Clinical Simulation in Nursing 108 (2025) 101825

Contents lists available at ScienceDirect

Clinical Simulation in Nursing

journal homepage: www.elsevier.com/locate/ecns

Research Article

Enhancing empathy and understanding: Developing a virtual reality simulation to educate healthcare students on deaf patient experiences

J. Terry*, J. Davies, R. Wilks, T. Thomas, S. Vowles, J. Hunt, D. Rowberry, M. Nosek, I. Humphreys

Swansea University, Wales, UK

ARTICLE INFO

Keywords:
Deaf
Health professions
Immersive simulations
Simulation
Virtual reality

ABSTRACT

Background: Deaf patients face challenges in healthcare settings, with limited deaf awareness in health professional programs, due to a lack of training. Healthcare professional students lack preparation about how to communicate effectively with deaf people and may not understand or empathize with their experiences in healthcare settings. The aim of the study was to co-design and develop a 360-degree VR simulation, informed by deaf patient experiences, to enhance health professional students' empathy and understanding when working with deaf patients.

Sample: Study sample was comprised of a purposive sample of preregistration healthcare professional students (n = 8) enrolled in an undergraduate degree at one university in Wales, UK. Participants were recruited through email invitation to all students in one School of Health and Social Care.

Methods: A user-centered design approach was used across three phases: gathering feedback from deaf communities on healthcare experiences, design and development of an immersive 360-degree video VR, and evaluating it with health professional students (n = 8), through a pre/post survey and focus group. The survey was analyzed using descriptive statistics and the focus group transcript analyzed using thematic analysis.

Results: Positive feedback from participating students emphasized the benefits of the simulation and its engaging, impactful nature with a focus on lived experience.

Conclusion: Simulation education is an effective tool in preparing students for working with deaf patients and in enhancing empathy.

Introduction

Deaf individuals face significant barriers in accessing appropriate healthcare due to language and communication barriers, particularly for those who use sign language as their primary mode of communication. The term 'deaf patients' refers to people with hearing loss, including those who identify as culturally deaf and use sign language as their primary language, with a lower case 'd' used throughout. The limited availability of health resources in Sign Language exacerbates the challenges deaf individuals face in understanding essential health information, such as medical instructions, warnings, and educational materials. These linguistic barriers often lead to miscommunication and underdiagnosis (Shank & Foltz, 2019). Reports from SignHealth (2025), the British Deaf Association (2016) and Emond et al. (2015) emphasize the need for tailored health literacy programs to address these gaps and improve health outcomes for deaf individuals. In addition to language barriers, deaf patients frequently encounter physical and administrative obstacles when seeking timely and appropriate healthcare. Healthcare providers often lack awareness of deaf culture, and the accommodations needed to provide inclusive care. Many healthcare professionals are not trained in sign language and may be unaware of the importance of using qualified interpreters. Lip reading can be ineffective, is hard work, and is not always used by deaf people (Yet et al., 2022). These communication barriers, compounded by systemic issues such as inconsistent availability of interpreters (SignHealth, 2025), can damage health professional-patient relationships, erode trust, and lead to dissatisfaction with care. Moreover, the reliance on family members or friends for interpretation compromises both privacy and the accuracy of conveyed information, ultimately worsening health inequalities for the deaf community (Terry et al., 2021).

* Corresponding author:
E-mail address: j.terry@swansea.ac.uk (J. Terry).

https://doi.org/10.1016/j.ecns.2025.101825

In response to these challenges, simulation-based-education has emerged as a promising educational tool to improve healthcare professionals' awareness and communication skills in working with patients. Simulation-based education, including virtual reality (VR), provides immersive experiences that bridge the gap between theoretical knowledge and practical application (Shin, 2018). Research suggests that simulated learning can lead to positive changes in attitudes, shifting from sympathy to empathy and advocacy for disability rights (McKenney, 2018). These educational interventions allow students to experience and understand deaf culture, improving communication and enhancing professional competence. A systematic review of simulation-based education for deaf patient care has identified multiple potential modalities for teaching healthcare providers about communication strategies and cultural sensitivities (Terry et al., 2025). Despite the potential, research in this area remains limited, highlighting a need for rigorous studies to better understand the impact of these interventions on healthcare professionals' preparedness and their interactions with deaf patients.

