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Use of virtual and augmented reality-based interventions in health education to improve dementia knowledge and attitudes: an integrative review

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ABSTRACT

Objectives Immersive technologies such as virtual (VR) and augmented reality (AR) can potentially help health professionals and trainees understand psychological symptoms and responsive behaviours associated with dementia within a safe and supportive learning environment. This integrative review sought to ascertain the types of VR and AR-based interventions used in dementia education and training and its efficacy to improve knowledge and attitudes of health professionals or trainees.

Design The protocol was submitted to PROSPERO and literature published from 2000 onwards was searched in eight databases: CINAHL, MEDLINE, Web of Science, Cochrane, Embase, PsycINFO, ERIC and Scopus. A total of 19 articles were included and assessed with the Mixed Methods Appraisal Tool. Methodological quality varied across studies.

Results VR rather than AR-based intervention are used in dementia education and training for health professional and trainees. Immersive virtual learning potentially enhance knowledge, attitudes, empathy and sensitivity of health professionals and trainees.

Conclusions While promising, there remains a lack of conclusive and robust evidence to fully recommend the introduction and inclusion of immersive virtual learning in dementia education and training. Additional rigorously designed research studies with larger sample sizes are needed to confirm the benefits on attitudes, empathy, sensitivity and knowledge.

PROSPERO registration number CRD42020182083.

Strengths and limitations of this study

- ► This is the first review to assess the use of virtual and augmented reality in dementia education and training across both qualitative and quantitative studies.
- ► This review conducted a quality assessment of the 19 included studies.
- ► The 19 included studies reported a broad range of sample sizes and reporting metrics, resulting in difficulties for formal comparisons and clear recommendations.
- ► Outcomes of this review may be subjected to selection bias due to the exclusion of grey literature and the inclusion of only studies published in English.

INTRODUCTION

Education and training of health professionals and trainees (ie, individuals formally trained or training to work in a health or health-related field), such as those in the fields of medicine and nursing, conventionally adopt the coaching approach of 'see one, do one, teach one'.[1 2] However, the growing emphasis on patient safety, care and awareness, as well as an increasing teaching cost in the clinical environment have led to the consideration and incorporation of advanced technology in coaching techniques.[3] One of these is immersive technologies that are defined as 'devices that provide sensory stimuli to provide a sense of realism and immersion to the interactions with the computer-generated world'.[4] Virtual reality (VR) and augmented (AR) are two principal types of immersive technologies. In the last 10 years, VR and AR have evolved from what was previously considered futuristic technology in science fiction to the reality of a potentially effective tool for health-related educators.[5–7]

Virtual experiences can exist in various forms (ie, fully, semi or non-immersive). Non-immersive virtual experiences are common in daily life. It refers to computer-generated environment where the user remains perceptive and maintains control of the physical environment. One such example is video games or activities, using consoles, keyboards, mice and controller. VR is regarded as a fully immersive experience or a computer simulated three dimensional (3D) world experience, where the user can interact with the virtual environment and characters via special electronic devices such as an enclosed headset or body suit.[6 8 9] Users of VR devices (eg, Oculus Quest/Rift or HTC Vive) are fully immersed

in a completely enclosed digital environment with sight and sound but no sense of the real world. On the other hand, AR is an enhanced reality or a semi-immersive virtual experience where realism is provided through 3D graphics, also known as vertical reality depth. The user operates an application on a device such as a smartphone, to render an interactive digital layer or image on top of reality (eg, a physical object).[5 6 10] Experience of the real world remains central to users of AR but this experience is enriched by information provided through a digital virtual overlay. With the rapid advancement and popularity of VR and AR, innovative ways to leverage immersive technologies are anticipated to transform not only healthcare education and training but also practices in areas of treatment and therapies (eg, in surgery), telemonitoring, care planning as well as patients' experience.[11 12] Specifically, this type of modern technology may influence the way education and training for dementia care and awareness could be effectively delivered in the future.

The WHO recognises dementia as a public health priority, and places an emphasis on enhancing health professionals' awareness of the condition with the goal to improve care and support for people living with dementia.[13] The need for better ways to educate our health professionals on dementia is essential now more than ever, as there are currently an estimated 50 million people living with the disease globally, with this expected to increase threefold to 115.4 million by 2050.[13–15] As health professionals and trainees would have never personally experienced life from the perspective of someone with dementia,[14 16] and some may not have prior personal or work experience in interacting or caring for people living with dementia, many have expressed feeling underprepared to manage and care for them.[17–19] For this reason, the nature and approach employed when determining which form of dementia training to use is an important area for consideration in health education.

Immersive technologies such as VR and AR can provide a feasible mean for orientating health professionals and trainees to aspects of dementia (eg, psychological symptoms and responsive behaviours related to dementia) that can be confronting but relevant to their work roles within a safe and supportive learning environment.[20 21] Responsive behaviours (eg, those brought on by unmet needs or a lowered stress response threshold) are displayed by up to 90% of people living with dementia in the form of agitation, aggression, apathy, repeatedly calling out, sleep-disturbance and wandering[22] and have been reported to be distressing or challenging for health professionals.[21] Those who have limited understanding of the causes of these behaviours can misunderstand their origins and the person's related intentions, potentially lowering the quality of care provision.[21] As such, it is imperative for health professionals to have the requisite education and training to respond to these complex psychological symptoms and responsive behaviours of dementia in an empathetic, patient and understanding manner.[14 16 23] Over the years, there have been growing utilisation of high-quality immersive technologies such as VR and AR in dementia education and training to enable health professionals and trainees to explore what and how it feels to be experiencing dementia, that is to see the world through the eyes of a person living dementia. More importantly, it can potentially improve their dementia knowledge and enhance their understanding of caring for someone living with dementia. This may then allow for them to identify support needs and develop a supportive approach to assist people living with dementia to live confidently and independently. Therefore, this review aims to examine current evidence of what and how VR and AR interventions are being used in dementia education and training as well as their efficacy to improve knowledge and attitudes of health professionals and trainees towards people living with dementia.

METHODS

Aim

Published literature, both qualitative, quantitative and mixed-methods studies, on VR and AR-based dementia training programmes is described, evaluated and synthesised in this review to answer the following research questions:

1. What are the different types of VR and AR-based interventions used in dementia education and training for health professionals or trainees?
2. What is the efficacy of health education interventions involving VR and AR in improving dementia knowledge and attitudes of health professionals or trainees?

Protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was followed for this review's outline.[24] The protocol was developed prospectively and submitted to PROSPERO, an International Prospective Register of Systematic Reviews[25] on 24 April 2020. This protocol was followed with only very minor deviations where required, and these are reported in the Methods section.

Design

An integrative approach is adopted where study outcomes from various methodologies and data are included to provide a comprehensive understanding of the phenomenon of interest.[26] Utilisation of this approach is suitable for this review as it will ensure the provision of an all-encompassing overview and contribution to the body of knowledge, practice and research in relation to VR and AR-based interventions used to educate or improve health professionals or trainees on dementia.[26]

Search strategy

Eight electronic databases across health, science, psychology, medicine and education were searched: CINAHL (EBSCO), MEDLINE (Ovid), Web of Science Core Collection, Cochrane Central Register of Controlled Trials

(CENTRAL; Wiley), Embase (Elsevier), PsycINFO (Ovid), ERIC (Ovid) and Scopus. Articles published between 2000 and 2021 were identified using the following search terms: "virtual realit*" OR VR OR "augmented realit*" OR AR OR "mixed realit*" AND health AND intervention OR educat* AND dementia OR "Alzheimer disease" AND knowledge* OR attitude* OR experience* OR aware* OR understand* OR perception* OR comprehension* AND "health professional*" OR personnel* OR "allied health personnel" OR doctor* OR "medical staff" OR "nurs* staff" OR "physical therap*" OR physiotherapy OR "occupational therap*" OR dieti* OR trainee* OR student*. The mesh terms included were 'virtual reality', 'augmented reality', 'mixed reality', mixed realities', 'augmented realities', 'health', 'education', 'training', 'dementia', 'Alzheimer disease', 'knowledge', 'attitude', 'awareness', 'understanding', 'perception', 'comprehension', and 'allied health personnel'. The Polyglot tool[27] was used to check title, abstract and keyword search terms. Reference lists of eligible articles and systematic reviews pertinent to this research area were searched manually. Full search strategies for all databases are presented in online supplemental file 1.

Inclusion/exclusion criteria

To be included in this review, articles had to meet the following criteria: (i) primary full-text studies published in English; (ii) published between 1 January 2000 to 31 March 2021; and (iii) qualitative, quantitative and mixed-methods studies involving the use of VR and AR-based interventions to improve dementia knowledge and attitudes of health professionals or trainees. Articles that reported: (i) trial registration materials; (ii) studies involving non-health professionals or trainees and (iii) non-original research such as literature reviews, theses, newsletters, editorials, commentaries, discussion papers and notes were excluded. Conference proceedings were also excluded with the exception of full text, peer-reviewed conference papers.

