario A vs Scenario B); degree type (undergraduate vs postgraduate); previous use of VR for leisure; previous use of VR for education; issues reported due to VR quality; and symptoms experienced while using VR. Logistic regression and Analysis of Variance were used to assess if these eight selected variables were statistically significantly associated with reporting issues for the VR. All main model assumptions were tested using the R package "performance" (version 0.13.0) (Lüdecke et al., 2021) and were adjusted accordingly (Supplementary Fig. S1), and Heteroscedasticity-Consistent (HC3) standard errors were generated using the R package "parameters" (version: 0.24.2) (Lüdecke et al., 2020). Cronbach's alpha was used to assess reliability of the SUS and VR feasibility scale with a score of 0.70 or more considered acceptable (Tavakol and Dennick, 2011). The 95% CIs for Cronbach's alpha was calculated using the R package "boot" (version: 1.3-31) (Canty et al., 2024; Davison and Hinkley, 1997).

Responses to the open-ended questions were analysed using both, inductive and deductive content analysis (Elo and Kyngäs, 2008). These responses were translated to English by the respective universities and preliminarily coded, supported by a purposely developed coding sheet. Codes were then cross-checked for accuracy by the lead investigators. Similar codes were collapsed and grouped into generic categories which were then organised into three pre-determined main categories, namely: positive aspects of the VR scenarios, challenges in engaging with the VR scenarios, and perspectives on integrating VR scenarios into nursing and medical education. To enhance data credibility and confirmability, one author conducted qualitative data analysis, which was then cross-checked by a second author.

Given the large sample size, quantitative content analysis was also used to analyse data from the three open-ended questions. This involved systematically categorising and recording textual material so that they can be analysed and presented using frequencies (Coe and Scacco, 2017). Lists of one or more codes were generated for each participant response to each of the three open-ended questions using consistent formatting. R was then used to count the number of individual codes.

### 2.6. Ethical approval

All participants were required to provide written informed consent. Ethical approval in Ireland was granted by the Social Research Ethics Committee at University College Cork in May 2024 (Log: 2024-062), with an amendment approved in August 2024 (Log: 2024-062A1). In Portugal, the study was conducted in accordance with the ethical principles outlined in the original approval granted by the same committee (Log: 2024-062). In Germany, ethical approval was obtained from two institutions: the Ethics Committee at Hannover Medical School in November 2023 (No. 11160_BO_K_2023), with an amendment approved in December 2024, and the Local Research Ethics Committee of the Medical Faculty at Ludwig-Maximilians-University Munich (No. 24-0971), approved on December 11, 2024, with an amendment on January 27, 2025. In the Czech Republic, approval for the First Faculty of Medicine, Charles University in Prague, was granted on August 22, 2024 (Reference No. 128/24 S-IV Grant), and for the Second Faculty of Medicine, Charles University in Prague, on August 7, 2024 (Reference No. EK-523/24). In the Netherlands, the study received ethical approval from the local research ethics committee in May 2024 (CEP, Institute of Psychology, Leiden University; Reference No. 2024-05-27-A.Skvortsova-V1-5500).

## 3. Results

### 3.1. Sample characteristics

Of a 230-target sample size, a total of 268 students were recruited, giving additional statistical power to the findings (93% power for a one in a hundred adverse events). Most participants were medical students ($n = 192$, 72%), female ($n = 199$, 74%), and aged between 21 and 25 years ($n = 150$, 56%). Around half of the participants ($n = 133$, 50%) engaged with Scenario A, and the remaining half ($n = 135$, 50%) with Scenario B. Prior experience with VR was low, with only 153 (57%) and 80 (30%) participants reporting ever using VR for leisure or for education respectively. Only 24 participants (9%) reported experiencing an issue while engaging with VR. None of these participants ended their participation early. The most common issues were technical issues ($n = 12$, 4%) and blurred vision ($n = 10$, 4%). The prevalence of quality issues (i.e., technical issues, blurred vision, and lack of realism) was 7% (95% CI: 5%–11%) and the prevalence of symptoms (i.e., headache, eye strain, nausea/motion sickness, dizziness, emotional upset, and physical discomfort) was 5% (95% CI: 3%–8%). The full sample characteristics are presented in Table 1.