This paper reports on the three phases of a project where the team co-designed a deaf patient simulation education experience for health professional students.

Our project objectives:

i) To gather knowledge about deaf patient experiences through focus groups in deaf clubs in Wales, UK.
ii) To co-create ideas with deaf people to identify scenario elements via storyboarding.
iii) To develop a VR application prototype to increase health professional student empathy with deaf patients.

We are aware that being deaf includes people with hearing loss, and also those who identify as members of the deaf community and may use sign language. Our focus for this project was on people who are deaf sign language users, and we have used the term deaf throughout our paper.

Theoretical framework

This project draws on Dewey's concept of experiential learning, emphasizing active engagement with real-world experiences over passive reception (Dewey, 1958). It informs the development of a 360-video simulation to enhance healthcare professionals' understandings of deaf patients' lived experiences. Immersive, contextually rich simulations offer participants firsthand insight into the challenges faced by deaf individuals, bridging the gap between theory and practice. Experiential learning theory suggests learning is best achieved when individuals actively engage with authentic experiences in a content domain and reflect on those experiences for relevance (abstraction) which they can try out in other settings. Kolb's model for this cycle expands on the constructivist ideas, highlighted by Dewey, who claimed successive processes of interaction, reflection and abstraction of learning resulted in improved understanding over time (Dewey, 1933). Kolb emphasized further analytical skills were necessary for conceptualization and that active experimentation to test ideas was vital for acquiring expertise (Kolb, 1984). Simulation-based education (SBE) can ameliorate safety concerns and offer an experiential environment where learners can acquire abilities in contextually, safe and relevant situations. Reflective practice can highlight strengths and areas for improvement, and grows understandings of beliefs, attitudes and values that impact performance (Forest & McKimm, 2019).

Grounded in co-production principles, the project fosters shared ownership, inclusivity, and mutual respect with a focus on teamwork, empathy and communication, incorporating the experiences of recipients of care, health professionals and other key stakeholders into design and delivery (Bovaird et al. 2015; McKenna, 2024). Co-production informed both the content creation and process design. Steering group invitations were shared via social media, including a sign language video with English and Welsh captions for accessibility. Recruiting a Research Assistant and Mentor (both deaf sign language users) further embedded deaf voices in the intervention. This novel approach integrates deaf individuals, professionals and learners at every stage, ensuring the simulation reflects the complexities of deaf patients' healthcare experiences while advancing the co-production methodology in educational tool development.

Materials and methods

We engaged a range of stakeholders from deaf clubs, virtual reality educators and industry, interprofessional education leads, statisticians, and employed a deaf research assistant and deaf consultant/mentor, to form our steering group and advise on all project phases. We followed a co-production design approach with three overall phases. In phase one, Deaf patient needs were obtained from focus groups both in-person and online. In phase two, we explored the development of simulation education content options with university students studying virtual reality and then through the building of a 360 video for a virtual reality module. In phase three, we tested the usability of the newly developed simulation module with health professional students who reported their feedback through a survey and focus group. This study was given ethical approval by the Faculty of Medicine Health and Life Science in April 2023 for phases one and two, and in May 2024 for phase three (Ref: 2 2024 9505 8730).The main ethical considerations were that deaf people could potentially become upset reflecting on past poor experiences in healthcare settings (phase 1); that students studying VR or the team developing the 360 degree video content may have become distressed when reflecting on or working on the development part of the simulation (phase 2); and that students may have become distressed experiencing the VR intervention (phase 3). The team were experienced with several deaf and hearing members all trained in safeguarding, who were ready to step in to support those involved in each phase of the project.

Phase 1: Co-produced content with deaf people

In order to develop content for the simulation education module, we invited members of the deaf community across Wales to participate in three focus groups (two face-to-face and one online). Each focus group lasted between 60 and 90 minutes and included people drawn from different locations across Wales, UK ($n = 31$ people). The focus groups were facilitated by deaf and hearing researchers, with sign language interpreters present at each. Participants were asked about (a) Visits to healthcare settings e.g. primary care/hospital and, what makes visits easy or difficult? (b) If they were unwell in a public place, what deaf-friendly things would help? The questions were developed by the steering group.