Search outcome

A list of 97 records was yielded from the initial search from databases. Following the removal of duplicates (n=17), title and abstract screening of 80 records plus a further 17 articles, identified through manual searching, were conducted independently by two reviewers (CJ and DJ) in line with the inclusion and exclusion criteria. A total of 31 records were eligible for full-text assessment. The full texts of these records were retrieved and assessed independently against the inclusion and exclusion criteria by the same two reviewers (CJ and DJ). No disagreement occurred in the article selection process where a total of 19 articles were identified to be eligible for inclusion in this review (refer to figure 1). Figure 1 presents the PRISMA flowchart diagram that illustrates the literature search and selection process.[24]

Quality appraisal

The Mixed Methods Appraisal Tool (MMAT) Version 2018 was used to assess the quality of the 19 included articles.[28] The MMAT is selected as it includes two initial questions to screen for empirical studies. Once established, it can be used to efficiently appraise different study designs (eg, quantitative randomised and non-randomised controlled trials, quantitative descriptive studies, qualitative studies and mixed-methods studies) across core quality criteria with the outcome for each criterion reported descriptively.[29] Two reviewers (CJ and DJ) conducted the quality appraisal independently. Outcomes of the quality assessment were cross-checked. A 5% disagreement found was subsequently resolved via referral to the third reviewer (CM) to reach quality appraisal consensus for all included studies.

Data extraction from the 19 included articles was initially completed by one reviewer (DJ) and then checked by a second reviewer (CJ). Information extracted included authors, publication year, country, study aim(s), participants, study design, intervention, outcome measures, results and study limitations including quality appraisal (refer to online supplemental file 2). An integrative approach, which involves the reduction, display and comparison of data followed by the drawing and verification of conclusions,[26] was used to synthesise data from all included studies. This was performed by two reviewers separately (CJ and DJ) to avoid bias. Studies included in the review are organised into groups and subgroups for the purpose of data reduction followed by arrangement of data in a way that allows the visualisation of patterns, relationships and variation to support the iterative analysis process. Conclusions are then made and verified to ensure the depth and breadth of included studies are evidently presented. Evidence gathered from the review, on interventions involving VR and AR in improving dementia knowledge and attitudes of health professionals or trainees, is summarised and presented narratively to identify any knowledge gaps and highlight areas for future research.

Patient and public involvement

No patients or the public were involved in the design, conduct, reporting or dissemination plans of our research.

RESULTS

Study characteristics and participants

In the 19 included articles, the earliest published paper was in 2002.[16] Studies in this review were conducted in Australia,[8 18 30] China,[31] Ireland,[32] Korea,[14] UK[17 20] and the USA.[14 16 33–41] Of these studies reviewed, seven were quantitative (ie, non-randomised controlled and pre-quasi-experimental and post-quasi-experimental studies with one or two groups),[8 16 18 34 36 37 40] five qualitative (ie, exploratory or phenomenology studies via reflection, individual or focus group interview),[14 30 32 41 42] and seven mixed methods (ie, quasi-experimental studies with pretest and post-test plus reflection or interview).[17 20 31 33 35 38 39] Across the studies reviewed, most participants were undergraduate students or students studying a discipline related

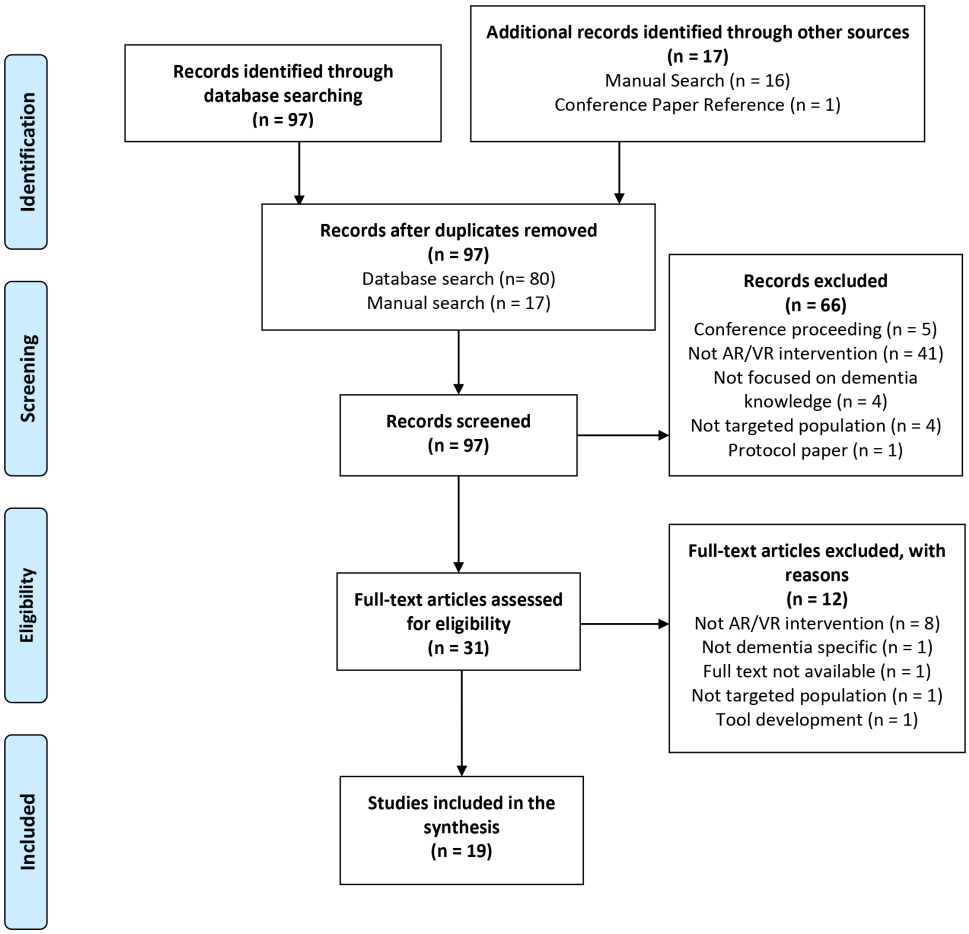

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 flow diagram. AR, augmented reality; VR, virtual reality.

to health (ie, medicine, nursing, paramedics, pharmacy, psychology, occupational or physical therapy), social work or human services.[8 17 18 20 30 31 33–42] Other participants include healthcare workers (ie, registered nurses, allied health professionals, social workers care aides/assistants, administrative and management staff including directors of nursing) and formal and informal caregivers[14 16 32] with one study involving health faculty teaching staff members.[41] As reflected in online supplemental file 2, not all studies reported participants' gender and age but of those that did, majority of participants were females and young adults.

VR/AR interventions and outcomes

A variety of interventions were assessed across the included studies. The intervention used in the majority of articles reviewed (ie, 10 out the 19) was the *Virtual Dementia Tour* (VDT).[16] Beville[16] designed and created a VDT experience, a dementia sensitivity training programme, that altered users' senses when completing everyday tasks. Users of the VDT were 'garbed' in special attire (ie, patented devices) to stimulate senses (eg, 'placing popcorn kernels in shoes/gloves to simulate poor circulation, neuropathy and/or arthritis as well as the loss of sensory and motor skills') in a distorted environment (eg, 'goggles darkened with yellow cellophane, smeared with Vaseline and a centred black dot to simulate variety of visual impairments') and were required to complete five simple tasks (eg, find and put on a sweater).[43] Studies involving the VDT either replicated it as the sole intervention[16 32 33 35 36 41] or combined it with other activities such as dementia-related lecture or movie/video, clinical experience, case vignette, role-play and/or discussion.[31 34 39 40]

Four articles evaluated the experiences of users who completed the *Dementia Live* (DL) programme.[14 37 38 42] This is a programme where users immersed in a simulated life of living with dementia and tasked to complete daily activities (eg, sorting cutlery) while experiencing cognitive impairments and sensory losses that are induced through headphones with MP3 Player (*to distract attention and hearing*), eyewear (*to limit peripheral vision*) and gloves (*to weaken the sense of touch and fine motor skills*).[44] The DL programme was modified for use in a Korean cultural context[14] and in conjunction with dementia-related lecture.[38]

Of the remaining five articles, two reported on the same *myShoes* project intervention study where one is a conference paper[20] and the other is a research article.[17] The *myShoes* project involves the augmentation of a

virtual environment to increase users' understanding of the experience of living with dementia.[17] Through the use of Oculus Rift (ie, a stereoscopic headset with touch controllers) and the Unity 3D software, users immerse in a manipulated virtual environment, aimed at causing misdirection and confusion, and navigate the avatar of an older person to complete simple tasks (eg, clearing dining table). Users will experience the emotions and cognitive function impairments people living with dementia encounter. Another two articles[18 30] reported on Alzheimer's Australia Victoria *Virtual Dementia Experience* (VDE), where an immersive multisensory, virtual simulation of light, sound, colour and visual content is projected on a 10×2 m screen, aimed for users to experience cognitive and perceptual difficulties encountered by people living with dementia. The final article on the *Virtual Reality Educational* project[8] conducted an intervention using the Oculus Rift headset and sensor, Leap Motion hand-tracking device and Embodied Labs programme for users to experience ageing-related macular degeneration and high-frequency hearing loss as well as conversations relating to Alzheimer's disease and end-of-life.