### 3.2. Usability and acceptability

The mean SUS score was 78.46 (95%CI: 77.06–79.86) with a standard deviation of 11.66. The median and interquartile range were 80 (72.5–87.5). Of the participants, 202 (75%; 95% CI: 70%–80%) found it "acceptable", 59 (22%; 95% CI: 17%–27%) were in the "marginal"

**Table 1**
Demographic characteristics of study participants ($N = 268$).

| Variable | Response | Number (%) |
|---|---|---|
| Age[a] (years) | 18–20 | 39 (15%) |
| | 21–25 | 150 (56%) |
| | 26–30 | 42 (16%) |
| | 31–35 | 19 (7%) |
| | ≥36 | 16 (6%) |
| Gender | Female | 199 (74%) |
| | Male | 65 (24%) |
| | Non-binary | 1 (<1%) |
| | Trans male | 1 (<1%) |
| | Prefer not to say | 2 (1%) |
| Country | Czech Republic | 90 (34%) |
| | Germany | 63 (24%) |
| | Ireland | 44 (16%) |
| | The Netherlands | 37 (14%) |
| | Portugal | 34 (13%) |
| Area of study | Medicine | 192 (72%) |
| | Nursing | 76 (28%) |
| Degree type | Undergraduate | 218 (81%) |
| | Postgraduate | 50 (19%) |
| Chosen scenario | Scenario A (Mr. Steward: NURSE) | 133 (50%) |
| | Scenario B (Mrs. Ibrahim: SPIKES) | 135 (50%) |
| Experience of virtual reality for leisure | None | 115 (43%) |
| | Used once | 96 (36%) |
| | Used several times | 52 (19%) |
| | Used a lot | 5 (2%) |
| Experience of virtual reality for education | None | 188 (70%) |
| | Used once | 58 (22%) |
| | Used several times | 15 (6%) |
| | Used a lot | 7 (3%) |
| Issues with the virtual reality scenario | Yes | 24 (9%) |
| | No | 244 (91%) |
| Issues reported[b] | Technical issues | 12 (4%) |
| | Blurred vision | 10 (4%) |
| | Headache | 4 (1%) |
| | Eye strain | 4 (1%) |
| | Nausea/motion sickness | 3 (1%) |
| | Dizziness | 3 (1%) |
| | Lack of realism | 3 (1%) |
| | Emotional upset | 2 (1%) |
| | Physical discomfort | 1 (<1%) |

[a] Missing for two participants.
[b] Relates to 24 participants who reported issues. Participants could select more than one issue.

group, and 7 (3%; 95% CI: 1%–5%) found it "not acceptable." There were 144 (54%; 95% CI: 48%–60%) participants who were likely to promote VR, 97 (36%; 95% CI: 31%–42%) who were likely to be passive about it, and 27 (10%; 95% CI: 7%–14%) who would detract from it. The SUS scores are presented in Table 2 and responses for individual SUS items are provided in Supplementary Table S3.

### 3.3. Feasibility

The mean score for the 10-item VR feasibility scale was 86.44 (95% CI: 85.12–87.75) with a standard deviation of 10.96 and a median and interquartile range of 87.5 (81.88–95). Responses for individual VR feasibility scale items are provided in Supplementary Table S4.

### 3.4. Satisfaction

Overall satisfaction was high, with 94% of participants (95% CI: 91%–97%) reporting satisfaction with using VR to learn about communication, and 92% (95% CI: 88%–95%) reporting satisfaction with the overall quality of the VR scenario (Supplementary Table S5).

### 3.5. Multivariable analysis

None of the confounding variables were significantly associated with whether participants experienced issues during the VR session, and the overall regression model was not statistically significant ($p = 0.468$). The SUS and VR feasibility scores for each of the confounding variables are presented in Supplementary Table S6.

The SUS score was significantly higher among participants who had previously used VR for leisure (+3.32, $p = 0.021$), and significantly lower among those who experienced symptoms during the session (−9.31; $p = 0.003$). These associations remained significant after adjusting for potential confounders (Table 3), with an adjusted increase of 3.49 points (95% CI: 0.58–6.39; $p = 0.019$) for prior leisure use, and a decrease of 7.37 points (95% CI: −1.14 to −13.60; $p = 0.021$) for those who experienced symptoms.