Focus group participants were recruited via a video in sign language sent out to deaf clubs and networks across Wales, with information sheets sent at the outset. At the start of each focus group, information sheets were translated into sign language with opportunity for questions and a consent form explained. Focus group data was collected on a flipchart visible to all throughout the focus group.

Focus group notes were analyzed using reflexive thematic analysis to identify key themes in deaf patient experiences, using Braun and Clarke's six-phase approach to thematic analysis, enabling systematic identification and interpretation of key patterns in the data (Braun & Clarke, 2006). Coding was conducted iteratively by multiple researchers, with regular discussions to refine categories and ensure consistency. Credibility of the findings was supported

through triangulation to confirm interpretations. Final themes were agreed and presented to the steering group. The data corpus fed directly into the steering group's storyboarding and development of the simulation education content.

Phase 2: Developing simulation education content

Development of MSc virtual reality student projects

In order to explore further simulation options, a two-pronged approach was used as part of the pilot. In line with the funding award, the team wanted to explore both a CGI and a 360-video approach, in terms of student experience and sustainability of content design. First, students of the Swansea VR MSc course were tasked with creating prototype VR CGI applications, as part of their Empathy Machines module. The aim of the development of these prototypes was to explore different methods of instilling empathy within the user, to best enhance the embodiment experience gained during playthrough for a hearing person. Student prototypes were then tested with deaf community representatives from the steering group, to gain feedback as to how well they reflected their own experiences in health service settings. This development and feedback process informed the next stage in the project process, and the planning and filming of 360 video content, which became the final format.

Building VR module and content

Themes from focus groups in phase one and ideas generated by the steering group were used to discuss potential developments for the simulation. Following the review of student developed content (primarily Computer-Generated Images), it was agreed to also develop a 360 video for use with VR headsets allowing for increased realism and use of volunteers/actors to engage in the scenarios. Given data about experiences of arriving in primary care settings, the group decided to focus on the story of a deaf person arriving at a GP surgery, with experiences portrayed from a deaf person and a staff member. First, the group storyboarded the narrative, and second, developed potential scenarios and scripts, that were discussed at an all-day steering group workshop. It was decided to reduce the audio (so students could hear very little) and introduce sounds similar to tinnitus (which is common amongst deaf people). The steering group also wanted potential students to be aware of the deaf patient's inner voice/thoughts to raise awareness of emotions experienced. These were developed as a running commentary from the patient perspective throughout the video.

Phase 3: Usability testing with students

The opportunity for health professional students to participate in the study was advertised in one school at a university in Wales, UK, with the intention of recruiting from all health professional programs (e.g. all fields of nursing, midwifery, healthcare sciences and public health). Participants were recruited through email invitation sent by the PI to all students in one School of Health and Social Care. The PI would not have been known to the majority of students, so no potential power imbalance existed. Due to the organization and resources required, students were asked to attend the Simulation Centre for a morning on a particular day when taught timetables were lighter. As students began responding to the invitation to participate, they were provided with full study details on a first come first served basis; with a reserve list in place. In line with resources, the intention was to pilot the education simulation with a small group only, aligned to the phase one grant award requirements. Students were asked to undertake a deaf awareness eLearning module first on the steering group's advice, which they were made aware of at the outset (Terry et al, 2024).

Before the students undertook the deaf patient VR experience, they were asked a set of seven survey questions (see Table 2) that were administered via Qualtrics and through a QR code that they accessed via an iPad or the student's mobile phone. We used Likert Scale designed questions that ranged from "Strongly Agree" through to 'Strongly Disagree'. The questions were designed as such to be able to ask roughly the same questions before and after the students undertook the deaf patient VR experience. This enabled us to elicit a defining change in participant responses before and after the VR experience. Questions included whether students had completed the Swansea University deaf awareness eLearning module beforehand, if they felt they had significant knowledge about deaf and hard of hearing people, and how confident and competent they felt when caring for a deaf or hard of hearing patient.

This was followed up with a focus group to ask students about their experiences. Student participants were made aware of all elements of the research at the outset and had all completed the prior e-learning. Focus group questions included: Can you tell us more about your experiences using the Virtual reality-based simulation platform?, How would you describe your Deaf awareness before you completed the Deaf awareness eLearning package?, Would you have worked with many Deaf patients on placement or know family or friends who are Deaf?, What do you think worked well in the VR session? and, How do you think the VR experience could have been improved? All students received a lunch voucher for participating.