Studies reviewed had a focus on improving participants': (i) knowledge of dementia[18 34 36–40]; (ii) attitudes towards dementia including perceived confidence and competence in care provision[17 18 20 34 36 37 39 40]; (iii) empathy for people living with dementia[8 17 20 31 37–40] and/or (iv) understanding and awareness of people living with dementia and sensitivity towards their care needs.[16 33 36] Instruments used to measure outcomes varied across studies. Knowledge and attitudes were measured using the Knowledge About Memory Loss and Care,[45] Dementia Knowledge Assessment Tool Version 2,[46] Knowledge in Dementia Scale,[47] Dementia Attitudes Scale,[48] or Confidence in Dementia Scale.[47] While sensitivity was assessed using the survey developed by Beville[16] for the VDT, empathy was measured using the Interpersonal Reactivity Index (IRI),[49] Comprehensive State Empathy Scale[50] or Jefferson Scale of Empathy-Health Profession Students.[51] These outcomes, together with perceived intervention experience, were also assessed qualitatively through individual and focus group interviews, observations and written reflections.

Knowledge and attitudes

The impact of interventions involving VR and AR on dementia knowledge is mixed. Of the seven studies evaluating dementia knowledge, four found a significant improvement in participants' knowledge of dementia from preintervention to postintervention when using the VDE,[18] DL[37] and VDT combined with dementia video, case vignette and role-play.[39 40] However, where studies involved a two-group comparison,[37 40] no significant group difference on dementia knowledge was found. The remaining three studies using DL with dementia lecture[38] and VDT,[34 36] where one also included dementia lectures,[34] did not find any improvement in participants' knowledge of dementia. On the other hand, significant improvements in attitudes towards dementia including perceived confidence and competence in care provision were found across all seven studies and intervention types that assessed attitudes, confidence and competence.[17 18 20 34 36 37 39 40] Likewise to knowledge, no group difference on attitudes was found in studies with a two-group comparison.[18 37 40] Qualitative data indicated that participants did perceive an overall improvement in their knowledge and attitudes towards people living with dementia,[30] as well as knowledge and confidence in dementia care following their intervention experience.[39]

Empathy and sensitivity

All studies, except for one using DL,[40] that focused on empathy reported a significant improvement from preintervention to postintervention. *myShoes*,[17 20] *Virtual Reality Educational* (VRE),[8] DL with and without[37 38] dementia lecture as well as VDT combined with dementia video, case vignette and role-play[39] or movie[31] led to significantly enhanced empathy in participants. However, no difference in empathy was found in Kimzey *et al*'s[37] two groups study. Furthermore, both studies by Kimzey *et al*[37] and Mastel-Smith *et al*[39] found an increased tendency in participants to spontaneously adopt the psychological point of view of people living with dementia (*from IRI subscale*) following VR and AR interventions. Participants described the VR and AR intervention as enlightening as they were able to gain an appreciation and comprehend that living with dementia is much harder than anticipated and could imagine how a person living with would feel and behave (*empathic imagination*).[38 42] They reported understanding and sharing feelings of distress (eg, sadness, anxiety, fear, frustration, anger and helplessness) experienced by people living with dementia in how they perceived the world and their future as well as when completing tasks related to daily activities of living.[14 31 32 38 39] Importantly, the opportunity of a simulated lived experience of living dementia enables reflection on a cognitive, moral and behavioural level, leading to empathy and promoting the use of new helpful care strategies.[32 41 42]

For VDT studies that assessed understanding and awareness of people living with dementia and sensitivity towards their care needs using the VDT survey, the use, analysis and results reporting of the survey varied across studies.[16 33–36] Nevertheless, all studies reported an overall improvement (via either statistical significance indicating higher quality evidence[33–35] or graphical means trend[16 36]), but specifically in participants' awareness of the need to be sensitised to people living with dementia's emotional needs (including feelings of anxiety) to provide good care[16 33 34 36]; and understand their incapability to perform simple everyday tasks,[16 33] experience of functional difficulties and challenges to get through the day,[16 33 34 36] and manifestation of inappropriate (or possibly justified)

behaviours,[16 34] as well as not always receiving the requisite care they need.[16 33 36]

User experience

Generally, participants reported satisfaction and perceived usefulness and effectiveness of their VR and AR experience and would recommend it as part of professional training and development for carers of people living with dementia.[31 32 42] It is considered by participants to be a viable training approach[42] that addresses gaps in traditional teaching methods and provides opportunities for immersive simulated experiential learning to occur.[31 41] On reflection, participants believed that these experiences have a positive impact on them both personally and professionally[33] as they give them an insight into the lives of older people living with ageing and dementia-related health challenges.[8 14 33] Participants indicated their experience has highlighted the need for them to (i) provide people living with dementia with more attention and affection; (ii) improve communication approach using dementia-friendly techniques; (iii) adopt appropriate care strategies such as not asking them to complete multiple tasks and providing ample time for tasks completion; (iv) avoid imposing negative behavioural judgements and (v) the need to support family carers.[14 30–32 35 36 38 41 42]

Quality appraisal

All studies met the first two screening criteria for MMAT except for the study by Dyer *et al*[8] where there was limited information provided in the rationale and description of the methodology used as well as the discussion of results. All five qualitative studies[14 30 32 41 42] met the quality appraisal criteria where the qualitative approach undertaken and data collected were appropriate to answer the research question. Furthermore, interpretation of qualitative findings was adequately derived and substantiated from collected data. On the other hand, none of the quantitative and mixed-method studies met all the quality appraisal criteria. One or more concerns were noted across these studies.

First, in some studies, participants without follow-up (ie, post) data were either excluded from the analysis and reasons for missing data were not always reported.[18 35 37 39] This can lead to non-response bias during the interpretation of results. Second, methodology was not clearly reported in two studies (ie, *myShoes*[17 20] and VDT[16]) where there were no to limited information on study design, sampling strategy, non-response bias and/or outcome measurements used. Third, several studies were limited by its small sample size[17 20 31 34 38 39] and the non-reporting of demographic characteristics such as age and gender.[8 16 17 20 36 40] Fourthly, although the VDT survey[16] has been used to assess understanding and awareness of people living with dementia and sensitivity towards their care needs following a VDT experience,[16 33–37] there is limited empirical evidence on the face validity and internal consistency of the VDT survey. It is also questionable whether the assessment tool (ie, KIDS) used in Lorio *et al*.'s[34] study is sensitive to changes in dementia knowledge. Finally, there was limited integration of the quantitative results and qualitative findings when interpreting and discussing the outcomes of the mixed-method study of Peng *et al*.[31]

DISCUSSION

The literature included in this integrative review presented five types of immersive VR-based interventions used in dementia education and training for health professionals or trainees to deliver simulated cognitive, sensory and perceptual experiences similar to those when living with dementia. No AR-based intervention was identified in this review. Both the VDT and DL programmes are similar to each other, through their use of sensory devices such as gloves, goggles and headphones as well as verbal instructions for tasks completion. In contrast, *myShoes* and the VRE projects require the use of the Oculus Rift headset while the VDE simply projects multisensory (ie, light, sound, colour and visual) content on a large screen. The majority of published studies focused on VDT, followed by DL with a few empirical studies on *myShoes*, VRE and VDE. Adverse experience of VR motion sickness has been reported by some users in *myShoes* study[17 20] but not the VRE project.[8] Dementia education and training using VR that incorporate VR headset needs to consider motion sickness (ie, cold sweats, vomiting and feelings of nausea and dizziness), a well-known, common occurrence in users of VR[9 52 53] as it can potentially impede on the development and adoption of this technology in future dementia education and training. However, advances in available consumer technologies, such as increased frames-per-second and movement sensors within the devices may alleviate these adverse health effects in the near future.

Earlier empirical studies have found a positive pedagogical value in immersive virtual learning when compared with traditional teaching approaches.[9 54–56] There is also research evidence to demonstrate the positive impact of immersive virtual learning in health sciences and medical education and training.[7 57 58] The immersive VR-based interventions in this review are reported to have allowed users to become more knowledgeable about the dementia condition; develop more positive attitudes towards people living with dementia; feel more confident and competence in care provision; as well as being more empathetic and sensitive towards people with dementia and their care needs. These were achieved through the manipulated virtual environment that simulated dementia-related living conditions such as cognitive impairments, sensory and perceptual losses and difficulties for users; as well as from their reflections on the impact of the immersive and interactive experiences. Further benefits users gained through their participation include: learning new approaches to care for people living with dementia; environmental issues that impede on a person with dementia's daily

routine; and environmental adaptions to address these issues to enhance care provision.