For the VR feasibility scale, nursing students had significantly higher scores as compared to medical students (+3.87; $p = 0.007$), while participants who had previously used VR for educational purposes had significantly lower scores (−4.38; $p = 0.010$). These associations were no longer statistically significant after adjustment (Table 3), with an increase of 3.08 points (95% CI: −0.10 to 6.25; $p = 0.057$) for nursing students, and a decrease of 3.49 points (95% CI: −7.04 to 0.07; $p = 0.054$) for prior educational use.

### 3.6. Open-ended questions

A total of 1297 codes were generated. The main categories, generic categories, and summary and frequency of codes are presented in Table 4.

#### 3.6.1. Positive aspects of the virtual reality scenarios

The VR scenarios were described as highly immersive and emotionally realistic: "*I really got immersed when Mr Stewart* [Scenario A] *was standing up and making use of hand gestures when speaking. It really demonstrated his emotion with the situation*" (Ireland_44). One participant emphasised: "*The way the environment simulates a real-world clinical situation, including the patient's tones of voice, facial expressions, and*

**Table 2**
System usability scale scores.

| System usability scale score | Grade | Typical percentile range of scores | Verbal description of score | Acceptability of score | Typical net promoter score | Number (%) |
|---|---|---|---|---|---|---|
| 84.1–100 | A+ | 96–100 | Best Imaginable | Acceptable | Promoter | 97 (36%) |
| 80.8–84.0 | A | 90–95 | Excellent | Acceptable | Promoter | 29 (11%) |
| 78.9–80.7 | A− | 85–89 | – | Acceptable | Promoter | 18 (7%) |
| 77.2–78.8 | B+ | 80–84 | – | Acceptable | Passive | 23 (9%) |
| 74.1–77.1 | B | 70–79 | – | Acceptable | Passive | 21 (8%) |
| 72.6–74.0 | B− | 65–69 | – | Acceptable | Passive | 0 |
| 71.1–72.5 | C+ | 60–64 | Good | Acceptable | Passive | 14 (5%) |
| 65.0–71.0 | C | 41–59 | – | Marginal | Passive | 39 (15%) |
| 62.7–64.9 | C− | 35–40 | – | Marginal | Passive | 0 |
| 51.7–62.6 | D | 15–34 | OK | Marginal | Detractor | 20 (7%) |
| 25.1–51.6 | F | 2–14 | Poor | Not Acceptable | Detractor | 7 (3%) |
| 0–25 | F | 0–1.9 | Worst Imaginable | Not Acceptable | Detractor | 0 |

**Table 3**
Association between two outcomes and descriptive variables including univariable and multivariable analysis ($N = 264$[a]).

| SUS score | Unadjusted mean difference (95% CI) | *p*-Value | Adjusted[b] mean difference (95% CI) | *p*-Value |
|---|---|---|---|---|
| Gender: Male (vs. Female) | 1.04 (−2.02, 4.11) | 0.503 | 0.64 (−2.87, 4.14) | 0.720 |
| Study: Nursing (vs. medicine) | −0.73 (−4.01, 2.56) | 0.664 | −1.12 (−4.67, 2.43) | 0.536 |
| Scenario: Nora (vs. Steward) | −1.63 (−4.43, 1.18) | 0.254 | −1.74 (−4.83, 1.35) | 0.268 |
| Postgraduate: Yes (vs. No) | 0.28 (−3.44, 4.01) | 0.881 | 0.60 (−3.12, 4.31) | 0.752 |
| VR for leisure: Yes (vs. No) | **3.32 (0.51, 6.13)** | **0.021** | **3.49 (0.58, 6.39)** | **0.019** |
| VR for education: Yes (vs. No) | −1.04 (−4.24, 2.15) | 0.520 | −2.26 (−5.76, 1.24) | 0.205 |
| Issues (quality only) | −5.28 (−11.37, 0.80) | 0.088 | −2.13 (−7.75, 3.48) | 0.455 |
| Issues (symptoms only) | **−9.31 (−15.49, −3.12)** | **0.003** | **−7.37 (−13.60, −1.14)** | **0.021** |