Results

Phase 1: Focus groups with deaf communities to guide educational content

Following analysis of data from deaf people in the three focus groups (n = 31 people), six main themes were identified. These were: (a) Lack of healthcare staff awareness about interpreter provision (b) Poor communication (c) Stereotypes of deaf people (d) Impact of poor health staff deaf awareness (e) Discrimination (specific acts) (d) Positive suggestions to improve care for deaf patients. Table 1 shows examples of data categorized under each theme.

Deaf BSL users who required sign language interpreters explained that few staff were aware about how to work with interpreters, how services were provided or paid for or booked. Poor communication by health service staff and service providers were reported with frequency. Deaf individuals gave examples of stereotypes that health staff had, often making negative assumptions about deaf people, which resulted in poor experiences for patients. Focus group participants highlighted the impact of these negative experiences citing isolation and being on the receiving end of poor staff behavior. Examples of discrimination experienced were common. Participants offered a number of suggestions about improving care including staff learning sign language, more visual cues for patients and deaf awareness training for workers.

Phase 2: Educational content creation and refinement

Following a six-cycle curriculum design approach (Kern et al., 2009, p.7), it was determined that for this pilot and the defined learning objectives (derived from our needs assessment), that using a 360-video VR approach with volunteers from the deaf community alongside our clinical educators would be the best approach for content accuracy, realism and which worked within our grant funding.

The team worked alongside a VR company RESCAPE^{TM}. RESCAPE^{TM} is a local company that supports community projects,

Table 1
Data From Deaf Club Focus Groups.

Lack of Healthcare Staff Awareness About Interpreter Provision	Poor Communication	Stereotypes of Deaf People	Impact of Poor Health Staff Deaf Awareness	Discrimination (Specific Acts)	Positive Suggestions to Improve Care for Deaf Patients
Wi-Fi is a big issue when using remote interpreters	Call name? reception call name, assume not present	Assuming I won't complain or answer back	Being a patient (in-patient), very lonely and isolating	Refusal to wear a clear mask. Told me to "watch my behavior"	Ask patient what works well for them
Assumption of not needing an interpreter without clarification or communication	I prefer to have it all written down, but their handwriting is terrible and not as detailed	Assumption – when you can talk	Lip reading is hard, when you are ill it's worse	Interpreter being asked to wait outside as too many people in the room	Male interpreter for male patients, female for female especially if treatment is sensitive
No clue about how to book interpreter	If they shout room number, then I don't know		Patients feel that staff can revert to shouting, banging, poking instead of the medical notes being clear that the patient is Deaf and seeking an interpreter	Issues of informed consent	Need a screen with name and room number and estimated wait times

and kindly volunteered time and expertise to the project. The workshop allowed for participants to agree upon defined learning objectives for two short VR exemplars. The first session included a deaf patient attending GP appointment when a booked interpreter had not arrived at the surgery and included the "internal thoughts of the receptionist." The second part of the education session was attending the GP appointment when the interpreter was en- route but had not yet presented for the actual visit until near the end of the GP visit. The internal voice (which is the audio heard by the learner) flipped to the patient perspective and supported a "lived experience" feel for the learner, so they could experience a running commentary on what the deaf patient was thinking and feeling at the time. Following our key simulation standard design, we included a prebrief, VR familiarization and debriefing element to the platform experience (Watts et al., 2021). The scenario was filmed within our Simulation and Immersive learning center -SUSIM and provided a highly realistic environment, alongside a professional film crew. We started the morning with walk throughs and pilots for the volunteers/actors and filmed the session in one afternoon with our teams. This allowed for a two-week window of time for editing of materials and initial reviews by the design group. Once we had the finished prototypes, we brought back the original members of the deaf community focus group to trial the VR experience and live streamed a session to a wider audience with BSL translation support throughout, ensuring we were ready for our student pilots with evaluation from the team.