Interestingly, unlike a previous study by Webster[59] which found immersive virtual learning to be as effective, if not better, than conventional lecture-based learning, this review noted that the effects of immersive virtual learning in the acquisition of declarative knowledge about dementia is conflicting and less evident when compared with improvements in attitudes, empathy and sensitivity. However, this may be explained by the purpose and nature of the immersive virtual learning where it is focused less on conceptual, propositional or descriptive content but more on users having first-hand, direct experience of dementia and ageing associated cognitive, sensory and perceptual challenges in actual daily living. The intent is placed on experiential learning where users transformed experience into an increased understanding and awareness of what is like living with dementia leading to enhanced attitudes and increased empathy and sensitivity to positively influence their care provision.[60]

Strengths and limitations

To our knowledge, this is the first integrative review that examines current quantitative and qualitative evidence of what and how VR and AR interventions are being used in dementia education and training as well as its efficacy to improve knowledge and attitudes of health professionals and trainees towards people living with dementia. The use of defined inclusion/exclusion criteria, rigorous search from eight databases and validated MMAT to ascertain quality of studies are considered the strengths of this review. Even though this review offers a descriptive results overview of the different types of immersive VR-based interventions used in dementia education and training as well as its efficacy on knowledge, attitudes, empathy and sensitivity of health professionals and trainees, findings should be interpreted with caution due to several limitations.

First, the small number of studies conducted for each type of reported immersive virtual learning, except for VDT, found in this review reflects the paucity of empirical studies in the research field of immersive technologies (eg, VR and AR) in dementia education and training. Second, the nature of the study designs adopted in the quantitative and mixed-method studies reviewed, as previously noted, does not permit the establishment of efficacy (ie, lack of causality due to non-control group comparison[8 16 17 20 31 33–36 38 39] or non-randomisation between groups[18 37 40]). Third, the sample sizes were quite small, and non-reporting of demographics occurred within some studies. In addition, the gender and age imbalance across studies where the majority of participants were female and young adult, together with the quality shortcomings determined through the reported methodology of included studies, suggest the need for caution in the interpretation and generalisability of findings. Fourth, the heterogeneity of study designs, immersive virtual learning (ie, types and duration), together with different types of outcome assessment and the different tools used to assess these outcomes make it impractical for results of studies reviewed to be collated for auxiliary analysis. Finally, language bias should be considered because only studies published in the English language were selected, thereby omitting the possible inclusion of studies published in other languages. Further and more rigorous empirical research with larger sample sizes is needed for the different types of immersive virtual learning used in dementia education and training to better ascertain its efficacy on knowledge, attitudes, empathy and sensitivity of health professionals and trainees.

CONCLUSION

This integrative review syntheses evidence from both quantitative and qualitative studies with a total of 19 published articles included in the review. The results imply that currently, VR, rather than AR-based interventions are used in dementia education and training. Of these, five separate studies assessing immersive VR-based interventions were identified. The VDT is the most commonly used intervention followed by the DL programme. To date, published literature suggests that immersive VR-based interventions provide a promising way for educators to enhance knowledge, attitudes, empathy and sensitivity of health professionals and trainees. However, there remains a lack of conclusive and robust evidence to fully recommend the introduction and inclusion of immersive virtual learning in dementia education and training. Additional rigorously designed RCT/CT studies with larger sample sizes are needed to confirm the benefits found in this review. In particular, the potential of immersive virtual learning to improve attitudes, empathy, sensitivity and especially knowledge requires further investigation.

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Supplementary File 1. Full Search Strategies For All Databases

Limiters:

- Date Range: 01 January 2000 – 31 March 2021
- Full-text studies published in English

1. PubMed

("virtual realit*"[Title/Abstract] OR "virtual reality"[MeSH Terms] OR "VR"[Title/Abstract] OR "augmented realit*"[Title/Abstract] OR "augmented reality"[MeSH Terms] OR "AR"[Title/Abstract] OR "mixed realit*"[Title/Abstract])

AND

("health"[Title/Abstract] OR "health"[MeSH Terms])

AND

("educat*"[Title/Abstract] OR "educational status"[MeSH Terms] OR "education"[MeSH Terms] OR "intervention*"[Title/Abstract])

AND

("dementia"[Title/Abstract] OR "dementia"[MeSH Terms] OR "Alzheimer disease"[Title/Abstract] OR "Alzheimer disease"[MeSH Terms])

AND

("knowledge"[MeSH Terms] OR "knowledge*"[Title/Abstract] OR "attitude"[MeSH Terms] OR "attitude*"[Title/Abstract] OR "experience*"[Title/Abstract] OR "awareness"[MeSH Terms] OR "aware*"[Title/Abstract] OR "understand*"[Title/Abstract] OR "perception"[MeSH Terms] OR "perception*"[Title/Abstract] OR "comprehension"[MeSH Terms] OR "comprehension*"[Title/Abstract])

AND

("health professional*"[Title/Abstract] OR "personnel*"[Title/Abstract] OR "allied health personnel*"[Title/Abstract] OR "allied health personnel"[MeSH Terms] OR "doctor*"[Title/Abstract] OR "medical staff"[Title/Abstract] OR "nurs*"[Title/Abstract] OR "physical therap*"[Title/Abstract] OR "physiotherapy"[Title/Abstract] OR "occupational therap*"[Title/Abstract] OR "dieti*"[Title/Abstract] OR "trainee*"[Title/Abstract] OR "student*"[Title/Abstract])

2. EMBASE

(“virtual realit*”:ti,ab OR ‘virtual reality’/exp OR VR:ti,ab OR “augmented realit*”:ti,ab OR ‘augmented reality’/exp OR AR:ti,ab OR “mixed realit*”:ti,ab)

AND

(health:ti,ab OR ‘health’/exp)

AND

Jones C, *et al. BMJ Open* 2021; 11:e053616. doi: 10.1136/bmjopen-2021-053616

(educat*:ti,ab OR ‘educational status’/exp OR ‘education’/exp OR intervention*:ti,ab)

AND

(dementia:ti,ab OR ‘dementia’/exp OR “Alzheimer disease”:ti,ab OR ‘Alzheimer disease’/exp)

AND

(‘knowledge’/exp OR knowledge*:ti,ab OR ‘attitude’/exp OR attitude*:ti,ab OR experience*:ti,ab OR ‘awareness’/exp OR aware*:ti,ab OR understand*:ti,ab OR ‘perception’/exp OR perception*:ti,ab OR ‘comprehension’/exp OR comprehension*:ti,ab)

AND

(“health professional*”:ti,ab OR personnel*:ti,ab OR “allied health personnel*”:ti,ab OR ‘paramedical personnel’/exp OR doctor*:ti,ab OR “medical staff”:ti,ab OR nurs*:ti,ab OR “physical therap*”:ti,ab OR physiotherapy:ti,ab OR “occupational therap*”:ti,ab OR dieti*:ti,ab OR trainee*:ti,ab OR student*:ti,ab)

3. Cochrane

("virtual realit*":ti,ab OR [mh "virtual reality"] OR VR:ti,ab OR "augmented realit*":ti,ab OR [mh "augmented reality"] OR AR:ti,ab OR "mixed realit*":ti,ab)

AND

(health:ti,ab OR [mh health])

AND

(educat*:ti,ab OR [mh "educational status"] OR [mh education] OR intervention*:ti,ab)

AND

(dementia:ti,ab OR [mh dementia] OR "Alzheimer disease":ti,ab OR [mh "Alzheimer disease"])

AND

([mh knowledge] OR knowledge*:ti,ab OR [mh attitude] OR attitude*:ti,ab OR experience*:ti,ab OR [mh awareness] OR aware*:ti,ab OR understand*:ti,ab OR [mh perception] OR perception*:ti,ab OR [mh comprehension] OR comprehension*:ti,ab)

AND

("health professional*":ti,ab OR personnel*:ti,ab OR "allied health personnel*":ti,ab OR [mh "allied health personnel"] OR doctor*:ti,ab OR "medical staff":ti,ab OR nurs*:ti,ab OR "physical therap*":ti,ab OR physiotherapy:ti,ab OR "occupational therap*":ti,ab OR dieti*:ti,ab OR trainee*:ti,ab OR student*:ti,ab)

4. CINAHL

((TI "virtual realit*" OR AB "virtual realit*") OR (MH "virtual reality+") OR (TI VR OR AB VR) OR (TI "augmented realit*" OR AB "augmented realit*") OR (MH "augmented reality+") OR (TI “AR” OR AB “AR”) OR (TI "mixed realit*" OR AB "mixed realit*"))

AND

((TI health OR AB health) OR (MH "health+"))

AND

((TI educat* OR AB educat*) OR (MH "educational status+") OR (MH "education+") OR (TI intervention* OR AB intervention*))