| Feasibility scale score | Unadjusted mean difference (95% CI) | *p*-Value | Adjusted[c] mean difference (95% CI) | *p*-Value |
|---|---|---|---|---|
| Gender: Male (vs. Female) | −1.81 (−4.53, 0.92) | 0.193 | −0.57 (−3.75, 2.61) | 0.724 |
| Study: Nursing (vs. medicine) | **3.87 (1.07, 6.67)** | **0.007** | 3.08 (−0.10, 6.25) | 0.057 |
| Scenario: Nora (vs. Steward) | −2.27 (−4.93, 0.39) | 0.094 | −1.41 (−4.31, 1.5) | 0.341 |
| Postgraduate: Yes (vs. No) | −2.09 (−5.57, 1.39) | 0.238 | −2.89 (−6.46, 0.67) | 0.111 |
| VR for leisure: Yes (vs. No) | −0.06 (−2.70, 2.59) | 0.967 | 1.22 (−1.32, 3.76) | 0.346 |
| VR for education: Yes (vs. No) | **−4.38 (−7.72, −1.05)** | **0.010** | −3.49 (−7.04, 0.07) | 0.054 |
| Issues (quality only) | −2.26 (−8.19, 3.67) | 0.453 | −2.43 (−9.81, 4.96) | 0.518 |
| Issues (symptoms only) | −0.75 (−5.98, 4.47) | 0.776 | 0.41 (−6.73, 7.55) | 0.910 |

CI: confidence interval; SUS: System Usability Scale; VR: virtual reality.
Bold in Table 3 designates statistically significant findings.
[a] This multivariable analysis includes 264 of the 268 participants (as 4 with different gender responses were not included given their responses were unclear or under representative).
[b] The adjusted model had an intercept value (estimated SUS score for someone with all the group 2 "reference" values) of 78.75 (95% CI: 75.43–82.07).
[c] The adjusted model had an intercept value (estimated feasibility scale score for someone with all the group 2 "reference" values) of 87.53 (95% CI: 84.69–90.36).

*reactions, creates an extremely effective learning environment*" (Portugal_9).

Step-by-step guidance and immediate practice were valued: "*It was good how you got a step-by-step tutorial, which you could then apply directly, and important things were always repeated*" (Germany_H12). Others highlighted the clarity of communication strategies, describing the VR scenario as an "*interactive and practical learning opportunity*" (Ireland_4).

Participants valued practicing communication in realistic, emotionally complex scenarios: "*A clear, structured way to conduct a bad news conversation*" (Netherlands_30) and "*forces us to develop communication in a challenging and complex context*" (Portugal_15).

Unique features such as detailed visual design and immersion stood out: "*I liked the way the office setting was thought out in detail, in order to become a welcoming place*" (Portugal_33), and "*the 360-degree view pulled you more into the scenario*" (Netherlands_4).

### 3.6.2. *Challenges in engaging with the virtual reality scenarios*

Some participants reported discomfort: "*Some of the visuals were*

**Table 4**
Qualitative and quantitative content analysis of responses to the open-ended questions.

| Main categories | Generic categories | Summary of codes | Number (%) of codes |
|---|---|---|---|
| Positive aspects of the virtual reality (VR) scenarios | Supportive learning environment | Structured, repeatable, and adaptive learning with clear guidance, safe practice space, and integration of communication frameworks. | 219 (82%) |
| | Authentic and realistic experience | Realistic and emotionally engaging scenarios with immersive visuals, responsive avatars, and a strong sense of presence and responsibility. | 159 (59%) |
| | Opportunity to practice communication skills | Opportunities for real-time, expressive communication using structured models, and emotionally challenging conversations. | 43 (16%) |
| | VR-specific features | High-quality visuals, immersive environments, smooth audio-visual flow. | 39 (15%) |
| Challenges in engaging with the VR scenarios | Logistical challenges | Technical and design issues affecting interaction flow, clarity, and scenario pacing. | 115 (43%) |
| | Barriers to communication | Limited dialogue flexibility, unnatural flow, and lack of non-verbal cues. | 110 (41%) |
| | Barriers to learning | Over-structured content, lack of feedback, cognitive overload, and limited scenario variety hindering engagement and learning. | 53 (20%) |
| | Lack of realism | Artificial scenarios, robotic avatars, scripted dialogue, and technical limitations reducing realism. | 42 (16%) |
| | Physical issues | Discomfort from headset use, visual/audio strain, and awareness of equipment disrupting immersion. | 39 (15%) |
| | Emotional issues | Anxiety and stress from sensitive topics, avatar appearance, and uncertainty in communication. | 37 (14%) |
| | None | No challenges. | 17 (6%) |
| Perspectives on integrating VR scenarios into nursing and medical education | Educational value | Reinforces theory through immersive practice, builds clinical skills, and supports reflective, repeatable learning. | 164 (61%) |
| | Future recommendations | Desire for broader scenario diversity, deeper emotional complexity, integration with other methods, and more realism and feedback. | 105 (39%) |
| | Benefits of VR | Strong support for VR as a flexible, confidence-building, and realistic learning tool. | 76 (28%) |