Phase 3: Education simulation usability: Feedback from student survey and focus group

Eight students took part in the deaf patient VR experience and all eight participants answered both before and after surveys. Table 2 shows the results of each question, before and after the VR experience. To elicit a change in attitude over time, we have specifically looked at the change in the two positive answers, "Strongly Agree" and "Agree." Descriptive statistics only were used due to the small sample size.

For Q1, of the eight people who took part in the survey, there was a 25% increase in their positive (Strongly Agree/Agree) attitude to the question about knowledge of deafness. Likewise, Q2 about confidence and competence working with deaf people there was a positive response in the participants with a 50% increase in their positive (Strongly Agree/Agree) attitude, which are only indicative due to small sample size

Conversely, for Q3 there was a very mixed response. The positivity in response (Strongly Agree/Agree) shown in both the before and after surveys didn't change. However, there was a slight decrease (12.5%) in the negative responses (Strongly Disagree/Disagree) with a 12.5% decrease in attitude to the initial question posed.

The results for Q4 again showed a mixed response with no change in the participants' positive (Strongly Agree/Agree) attitude to the initial question posed with both pre and post responses remaining the same.

A mixed response was seen for Q5 with no change in participants' positive (Strongly Agree/Agree) attitudes to the initial question posed with both pre and post responses remaining the same (Table 2). It is likely that the prelearning eModule on deaf awareness could have influenced pretest scores, as many participants selected 'strongly agree' before the interventions.

Again, there was a mixed response for Q6 with no change. For Q7, there was a positive response in the participants with a 12.5% increase in their positive (Strongly Agree/Agree) attitude about walking in the patients' shoes.

For Q8, about VR as an education modality there was another positive response in the participants with a 37.5% increase in their positive (Strongly Agree/Agree) attitude. For Q9, students reported little experience with VR learning with the majority of participants ($n = 4$) having no experience at all.

Overall, the VR experience appeared to be a positive experience. Fifty percent of the cohort had no prior experience of VR learning at all. With these results in mind, it is heartening to see the increased change in positive attitude to many of the questions posed throughout the before and after survey results.

Immediately following the post VR experience survey, a focus group interview was held with Phase 3 health professional students. The focus group took place in the university Simulation Centre. One participant self-identified as being deaf. In order that the discussion addressed the study objectives, the focus group was facilitated by two members of the research team. Following the focus group, students were each given a debrief sheet signposting them to support and wellbeing services.

The focus group enabled a deeper understanding of the deaf patient VR experience for the students. Participants were encouraged to talk to one another, ask one another questions, and to comment on each other's experiences, thoughts and viewpoints. Time and again, students spoke of the ways in which the VR experience intensified their awareness of the experiences of deaf patients. As one student put it:

> *"It puts you in the person's shoes. Even if it's only for 2 minutes, it does give you a really good idea of how they deal with things, or how they function, or how they're feeling. It's really really good." (Part. 1)*

Table 2
Data From Pre- and Postintervention Student Surveys.

No.	Question	Strongly Agree/Agree Pre	Strongly Agree/Agree Post	Change	% Change
Q1	At the moment: I feel I have significant knowledge about Deaf and hard of hearing people	4	6	2	+25%
Q2	At the moment: I feel confident and competent when caring for a Deaf or hard of hearing patient	3	7	4	+50%
Q3	At the moment: It is difficult for a healthcare worker to view things from a patient's point of view	5	5	0	0%
Q4	At the moment: Healthcare workers need to understand the emotional status of patients, and is an important part of the health worker/patient relationship	8	8	0	0%
Q5	At the moment: I think empathy is a vital factor in patient treatment	8	8	0	0%
Q6	At the moment: Understanding body language is as important as verbal and other forms of communication in health worker/patient relationships.	8	8	0	0%
Q7	At the moment: Health workers should try to 'stand in patient's shoes' (to see from another's point of view; to feel what another feels), when providing care to them.	7	8	1	+12.5%

Q8							
Do you feel VR training is an efficient and effective education modality for healthcare staff/teams ? (Modality is the way/type/how something is done)							
Now that I have completed the VR Deaf awareness experience, do you feel VR training is an efficient and effective education modality for healthcare staff/teams ? (Modality is the way/type/how something is done)							
Yes	Maybe	Total	Yes	Total	Change	Total	% Change
5	3	8	8	8	2	8	+37.5%

Q9					
On a scale of 1 to 5 how much prior experience do you have in Virtual Reality (VR) learning (1 being no experience, 5 being lots of experience)?					
Scale:	1	2	3	4	5
	4	2	2	0	0

Table 3
Student Focus Group Themes—Individual Quotes.