AND

((TI dementia OR AB dementia) OR (MH "dementia+") OR (TI "Alzheimer disease" OR AB "Alzheimer disease") OR (MH "Alzheimer's disease+"))

AND

((MH "knowledge+") OR (TI knowledge* OR AB knowledge*) OR (MH "attitude+") OR (TI attitude* OR AB attitude*) OR (TI experience* OR AB experience*) OR (MH "cognition+") OR (TI aware* OR AB aware*) OR (TI understand* OR AB understand*) OR (MH "perception+") OR (TI perception* OR AB perception*) OR (TI comprehension* OR AB comprehension*))

AND

((TI "health professional*" OR AB "health professional*") OR (TI personnel* OR AB personnel*) OR (TI "allied health personnel*" OR AB "allied health personnel*") OR (MH "allied health personnel+") OR (TI doctor* OR AB doctor*) OR (TI "medical staff" OR AB "medical staff") OR (TI nurs* OR AB nurs*) OR (TI "physical therap*" OR AB "physical therap*") OR (TI physiotherapy OR AB physiotherapy) OR (TI "occupational therap*" OR AB "occupational therap*") OR (TI dieti* OR AB dieti*) OR (TI trainee* OR AB trainee*) OR (TI student* OR AB student*))

5. Scopus

(TITLE-ABS("virtual realit*") OR INDEXTERMS("virtual reality") OR TITLE-ABS("VR") OR TITLE-ABS("augmented realit*") OR INDEXTERMS("augmented reality") OR TITLE-ABS("AR") OR TITLE-ABS("mixed realit*"))

AND

(TITLE-ABS("health") OR INDEXTERMS("health"))

AND

(TITLE-ABS("educat*") OR INDEXTERMS("educational status") OR INDEXTERMS("education") OR TITLE-ABS("intervention*"))

AND

(TITLE-ABS("dementia") OR INDEXTERMS("dementia") OR TITLE-ABS("Alzheimer disease") OR INDEXTERMS("Alzheimer disease"))

AND

(INDEXTERMS("knowledge") OR TITLE-ABS("knowledge*") OR INDEXTERMS("attitude") OR TITLE-ABS("attitude*") OR TITLE-ABS("experience*") OR INDEXTERMS("awareness") OR TITLE-

ABS("aware*") OR TITLE-ABS("understand*") OR INDEXTERMS("perception") OR TITLE-ABS("perception*") OR INDEXTERMS("comprehension") OR TITLE-ABS("comprehension*"))

AND

(TITLE-ABS("health professional*") OR TITLE-ABS("personnel*") OR TITLE-ABS("allied health personnel*") OR INDEXTERMS("allied health personnel") OR TITLE-ABS("doctor*") OR TITLE-ABS("medical staff") OR TITLE-ABS("nurs*") OR TITLE-ABS("physical therap*") OR TITLE-ABS("physiotherapy") OR TITLE-ABS("occupational therap*") OR TITLE-ABS("dieti*") OR TITLE-ABS("trainee*") OR TITLE-ABS("student*"))

6. Web of Science Core Collection

ALL=("virtual realit*" OR VR OR "augmented realit*" OR AR OR "mixed realit*")

AND

ALL=(health)

AND

ALL=(educat* OR intervention*)

AND

ALL= (dementia OR "Alzheimer disease")

AND

ALL=(knowledge* OR attitude* OR experience* OR aware* OR understand* OR perception* OR comprehension*)

AND

ALL=("health professional*" OR personnel* OR "allied health personnel*" OR doctor* OR "medical staff" OR nurs* OR "physical therap*" OR physiotherapy OR "occupational therap*" OR dieti* OR trainee* OR student*)

7. PsychINFO

("virtual realit*".ti,ab OR exp virtual reality/ OR VR.ti,ab OR "augmented realit*".ti,ab OR exp augmented reality/ OR AR.ti,ab OR "mixed realit*".ti,ab)

AND

(health.ti,ab OR exp health/)

AND

(educat*.ti,ab OR exp education/ OR intervention*.ti,ab)

AND

(dementia.ti,ab OR exp dementia/ OR "Alzheimer disease".ti,ab OR exp Alzheimer disease/)

AND

(exp health knowledge/ OR knowledge*.ti,ab OR exp attitudes/ OR attitude*.ti,ab OR experience*.ti,ab OR exp awareness/ OR aware*.ti,ab OR understand*.ti,ab OR exp perception/ OR perception*.ti,ab OR exp comprehension/ OR comprehension*.ti,ab)

AND

("health professional*".ti,ab OR personnel*.ti,ab OR "allied health personnel*".ti,ab OR exp allied health personnel/ OR doctor*.ti,ab OR "medical staff".ti,ab OR nurs*.ti,ab OR "physical therap*".ti,ab OR physiotherapy.ti,ab OR "occupational therap*".ti,ab OR dieti*.ti,ab OR trainee*.ti,ab OR student*.ti,ab)

8. ERIC (Ovid)

(ti,ab("virtual realit*") OR MAINSUBJECT.EXACT.EXPLODE("Computer Simulation") OR ti,ab("VR") OR ti,ab("augmented realit*") OR ti,ab("AR"))

AND

(ti,ab("health") OR MAINSUBJECT.EXACT.EXPLODE("Health"))

AND

(ti,ab("educat*") OR MAINSUBJECT.EXACT.EXPLODE("Education") OR ti,ab("intervention*"))

AND

(ti,ab("dementia") OR MAINSUBJECT.EXACT.EXPLODE("Dementia") OR ti,ab("Alzheimer disease") OR MAINSUBJECT.EXACT.EXPLODE("Alzheimers Disease"))

AND

(ti,ab("knowledge*") OR MAINSUBJECT.EXACT.EXPLODE("Attitudes") OR ti,ab("attitude*") OR ti,ab("experience*"))

AND

(ti,ab("health professional*") OR ti,ab("personnel*") OR ti,ab("allied health personnel*") OR MAINSUBJECT.EXACT.EXPLODE("Allied Health Personnel") OR ti,ab("doctor*") OR ti,ab("medical staff") OR ti,ab("nurs*") OR ti,ab("physical therap*") OR ti,ab("physiotherapy") OR ti,ab("occupational therap*") OR ti,ab("dietic*") OR ti,ab("trainee*") OR ti,ab("student*"))

Supplementary File 2: Data Extraction Table

No.	Author/Year/ Country	Study Aim	Participants	Study Design	Intervention	Outcome Measures	Results	Study Limitations & Quality Appraisal (MMAT)
1 + 2	Adefila et al. (2016), United Kingdom + Ball et al. (2015), United Kingdom ***(Published conference paper reporting preliminary findings)***	The pilot study aimed to evaluate the effects of a developed VR resource on participants' understanding of dementia; attitudes towards the care treatment of people living with dementia; and opinions of the behaviours and attitudes of people living with dementia.	Students studying health and social care degrees (n=55): • Adult and mental health nurses • Clinical psychologists • Occupational therapists • Paramedics • Physiotherapists • Social workers	Mixed method: • One group pre/post tests • *"Think Aloud"* technique	***myShoes Project:*** • Development of a resource that would augment a virtual environment and enhance users' understanding of what living with dementia might be like. • Focused on facilitating user's affective empathy via the engagement of sensorimotor processing that are linked to cognitive and affective involvement in addition to the physical conditions (i.e., visual, audio and movement). **Equipment/Software:** • Oculus Rift (i.e., stereoscopic headset with touch controllers). • Unity 3D software engine. **VR Immersive Experience:** • User immerses and navigates the avatar of an older person. • Virtual environment is manipulated to misdirect and confuse user to complete simple tasks (e.g., clearing dining table). • User attempts open-ended tasks to experience the emotions and cognitive function impairments people living with dementia encounter.	**Standardised Self-Reporting Instruments Completed Prior to VR Experience:** • Interpersonal Reactivity Index (IRI) : Assesses perspectives of and empathetic concerns for others. • Inventory of Interpersonal problems-32 : Identifies interpersonal relationship issues that can influence VR experience. • Generalised Anxiety Disorder-7 : Assesses anxiety issues that can inhibit engagement of emotionally challenging tasks, acquire and assimilate new information as well as ability to empathise. **Pre/Post Tests:** Same questionnaire administered before and after VR experience to capture self-perceived confidence, competence and compassion on a non-numeric visual analogue scale plus questions on: ○ previous understanding of dementia (pre-test); and ○ the Impact of VR experience on understanding of dementia and how it can be improved (post-test).	Potentially a useful training tool that facilitates person-centred dementia care where consideration is not only placed on personal skills or competency in treatment but also the feelings, dignity and well-being of people living with dementia in order to appropriately adjust care approach. **Improved Confidence:** • Pre (M=4.35; SD=2.50) • Post (M=5.75; SD=2.61) • p<.001; d=0.90 **Improved Competence:** • Pre (M=4.36; SD=2.59) • Post (M=5.84; SD=2.50) • p<.001; d=0.93 **Improved Compassion (Empathy - IRI):** • Pre (M=8.48; SD=1.73) • Post (M=9.10; SD=1.65) • p<.001; d=0.51	• Small sample size. • Simulation sickness reported by some users. • Unclear reporting of methodology including sampling strategy, nonresponse bias and details of outcome measurement used. • Demographics participants (e.g., age and gender) were not reported.
3	Beville (2002), United States of America	To assess caregivers' experience following sensitivity training using the Virtual Dementia Tour.	Eldercare Workers (n=146): • Nurses • Aides • Social workers • Activity directors • Administrators • Directors of Nursing	Quasi-experimental (one group pre/post-tests).	***Virtual Dementia Tour (VDT).*** **Equipment:** *Participants 'garbed':* • Popcorn kernels in shoes/gloves *(simulate poor circulation, neuropathy and/or arthritis + loss of sensory and motor skills)*. • Gloves with tape *(simulate loss of mobility and motor skills)*. • Goggles darkened with yellow cellophane, smeared with Vaseline and a centered black dot *(simulate variety of visual impairments)*. • Headphones and cassette players *(simulate variety of hearing impairments)*.	**Developed Survey (Pre/Post):** Q1) Do you feel you understand the emotional needs for our elders? Q2) From a physical standpoint, do you feel capable of carrying out simple tasks? Q3) What is your current state of relaxation? Q4) Is it necessary to sensitise yourself to elders to provide good care? Q5) How easy is it for a dementia resident to get through the day? Q6) *(Pre-Test)* How often do you experience inappropriate behaviour? Q6) *(Post-Test)* If you had dementia, how justified would you feel about exhibiting inappropriate behaviour?	Participants' empathy towards patients living with dementia increased along with awareness that their high expectations of these patients are unrealistic and need to change. An increase in understanding and/or awareness of residents with dementia: Q1) emotional needs. Q2) incapability to perform simple everyday tasks. Q3) feelings of anxiousness. Q5) functional difficulties and challenges to get through the day.	• Unclear reporting of project aim (*implied*) and methodology including study design, sampling strategy, and nonresponse bias. • Demographics participants (e.g., age and gender) were not reported. • Face validity/internal consistency of VDT survey was not clearly reported.