(*continued on next page*)

Table 4 (*continued*)

| Main categories | Generic categories | Summary of codes | Number (%) of codes |
|---|---|---|---|
| | Communication skills | Enhances communication in emotionally charged scenarios, offering a safe space for practice and skill development. | 65 (24%) |
| | Supplementary role | VR valued as a supplement, not a replacement—some prefer real-life interaction for emotional depth and spontaneity. | 13 (5%) |
| | No Interest | One participant expressed no interest in VR, with no further explanation. | 1 (<1%) |

VR: Virtual reality.

*slightly blurred as I couldn't wear my glasses, I had to strain to read*" (Ireland_3). Others mentioned "*nausea and dizziness*" (Ireland_42), and "*the VR also gave me a headache*" (Netherlands_30).

Emotional responses were common and often linked to the realism and intensity of the task. One participant wrote: "*I felt uncomfortable breaking the bad news to Nora* [Scenario B]" (Ireland_20). Others described the virtual characters as "*scary*" (Ireland_22), and "*intimidating*" (Netherlands_36). One participant noted the realism heightened their stress: "*I was a bit stressed, because it felt like a real situation*" (Czech Republic_47).

Technical issues disrupted the flow and realism of the scenario for some participants, primarily due to delays between participant input and the AI-generated avatar responses. One participant noted: "*Having to repeat myself when responding. I imagine it's just a small bug that could be fixed very easily*" (Ireland_1), while others wrote: "*It took a while for the microphone recordings to be analysed*" (Netherlands_25) and "*the wait until I was allowed to speak again took too long for me in some places*" (Germany_H3).

A few participants struggled with natural conversation: "*If you don't follow the script, the computer doesn't understand you*" (Ireland_10). One participant noted: "*It didn't matter much what I said, as the patient would respond the same way…There's no space to speak whenever you want*" (Netherlands_2) and another wrote: "*Sometimes the program misunderstood me, I felt I said something right, but the program was looking for something else*" (Czech Republic_86).

Some felt elements of the VR scenario lacked realism, disrupting authenticity: "*It's very rare we get to go into a private room with family members in real life*" (Ireland_30). Others found avatars' movements unnatural: "*The VR patient rarely blinks and keeps her eyes open while crying*" (Netherlands_23). The dialogue was also seen as artificial: "*The language felt very sterile…compared to a live-action scenario with actors, VR falls flat*" (Germany_M8).

Some found the structure limiting: "*It was somewhat spoon-fed, which made it easier*" (Netherlands_8), and "*more of an exercise in repeating after the tutor instead of really learning*" (Netherlands_23). Others wanted more personalised feedback: "*The feedback after the simulation could be more complete, with suggestions on how to improve some aspects of communication*" (Portugal_28).

#### *3.6.3. Perspectives on integrating virtual reality scenarios into nursing and medical education*

All but one participant supported VR integration, citing its engaging, realistic, and confidence-building qualities. One called it "*a really fun way to learn new things*" (Netherlands_17), while another valued its consistency: "*Not dependent how well a real person is acting*" (Germany_M24).

VR was widely recognised for bridging theory and real-world practice and preparing students for complex situations: "*VR can help to emphasise what we learn in theory and practical experiences… this solidifies my learning*" (Ireland_4). Many highlighted its interactive and immersive nature, with one participant describing VR as "*an interactive learning strategy… great to remember things*" (Netherlands_7).

Participants highlighted VR's value for practicing difficult conversations safely. One participant shared: "*It is a valuable tool to help get used to having difficult conversations… better to practice with a digital tool than be awkward and say the wrong things to a real patient*" (Ireland_31). Others described it as "*a very efficient way to learn communication in difficult situations*" (Netherlands_3).

Suggestions included expanding VR to cover more clinical settings, patient scenarios, and provide feedback. Ideas ranged from involving patients with intellectual disabilities, breastfeeding support, and decision-making. One participant proposed: "*Perhaps also to observe how things work on different hospital wards*" (Netherlands_26).

Some participants supported VR as a supplement, not a replacement, for real-life practice: "*It would help beginning healthcare students… but practicing with real people does seem more effective in the end*" (Netherlands_19). Others stressed the value of real-life spontaneity: "*I don't think VR can replace conversations with real people*" (Germany_H8).