Themes:	Quotes:
Feelings	*"It takes the fear factor away, it's not as daunting" (Part. 3)*
	"I had no idea what it would feel like to not hear anything" (Part. 4)
Empathy	*"You are that person, you're in that scenario" (Part. 7)*
	"Gave a good representation of how you struggle when you don't know what to do" (Part. 5)
Communication	*"Body language matters a lot…in the VR, the doctor was right behind. We don't know what is happening [out of our line of sight], the person who is communicating should come in front with a smile, make use of the person's vision, stand right in front" (Part. 2)*
Challenges	*"You're looking at trying to capture so many deaf or hard of hearing perspectives" (Part. 8)*
Positives	*'when you're in a job that so clearly needs empathy, that clearly needs care and consideration of other people, it was definitely a very positive experience' (Part. 7)*
Suggestions for improvement	*'I wish there were no inner thoughts because it would have given us more explanation of what the Deaf person experienced, just seeing lips moving, the inner thoughts just made us feel comfortable as the wearer'(Part. 3)*

In this way, the VR experience made real the weight of previously unnoticed ordinary everyday life experiences for deaf patients:

> *"Just how overwhelming normal environments are [for deaf people] … Quite enclosing. Nothing was going on, yet everything was going on, and you felt overwhelmed by it." (Part. 4)*

During the course of the focus group, it was clarified to students that the ringing sound they heard on the VR headset, rather than being the sound of a hearing aid as a number had thought, was the sound of tinnitus. One student commented:

> *"that sound [tinnitus] alone, it causes a lot of meltdown. That sound alone is really troubling". (Part. 6)*

In a number of ways, the themes drawn from the focus group complement the post survey data and offer a more comprehensive understanding of the VR experience for students. Tables 3 and 4 below offer a number of themes and student quotes drawn from the focus group.

Discussion

The Deaf patient simulation education module was designed to increase Deaf awareness in health and care professional students, and to increase confidence and competence when communicating with Deaf patients. The importance of co-producing content for simulation education with communities with lived experience cannot be under-stated (Tang et al., 2022; Terry, Wilks & Davies, 2025). The early-stage workshops enabled data collection from Deaf communities about the challenges, barriers and what Deaf people would like to happen in healthcare and were an essential foundation for our project.

Our simulation was co-produced with Deaf colleagues, using data from workshops with Deaf participants. Co-production differs from user-centred design (designing for users) and co-design (problem-solving with users and designers). Co-production involves creating something new collaboratively. This project blended user-centered design, co-design, and co-production, with deaf sign language users' input shaping content through interdis-

Table 4
Examples of Group Conversation Quotes.

Theme:	Examples of group conversation quotes:
Feelings	"What did you learn from that person's experiences?" "Just how overwhelming normal environments are [for deaf people] ...quite enclosing, nothing was going on, yet everything was going on, and you felt overwhelmed by it." (Part. 4) "A constant heightened sense. Some people can get quite aggressive if they can't get their point across." "Understandably" (Part. 2)
Empathy	"It could be used in so many different ways. I think the sky's the limit with it [the VR]" (Part. 1) "In much less time as well, whereas you have scheduled a 3-hour lecture, I mean that was 10 minutes and we learned so much. I know it's expensive and there are other cons to it, but I think the pro's definitely outweigh the cons" (Part. 5) "It puts you in the person's shoes. Even if it's only for 2 minutes, it does give you a really good idea of how they deal with things, or how they function, or how they're feeling. It's really really good" (Part. 1)
Positives	"Having a chance to talk about what other people thought and encourage learning through the group" (Part. 3) "Not dissimilar to a debrief [that would occur in a simulation], ...today you had 7 mins of learning that has generated over an hour of learning conversation." "And it's much more beneficial" (Part. 2)

ciplinary steering groups. Their views were central to content creation.