					Environment: Imitation of a residential room with bed, desk, closet, nightstand and bathroom plus a range of objects to create confusion. • Transparency image of an elder person on bathroom mirror *(simulate loss of recognition)*. • Camera flashed every three minutes *(simulate privacy loss)*. • Dimly lit. **Experience:** • To complete five simple everyday tasks (i.e., find and put on a sweater; write a three-sentence note and place it in an envelope for family; towel folding, teeth brushing; and rearrangement of clothing in closet by colours). • Participants were allowed 10 minutes per task but were only informed that it was a *'timed exercise'*.	Q7) *(Pre-Test)* Assuming you have exhibited inappropriate behaviour at some point, how justified did you feel in that behaviour? Q7) *(Post-Test)* If you suffered from dementia, how justified would you feel about exhibiting inappropriate behaviour? Q8) In your opinion, do dementia residents generally get the care they need? **Observation Form:** Standardised form: • Interactions • Verbal and nonverbal communications • Types of tasks completed	Q6) exhibited 'inappropriate behaviours' may not be inappropriate after all. Q7) unjustified 'inappropriate behaviours' may not be unjustified after all. Q8) do not always receive the care they need. Participants also believed there is a need to be sensitised to elders in order to provide good care (Q4). Subvocalisation occurred in participants as a coping strategy, and they displayed inappropriate behaviours during the VDT experience.	
4	Campbell et al. (2021), United States of America	To evaluate the impact of a simulated virtual reality dementia experience on future nurses' perceptions of awareness, knowledge and sensitivity of Alzheimer's Disease (AD).	Undergraduate nursing students (n=70).	Quasi-experimental (one group pre/post-tests).	Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Survey (Pre/Post):** • Dementia Attitudes Scale (DAS) : Assessed attitudes towards dementia. • Knowledge About Memory Loss and Care (KHML-C) : Assessed knowledge of caregivers patients' memory loss in early stages of AD. • Five questions from Beville et al. (2002) VDT survey used – Q3, Q5, Q8 plus two others (not reported). **Students' Written Reflections:** • How VDT affected them. • Memorable and impactful aspect(s) of VDT. • Difference in approach to care after VDT.	Virtual reality dementia experience improved perceptions of awareness, knowledge and sensitivity of AD. **Improved Attitudes (DAS):** • Significantly improved DAS total scores (p<.001). **Knowledge (KHML-C):** • No significant change (p>.05). **VDT Survey:** • An increase in understanding and/or awareness of residents with dementia: ○ feelings of anxiousness; ○ functional difficulties and challenges to get through the day; and ○ do not always receive the care they need. Participants reflected on: • The value of the VDT experience in enhancing their knowledge and appreciation of the care required by people with AD. • The need for sensitivity and empathy when caring for people with AD. • The need to change their care approach for people with AD.	• Demographics participants (e.g., age and gender) were not reported.

							• Carers' stress and the need to support families of people with AD.	
5	Donahoe et al. (2014), United States of America	To increase students' knowledge and empathy towards older adults with dementia using the Virtual Dementia Tour.	Students (n=208): • Studying social work or a related human service profession • Females (n=185) and males (n=23) • Age range: 18-63	Mixed Method: • Non-experimental, non-equivalent groups with pre/post tests • Reflection	Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Survey (Pre/Post):** • Beville et al. (2002) VDT survey – Q1 to Q5 plus Q8. • Inclusion of two qualitative questions regarding how students were affected and what they may do differently due to their VDT experience. **Reflective Write-up:** • Awareness and feelings of aging and dementia. • Empathy towards older people. • Effects of VDT experience on both their professional and personal life. • Impact on future practice and interactions with clients.	The learning tool was effective in increasing participants' empathy towards people with dementia. **VDT Survey:** • Significant change (p <.0001) from pre (*M*=17.14; *SD*=3.07) to post (*M*=21.20; *SD*=3.69) with an increase in understanding and/or awareness of residents with dementia: ○ emotional needs; ○ incapability to perform simple everyday tasks; ○ feelings of anxiousness; ○ functional difficulties and challenges to get through the day; and ○ do not always receive the care they need. Furthermore, participants believed there is a need to be sensitised to elders in order to provide good care. Upon reflection, they also indicated that the VDT experience: • Had positively affected them personally and professionally. • Provided them an insight into the experience of living with dementia. • Increased their awareness of aging-related health challenges (e.g., vision and hearing problems). • Increased their confidence and interest to work with people living with dementia.	• Face validity/internal consistency of VDT survey was not clearly reported.
6	Dyer et al. (2018), Australia	To increase students' empathy towards older adults via a virtual reality experience.	Students studying (n = > 600): • Medicine • Physical Therapy • Physician Assistant	Quasi-experimental (pre/post-tests).	***Virtual Reality Educational Project.*** **Equipment:** • Alienware laptop or desktop stations. • Embodied Labs program. • Oculus Rift headset and sensor. • Leap Motion hand-tracking device. **Experience:** • Age-related conditions: macular degeneration and high-frequency hearing loss. • Alzheimer's disease and end-of-life conversations.	**Assessment:** • Pre/post assessment via REDCap platform.	• Increased understanding of health problems associated with aging. • Increased empathy of older people experiencing vision and hearing loss as well as Alzheimer's disease.	A brief report with limited information on: • The appropriateness of collected data to answer research question. • Methodology: ○ participants' recruitment; ○ procedures; ○ appropriateness measurement (i.e., that is the nature and validity of developed assessment tool); and

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>○ data analysis (i.e., the statistical analysis conducted).
• Demographics participants (e.g., age and gender) were not reported.
• Discussion of results (e.g., non-response bias, limitations).</td></tr>
<tr><td>7</td><td>Gilmartin-Thomas et al. (2018), Australia</td><td>To quantitatively evaluate the impact of a virtual dementia experience on medical and pharmacy students' knowledge and attitudes toward people with dementia.</td><td>Students studying (n=278):
• Medicine and Surgery (n=64)
• Pharmacy (n=214)
• Females (n=184) and males (n=94)
• Mean age: 22.5</td><td>Non-randomised controlled.</td><td>Intervention & Control Group:
• Standard curriculum

Intervention Only Group:
• Alzheimer's Australia Victoria Virtual Dementia Experience (VDE).

Equipment:
• An immersive environment with a 10x2m screen that provides a multisensory and virtual simulation of light, sound, colour, and visual content.

Experience:
• Cognitive and perceptual difficulties encountered by people living with dementia.
• Facilitator guided personal reflection and group discussion.</td><td>Survey (Pre/Post):
• Dementia Attitudes Scale (DAS) : Assessed attitudes towards dementia.</td><td>Participants' knowledge and attitudes towards people with dementia was positively impacted.