## 4. Discussion

### *4.1. Summary of findings*

This study evaluated the feasibility, usability, acceptability, user satisfaction, and overall experience of VR-based communication training among 268 nursing and medical students from six universities in five European countries. Findings demonstrate the potential of VR as a communication training tool in nursing and medical education and align with existing literature, demonstrating VR's effectiveness in simulating real-world environments and enhancing students' engagement and communication skill development (Saab et al., 2023; Khodabakhshian et al., 2024; Saab et al., 2022). The recruitment of 268 participants across six universities in five European countries demonstrates the feasibility of implementing VR-based communication training on a large scale.

Emotional strain, particularly during bad news delivery, highlights the importance of structured pre-briefing and debriefing to support psychological safety (Zigmont et al., 2011; Cheng et al., 2017), which was built into the current study design. Indeed, the two VR scenarios in this study were based on the NURSE and SPIKES frameworks, both widely recognised as effective tools for teaching communication and delivering bad news (Childers et al., 2023; Baile et al., 2000). The capacity of VR to replicate these frameworks within immersive simulations provided the participants with a psychologically safe space to practice sensitive conversations without compromising patient care, a strength reported in previous studies (Teixeira et al., 2024; Meany et al., 2024; Foronda et al., 2020). The strong guidance provided in the guided version of each of the VR scenarios can be viewed as a form of scaffolding in the training of healthcare professionals, potentially enhancing the development of competencies (Masava et al., 2022). That said, some participants noted over-scripted interactions and a lack of dialogue flexibility, reducing the authenticity in communication. They expressed a need for more flexibility, personalised feedback, and greater variability in VR scenarios, echoing recommendations for adaptive, learner-responsive VR design (Padilha et al., 2019).

Technological features such as 360-degree views and high-quality visual design enhanced realism and increased participants' sense of immersion and engagement. This is consistent with literature indicating that presence in VR environments is closely linked to learning outcomes (Makransky and Lilleholt, 2018; Jensen and Konradsen, 2018). Participants also valued the realism provided by the avatars' non-verbal responses and tone of voice. The opportunity to practice emotionally challenging conversations within a structured, controlled environment was repeatedly mentioned as a benefit. This is in line with findings that VR simulations enhance emotional intelligence and clinical confidence (Kim and Kim, 2023). Additionally, in their feedback, participants reported that guided support from a virtual assistant followed by immediate practice enhanced VR's educational impact. Indeed, VR enables repeated scenario rehearsal, which offers a key advantage over traditional role-playing with standardised patients (Kyaw et al., 2019).

Issues were reported by 9% of participants, primarily involving visual discomfort and technical glitches. Technical challenges such as lag in avatar responses and occasional robotic behaviour disrupted the sense of realism, reflecting known limitations in VR implementation (Lioce et al., 2015). Notably, this 9% issue rate is lower than figures reported in the broader literature. For example, a recent scoping review of 69 studies found that cybersickness was mentioned in 14.5% of the included studies, and technical limitations were reported in over a third of studies (Mergen et al., 2024). Additionally, studies of digital eye strain in virtual learning environments have reported prevalence rates as high as 87.6% among nursing students (Huyhua-Gutierrez et al., 2023). The relatively low incidence of adverse events in the current study may be due to the iterative development and pre-testing of scenarios; the use of seated, stationary experiences to minimise physical strain; the presence of trained data collectors during testing at all times; and the deployment of up-to-date technology for data collection.

None of the potential confounding variables significantly predicted whether participants experienced issues during the VR session, suggesting that such reactions may be driven by individual susceptibility rather than demographic or experiential factors. This aligns with findings by Rebenitsch and Owen (Rebenitsch and Owen, 2016), who highlighted high variability in user responses to VR. Usability scores were higher among participants with prior leisure VR use and lower among those who experienced symptoms. These results reflect prior evidence that previous exposure to VR, especially for gaming, enhances comfort and perceived usability (Makransky et al., 2019), while negative physical responses such as cybersickness undermine the user experience (Weech et al., 2019).