VR is uniquely suited to help a user "walk a mile in someone else's shoes" (Geier et al. (2022), and the term 'embodiment' means that a user/learner connects with or embodies a person in a virtual environment. Elements that would ordinarily ground learners in their own sense of self are disrupted. For example, in our VR we changed the audio experience so there was limited sound when student 'became' the deaf patient and there was also the introduction of a noise similar to tinnitus. This displacement or disruption can foster empathic connections (Wiederhold, 2018, 2020) with population groups. Our project results suggest that it is possible to capture the patient perspective with a well-scripted learning activity. In ways similar to Donelly et al. (2023), post viewing of the VR, participants reported feeling better prepared and more confident about communicating with deaf people, whilst having gained a unique insight into the patient experience through the headset.

Due to the small test group sample size these marginal results can be reviewed as a starting point for reframing the pre- and post-survey data for the larger study, and with further model development to measure learning and perception of impact from such training. The prelearning computer-based training may have further impacted the students' knowledge and views on the empathy and lived experience questions, in that a high number of participants had 100% Strongly Agree/Agree as their presurvey results. It also is a consideration for where this type of training is placed as part of a curriculum in terms of integration and how empathy-based storytelling from real patients can add significant meaning to learning.

The next step for the research team is to pursue a larger grant to develop content addressing other significant healthcare access issues faced by the deaf community. This initial study highlights the ways in which 360° video filming offers realistic patient and caregiver journeys, cost efficiency, and creative storytelling. However, computer-based simulations provide flexibility, enabling active learning through diverse environments and patient profiles, ensuring rigor in education. VR materials can also be used in immersive suites, supporting students unable to use VR and scaling training through adaptable modalities.

Conclusion

Our collaborative approach to developing VR content brought together the deaf community, learners, subject experts, and industry partners to co-create authentic, lived-experience educational tools. This work demonstrates the value of immersive learning for fostering empathy, reflection, and confidence in health professional students, while ensuring realism through the replication of deaf community stories. Key next steps include integrating these tools within curricula, conducting trials to evaluate learning outcomes, and assessing long-term impacts on both learners and patient care.

To support accessibility and scalability, the VR module can be adapted into alternative formats such as desktop-based simulations, 360° video experiences, or interactive case studies, ensuring students who cannot use VR headsets are still able to engage with the content. These flexible formats also create opportunities for wider integration across health professional programmes, allowing consistent delivery of the learning objectives while tailoring the level of immersion to available resources and learner needs.

Funding

The project was funded by a 2-year Morgan Advanced Studies Institute project at Swansea University.

Declaration of competing interest

None.

CRediT authorship contribution statement

J. Terry: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **J. Davies:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **R. Wilks:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **T. Thomas:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Data curation. **S. Vowles:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Data curation. **J. Hunt:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **D. Rowberry:** Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Formal analysis, Data curation. **M. Nosek:** Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Conceptualization. **I. Humphreys:** Writing – review & editing, Writing

– original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation.

Acknowledgments

The amazing Deaf Community Focus Groups, BSL-using steering group members for all their time and expertise; and BSL/English interpreter colleagues. The MSc Virtual reality students and staff team for the CGI development. RESCAPE for donating resources and time. Also our thanks to the SUSIM centre and team, Interprofessional Education Lead Nikki Williams in the School of Health and Social Care, Faculty of Medicine Health and Life Science at Swansea University for advice in promoting the student pilot opportunity; and Cathie Robins-Talbot, Deaf Consultant, for her time and commitment to the project throughout.

References

Bovaird, T., Van Ryzin, G. G., Loeffler, E., & Parrado, S. (2015). Activating citizens to participate in collective co-production of public services. *Journal of Social Policy, 44*(1), 1–23. https://doi.org/10.1017/S0047279414000567.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

British Deaf Association. (2016). *Access & inclusion (Health) review: Impact and influence on health care services between deaf British sign language users and service providers in Scotland* Retrieved from Health-Report-FINAL-2016.pdf .

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. D.C. Heath & Co Publishers.

Dewey, J. (1958). *Art as experience*. New York, NY: Capricorn Books.

Donnelly, F., McLiesh, P., Bessell, S. A., & Walsh, A. (2023). Preparing students for clinical placement using 360-video. *Clinical Simulation in Nursing, 77*, 34–41. https://doi.org/10.1016/j.ecns.2023.02.002.