Improved Attitudes (DAS):
• Significantly improved DAS total scores (p<.05) and subdomains of comfort and knowledge (p<.01) for the intervention group when compared to the control group across medical students, pharmacy students and students combined.
<table>
<tr><td></td><td>Int</td><td>Ctrl</td></tr>
<tr><td>Medical - C</td><td>9.9</td><td>0.5</td></tr>
<tr><td>Medical - K</td><td>4.6</td><td>-1.0</td></tr>
<tr><td>Medical - O</td><td>14.4</td><td>-0.1</td></tr>
<tr><td>Pharmacy - C</td><td>11.3</td><td>1.8</td></tr>
<tr><td>Pharmacy - K</td><td>6.1</td><td>0.1</td></tr>
<tr><td>Pharmacy - O</td><td>17.8</td><td>2.1</td></tr>
<tr><td>Combined - C</td><td>10.6</td><td>1.7</td></tr>
<tr><td>Combined - K</td><td>5.4</td><td>-0.1</td></tr>
<tr><td>Combined - O</td><td>16.1</td><td>1.8</td></tr>
</table>
Difference in means; Int = Intervention; Ctrl = Control; C = Comfort; K = Knowledge; O = Overall</td><td>• Students were not randomly allocated to groups.
• Students without follow-up (post) data were excluded from the final analysis.</td></tr>
<tr><td>8</td><td>Gilmartin-Thomas et al. (2020), Australia</td><td>To qualitatively evaluate the impact of a virtual dementia experience on medical and pharmacy students' self-reported knowledge and attitudes toward people with dementia.</td><td>Students studying (n=53):
• Medicine and Surgery (n=29)
• Pharmacy (n=24)
• Female (n=35), male (n=17), and gender not recorded (n=1)</td><td>Qualitative study Focus group interviews (n=10).</td><td>Gilmartin-Thomas et al. (2018) - Virtual Dementia Experience (VDE).</td><td>Individual Interviews:
• Thematic analysis of semi-structured, open-ended questions focusing on:
○ perceived usefulness of VDE;
○ potential improvements to VDE; and
○ VDE's ability to inform understanding of dementia-friendly environments.</td><td>• Improved self-reported knowledge and attitudes towards people living with dementia.
• VDE is useful and impactful, and could be included in hospital, medical, and pharmacy-specific scenarios and opportunities for role play to enhance learning.
• Acknowledge the need to include dementia-friendly communication techniques in future practice.
• Recognise the need to incorporate dementia-friendly characteristics in workplace (i.e., medical environments and pharmacy).</td><td>• Met all criteria.</td></tr>
<tr><td>9</td><td>Han & Brown (2019), United States of America</td><td>To explore experiences of caregivers of people with dementia who participated in a</td><td>Caregivers (n=14):
• Formal (n = 10)
• Informal (n = 4)
• Females (n=12) and males (n=2)</td><td>Qualitative Individual interviews.</td><td>Dementia Live (DL) Program comprising of 3 sessions lasting a total of 30-40 minutes (see below) – www.ageucate.com</td><td>Individual Interviews:
• Thematic analysis, using NVivo 11 software, of semi-structured, open-ended questions focusing on:</td><td>• An eye-opening opportunity to be in the shoes of people with dementia (i.e., sharing their feelings and experiences) and the realisation of</td><td>• Met all criteria.</td></tr>
</table>

		dementia simulation program.	• Mean age: 35.5		**Equipment:** • Headphones with MP3 Player (*to distract attention and hearing*). • Eyewear (*to limit peripheral vision*). • Gloves (*to weaken sense of touch and fine motor skills*). • Experience room. **Experience:** • Preparation session (~10 minutes) • Experience session (~7 minutes): to complete 5 daily tasks that are read out. • Empowerment session (~10-20 minutes) to discuss: ○ participants performance, behaviours and reactions (feelings); ○ reasoning of people with dementia's behaviours; and ○ possible changes to care approaches with a trained DL program coach.	○ experience of participating in the DL program; and ○ perceived impact of DL program on their perspectives on and caring for people with dementia.	how living with dementia was much harder than anticipated. • Perceived benefits from increased empathy and sympathy through an understanding of the emotions and behaviours of people with dementia; as well as promoting the use of new helpful care strategies. • Caregivers should have the DL experience and it is a better training method than others.	
10	Han et al. (2019), Korea	To explore experiences of caregivers of people with dementia who participated in a Korean dementia simulation program.	Caregivers (n=28): • Formal (n = 12) • Informal (n = 16) • Females (n=25) and males (n=3) • Mean age: 54.1	Qualitative Phenomenological study via individual interviews.	*Modified version of the **Dementia Live (DL)* program** www.ageucate.com – translated to Korean with daily tasks adjusted to suit the Korean cultural context.	**Individual Interviews:** • Thematic analysis, using ATLAS.ti 8 software, of semi-structured, open-ended questions focusing on: ○ experience of participating in the DL program; and ○ perceived impact of DL program on their perspectives and carding for people with dementia.	• Improved empathy through an understanding of how people with dementia perceived the world, as well as their emotional daily struggles and behaviours in daily lives. • Positively impacted care strategies through using or promoting the use of new helpful strategies; and the realisation of the emotional and social benefits on self and people with dementia through changing care strategies. • Increased awareness of the need to provide people with dementia more attention and affection. • Increased awareness of the need to educate people aging and dementia related health changes.	• Met all criteria.
11	Kimzey et al. (2019), United States of America	To ascertain the effects of a dementia simulation on empathy, dementia knowledge and self-confidence for dementia care of nursing students.	Undergraduate nursing students enrolled in a Behavioural Health Course (n=108): • Female (n=101) and Male (n=7) • Age range: 17-21 (n=84); >21 (n=24)	Quasi-experimental (2 groups pre/post-tests): • Intervention • Control	**Intervention & Control Group:** • Dementia-related online modules: ○ Definitions, background, anatomy and physiology; and ○ Brief videos on dementia progression and perspectives of a people with dementia and a caregiver • Dementia-related lectures: ○ Incidence/prevalence; ○ Delirium, depression and dementia; and ○ Common communication challenges.	**Survey (Pre/Post):** • Dementia Attitudes Scale (DAS) : Assessed attitudes towards dementia. • Interpersonal Reactivity Index (IRI) : Assesses perspectives of and empathetic concerns for others. • Dementia Knowledge Assessment Tool Version 2 (DKAT2) : Assesses knowledge of dementia and dementia care. • Confidence in Dementia Scale (CODE) : Assesses overall confidence in working with people with dementia.	81 out of 108 matched paired pre/post surveys **Improved Attitudes (DAS):** • Significant improvement over time from pre to post (p=.049). • No significant difference between groups (p>.05). **Empathy (IRI):** • No significant difference between groups (p>.05) except for a significant improvement over time from pre to	• Students were not randomly allocated to groups. • Students without follow-up (post) data were excluded from the final analysis – low post intervention response rate (reasons unknown) - drop from 108 (pre) to 81 (post) participants.

					○ Behaviours and associated factors **Intervention Only Group:** ○ ***Dementia Live (DL)* program** – www.ageucate.com		post on the subscale of *Perspective Taking* (*p*=.007): **Knowledge (DKAT2):** • Significant improvement over time from pre to post (*p*<.001). • No significant difference between groups (*p*>.05). **Confidence (CODE):** • Significant improvement over time from pre to post (*p*<.001). • No significant difference between groups (*p*>.05).	
12	Kimzey et al. (2020), United States of America	To ascertain the effects of a dementia simulation on empathy and dementia knowledge of nursing students.	Undergraduate nursing students enrolled in a Behavioural Health Course (n=55): • Female (n=46) and Male (n=9) • Age range: 17-25	Mixed method: • One group pre/post tests • Focus group interviews (n=8)	**Lesson:** • Dementia-related lecture covering: ○ incidence/prevalence; ○ delirium, depression and dementia; and ○ common communication challenges. **Simulation:** • ***Dementia Live (DL)* program** – www.ageucate.com	**Survey (Pre/Post):** • Dementia Knowledge Assessment Tool Version 2 (DKAT2) : Assesses knowledge of dementia and dementia care. • Comprehensive State Empathy Scale (CSES) : Assesses empathy. **Focus Group Interviews:** • Thematic analysis of semi-structured, open-ended questions focusing on thoughts, perspectives, feelings, motivation to help following participation in the DL program.	Significant improvement on participants' empathy. **Improved Empathy (CSES):** • Pre (*M*=94.67; *SD*=20.22) • Post (*M*=112.75; *SD*=21.08) • Significance (*p*<.001) **Knowledge (DKAT2):** • No significant change (*p*=.369) **Interviews:** • Cognitive empathy: Dementia related experience of losses in cognitive, independence, purpose, socialisation and sensory perception and the impact on daily life as well as feelings of isolation and stigmatisation were recognised. • Distress: Expressed feelings of distress (e.g., sadness, anxiety and frustration) associated with living with dementia, as well as fear of having dementia in the future (personally or a family member). • Empathic Imagination: Appreciated and can imagine how they, personally, or others living with dementia would feel/behave. • Helping Motivation: Increased inclination to engage with people with dementia by spending more time with them, listening to, as well as being understanding, assuring and patient etc.	• Small sample size.
13	Lorio et al. (2017), United States of America	To educate physical therapy students on the challenges associated with dementia and to increase knowledge and confidence	Physical Therapy students (n=31): • Females (n=17) and males (n=14) • Age range: 22-29 (n=25); 30-39 (n=3); >40 (n=1)	Quasi-experimental (one group pre/post-tests).	• 12-hour multimodal experimental learning module comprising of: ○ dementia-related lectures; ○ Beville et al. (2002) - ***Virtual Dementia Tour (VDT);***	**Survey (Pre/Post):** • Confidence in Dementia Scale (CODE) : Assesses overall confidence in working with people with dementia. • Knowledge in Dementia Scale (KIDS) : Assesses knowledge of dementia.	Overall, the experimental learning improves participants' understanding of the challenges related to the treatment of patients with dementia and their confidence in working with them.	• Small sample size. • Face validity/internal consistency of VDT survey was not clearly reported. • Appropriateness of measurement tool (i.e.,