### 4.2. Implications

Findings from this study have several important implications for nursing and medical education. The successful testing of VR-based communication training across six universities in five countries demonstrates its scalability and potential adaptability in various educational contexts. VR simulations offer a promising solution to a longstanding challenge: preparing students for emotionally complex conversations, such as delivering bad news. For instance, Saab et al. (Saab et al., 2025) recently identified poor communication by junior doctors around palliative care referral as a key barrier to early integration, emphasising the need for targeted training in such areas. Pedagogically, this study aligns with Kolb's Experiential Learning Model, which emphasises learning through a cyclical process involving four stages: concrete experience, reflective observation, abstract conceptualisation, and active experimentation (Kolb, 2015). In this study, participants engaged in concrete experiences by interacting with immersive, realistic VR scenarios simulating difficult clinical conversations. This was followed by structured debriefing sessions, enabling reflective observation on their performance and emotional responses. Participants then internalised communication strategies using either the NURSE or SPIKES frameworks, representing abstract conceptualisation. Finally, the opportunity to engage with guided then unguided scenarios and to apply feedback facilitated active experimentation, allowing learners to refine their skills in a safe, supportive environment.

Despite its promise, several barriers to using VR in communication training must be addressed to facilitate broader adoption (Plotzky et al., 2021b). Financial constraints, faculty development needs, and the challenge of curriculum integration remain significant obstacles. Technical limitations including avatar realism, hardware comfort, and system responsiveness also affect user experience and learning outcomes. Institutional investment in infrastructure, educator support, pedagogical adaptation, and assessment methodologies specific to VR-based learning will be essential for sustainable implementation (Lie et al., 2023).

Future research should evaluate the long-term impact of VR-based communication training on clinical performance and patient outcomes. Economic evaluations are also needed to assess cost-effectiveness and inform resource allocation. Expanding the use of VR to other healthcare professions, such as pharmacy, physiotherapy, and social work, as well as to additional universities and countries, may help demonstrate its broader utility. Incorporating AI could enhance the natural flow of scenarios and improve learner engagement through more responsive interactions with avatars. In addition, cultural and linguistic adaptations are crucial to ensure inclusivity and relevance for diverse learners. Finally, longitudinal studies are warranted to assess skill retention, confidence, and transfer to clinical practice over time.

### 4.3. Strengths and limitations

This study has several strengths, including the development, validation, and continuous refinement of bespoke VR scenarios, created and tested by an experienced, interdisciplinary team. Another notable strength is the sample size of 268 participants, as well as the study's broad scope which enhances the generalisability of study findings. Both qualitative and quantitative methods were used to collect and analyse data, providing a more comprehensive account of usability, feasibility, and acceptability. Additionally, the two training manuals developed in this study helped standardise the data collection process across all sites.

This study is not without limitations. In some universities, students may have known the data collector (e.g., an educator), potentially introducing social desirability bias. Most participants were first-time VR users, and all were recruited using non-probability sampling strategies, which increases the likelihood of more favourable results due to novelty bias and reduces the generalisability of findings. In addition, data collection was limited to six universities across five European countries. While the sample size can be considered representative of the target population in these six universities, this limits the generalisability of findings beyond the European context. Finally, it was not feasible to calculate a response rate due to slight variations in recruitment strategies across universities and the use of snowball sampling.

## 5. Conclusion

This multi-country study demonstrates that VR is a feasible, usable, and well-accepted tool for teaching difficult communication skills to nursing and medical students across diverse European settings. Participants reported high satisfaction. Strong usability and feasibility scores indicate that VR is accessible and effective for learners at various educational stages. The low rate of adverse events suggests that VR can be safely integrated into health professions education with appropriate support.

Findings from this study show that VR enables students to practice challenging conversations with virtual patients in a safe, realistic, and reproducible environment, fostering essential communication competencies. The opportunity for immediate feedback supports self-reflection, empathy and confidence, enhancing the overall educational value of VR. As an experiential, learner-centred approach, VR bridges theoretical knowledge with real-world practice, supporting clinicians' transition from novice to competent practitioners through reflective and immersive learning. The positive student reception and minimal negative effects highlight VR's potential for broader adoption in nursing and medical curricula. Nevertheless, challenges remain, including the need for ongoing technical support and solutions to financial and logistical barriers. Future research should evaluate the long-term impact of VR-based communication training on clinical performance and patient outcomes and explore scalable approaches for integrating VR into nursing and medical curricula. This has the potential to improve learners' communication skills while fostering more compassionate, safe, patient-centred care across diverse clinical contexts.

## CRediT authorship contribution statement

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

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