Emond, A., Ridd, M., Sutherland, H., Allsop, L., Alexander, A., & Kyle, J. (2015). The current health of the signing Deaf community in the UK compared with the general population: A cross-sectional study. *BMJ Open, 5*(1), Article e006668.

Forrest, K., & McKimm, J. (2019). *Healthcare simulation at a glance*. John Wiley & Sons, Inc.

Geier, A. K., Lippmann, S., Rau, A., Schrimpf, A., Bleckwenn, M., & Deutsch, T. (2022). Walking a mile in Grandma's shoes-medical students' evaluation of a very simple online aging game to enhance their understanding of older patients. *BMC Geriatrics, 22*(1), 865. https://doi.org/10.1186/s12877-022-03470-0.

Kern, D. E., Thomas, P. A., & Hughes, M. T. (2009). *Curriculum development for medical education: A six-step approach* (2nd ed.). Johns Hopkins University Press.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall http://academic.regis.edu/ed205/Kolb.pdf.

McKenna, L. (2024). Utilizing co-design and research for authentic simulation development. *Clinical Simulation in Nursing, 94*. https://doi.org/10.1016/j.ecns.2024.101609.

McKenney, A. (2018). Attitude changes following participation in disability simulation activities. *Therapeutic Recreation Journal, 52*(3).

Shank, C., & Foltz, A. (2019). Health and wellbeing for deaf communities in Wales. *Scoping for a Wales-wide Survey*. https://research.bangor.ac.uk/portal/files/26546430/PHW_Health_and_Wellbeing_for_Deaf_Communities_in_Wales_Report_ENG.pdf.

Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience? *Computers in Human Behavior, 78*, 64–73. https://doi.org/10.1016/j.chb.2017.09.012.

SignHealth. (2025). Still ignored: the fight for accessible healthcare. *2025 Policy report Wales*. Retrieved 26 Sept 2025. https://signhealth.org.uk/wp-content/uploads/2025/04/WALES-Still-Ignored-The-fight-for-Accessible-Healthcare-policy-report-FINAL.pdf

Tang, K., Gerling, K., & Geurts, L. (2022). Virtual feed: Design and evaluation of a virtual reality simulation addressing the lived experience of breastfeeding. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (pp. 1–17).

Terry, J., Redfern, P., Bond, J., Fowler-Powe, M., & Booth, C. (2021). *Deaf people wales: hidden inequality*. https://bit.ly/36ao3IE. 2021.

Terry, J., Parkinson, R., England, R., Nosek, M., Humphreys, I., Howells, A., & Meara, R. (2024). Improving nursing students' knowledge of working with Deaf and hard of hearing patients: Evaluation of a Deaf awareness eLearning package. *Nurse Education Today*. https://doi.org/10.1016/j.nedt.2024.106446.

Terry, J., Wilks, R., & Davies, J. (2025). Simulated learning interventions to improve communication and practice with deaf and hard of hearing patients: A systematic review and qualitative synthesis. *Advances in Health Sciences Education*. https://doi.org/10.1007/s10459-025-10452-5.

Watts, P. I., McDermott, D. S., Alinier, G., Charnetski, M., Ludlow, J., Horsley, E., & Sando, C. R. (2021). Onward and upward: Introducing the healthcare simulation standards of best practice™. *Clinical Simulation in Nursing, 58*, 1–4. https://doi.org/10.1016/j.ecns.2021.08.014.

Wiederhold, B. K. (2018). The next level of virtual reality isn't technology—It's storytelling. *Cyberpsychology, Behavior, & Social Networking, 21*, 671. https://doi.org/10.1089/cyber.2018.29129.bkw.

Wiederhold, B. K. (2020). Embodiment empowers empathy in virtual reality. *Cyberpsychology, Behavior, and Social Networking, 23*(11), 725–726. https://doi.org/10.1089/cyber.2018.29129.bkw.

Yet, A. X. J., Hapuhinne, V., Eu, W., Chong, E. Y. C., & Palanisamy, U. D. (2022). Communication methods between physicians and Deaf patients: A scoping review. *Patient Education and Counseling, 105*(9), 2841–2849. https://doi.org/10.1016/j.pec.2022.05.001.