		when treating these patients.			○ clinical work with patients with dementia at a memory care centre; and ○ interactive book club discussion.	• Beville et al. (2002) VDT survey plus two questions on: ○ confidence to treat patient with dementia; and ○ understanding that aged-related changes can further impact communication and comprehension in patients with dementia.	**Improved Confidence (CODE):** • Pre (*M*=30.63; *SD*=5.18) • Post (*M*=36.97; *SD*=4.90) • *p*<.001 **Knowledge (KIDS):** • No significant change (*p*=.604) **VDT Survey:** • Increased awareness of the need to be sensitised to older people to provide good care (*p*<.025). • Increased awareness of how difficult it is for patients with dementia to get through the day (*p*<.004). • Increased understanding on why people with dementia exhibit inappropriate behaviours (*p*<.001).	KIDS may not be sensitive to assess changes in knowledge.
14	Mastel-Smith et al. (2020), United States of America	To promote students' knowledge, attitudes, empathy and self-confidence for dementia care via the Dementia Care Bootcamp.	Undergraduate students (n=43): • Nursing (n=19) • Occupational Therapy Assistant (n=13) • Pharmacy (n=3) • Psychology (n=8) • Female (n=39) and Male (n=4) Age range: 17-21 (n=15); 22-25 (n=18); 26-30 (n=4); 31-40 (n=3); and 41-50 (n=3)	Embedded mixed method: • Quasi-experimental (one group pre/post-tests) • Focus group interviews (n=3)	**Dementia Boot Camp (2 x 8-hour sessions) consisting of:** • A Dementia care expert trainer. • Videos about dementia care. • Case-specific vignettes. • Role-plays. • Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Survey (Pre/Post & Follow-up @ 3 months):** • Dementia Knowledge Assessment Tool Version 2 (DKAT2) : Assesses knowledge of dementia and dementia care. • Dementia Attitudes Scale (DAS) : Assessed attitudes towards dementia. • Interpersonal Reactivity Index (IRI) : Assesses perspectives of and empathetic concerns for others. • Confidence in Dementia Scale (CODE) : Assesses overall confidence in working with people with dementia. **Focus Group Interviews:** • Colaizzi's seven step approach to qualitative data analysis was used to examine participants' experience of: ○ what went well; ○ what needed improvements; ○ activities where new information are learnt from; ○ activities that facilitated learning; ○ barriers to learning; and suggestions for future program.	Significant results for: **<u>Pre/Post</u>** **Improved Knowledge (DKAT):** • Pre (*M*=14.63; *SD*=2.44) • Post (*M*=17.23; *SD*=1.61) • Significance (*p*<.001) **Improved Attitudes (DAS):** • Pre (*M*=5.38; *SD*=0.57) • Post (*M*=5.81; *SD*=0.54) • Significance (*p<.001*) **Improved Confidence (CODE):** • Pre (*M*=3.18; *SD*=0.67) • Post (*M*=4.03; *SD*=0.58) • Significance (*p<.001*) **Improved Perspective Taking (IRI Sub-Scale):** • Pre (*M*=3.26; *SD*=0.43) • Post (*M*=3.88; *SD*=0.69) • Significance (*p<.05*) **<u>Follow-up @ 3 Months</u>** **Improved Knowledge (DKAT):** • Pre (*M*=14.58; *SD*=2.55) • Post (*M*=16.92; *SD*=1.78) • Significance (*p*<.001) **Improved Attitudes (DAS):** • Pre (*M*=5.36; *SD*=0.57) • Post (*M*=5.01; *SD*=0.31) • Significance (*p<.001*) **Improved Confidence (CODE):**	• Small sample size. • Students without post or follow-up data were excluded from the final analysis.

							• Pre (*M*=3.13; *SD*=0.68) • Post (*M*=3.83; *SD*=0.67) • Significance (*p<.001*) **Improved Fantasy (IRI Sub-Scale):** • Pre (*M*=3.18; *SD*=0.56) • Post (*M*=3.62; *SD*=1.09) • Significance (*p=.003*) **Improved Empathy (IRI Sub-Scale):** • Pre (*M*=3.13; *SD*=0.33) • Post (*M*=4.19; *SD*=0.69) • Significance (*p<.001*) **Improved Personal Distress (IRI Sub-Scale):** • Pre (*M*=2.69; *SD*=0.43) • Post (*M*=2.29; *SD*=0.61) • Significance (*p<.001*) **Improved Perspective Taking (IRI Sub-Scale):** • Pre (*M*=3.29; *SD*=0.42) • Post (*M*=3.88; *SD*=0.69) • Significance (*p<.001*) Qualitative findings supported quantitative results with perceived improvements in empathy, attitudes towards dementia, as well as knowledge and confidence for dementia care.	

15	Mastel-Smith et al. (2019), United States of America	To promote students' knowledge, attitudes, empathy and self-confidence for dementia care via the Dementia Care Bootcamp and clinical experience.	Undergraduate nursing students (n=100):
			• Female (n=83) and Male (n=17)
				Quasi-experimental (2 groups pre/post-tests).	**Group 1:** Mastel-Smith et al. (2020) – ***Dementia Boot Camp* (10-hour)**.
					
					Group 2: Dementia Boot Camp + Clinical Experience (1-day).
						Survey (Pre/Post):
						• Dementia Knowledge Assessment Tool Version 2 (DKAT2) : Assesses knowledge of dementia and dementia care.
						• Dementia Attitudes Scale (DAS) : Assessed attitudes towards dementia.
						• Interpersonal Reactivity Index (IRI) : Assesses perspectives of and empathetic concerns for others.
						• Confidence in Dementia Scale (CODE) : Assesses overall confidence in working with people with dementia.
							Significant results for *all* participants on:
							
							Improved Knowledge (DKAT):
							• Pre (**EMMs*=14.58; *SE*=0.28)
							• Post (*EMMs* =16.25; *SE*=0.28)
							• Significance (*p*<.001)
							
							Improved Attitudes (DAS):
							• Pre (*EMMs* =106.22; *SE*=1.46)
							• Post (*EMMs* =112.07; *SE*=1.69)
							• Significance (*p*=.002)
							
							Improved Confidence (CODE):
							• Pre (*EMMs* =30.51; *SE*=0.76)
							• Post (*EMMs* =32.56; *SE*=0.67)
							• Significance (*p*=.017)
							
							Overall:
							• No significant difference (*p*>.05):
							  ○ In all participants' empathy; and
							  ○ between groups on all outcome measures.
								• Students were not randomly allocated to groups.
								• Demographics participants (e.g., age) were not reported.

							** EMMs = Estimated Marginal Means*	
16	Meyer et al. (2020), United States of America	To examine how a simulation training program can prepare healthcare trainees to treat people with dementia.	Participants (n=28): • Healthcare students (n=5) • Teaching faculty members (n=3) • Nursing students (n=20)	Qualitative: • Individual interviews (n=8) • Reflection papers (n=20)	Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Individual Interviews:** • Thematic analysis of semi-structured questions focusing on VDT experiences and how they would deliver care to people with dementia. **Reflection Papers:** • Visceral experiences and reactions during VDT. • How they would for people with dementia following the VDT experience.	• Gaps in traditional teaching approaches are addressed by simulated learning. • Gain an insight into the lived experience of living with dementia and co-morbid conditions (empathy). • Application of simulation into care practice via: ○ having patience; ○ assessing and anticipating care needs; ○ educating others (e.g., family members of people with dementia); and ○ creating a culture of care.	• Met all criteria.
17	Peng et al. (2020), China	To evaluate the effect of Virtual Dementia Tour on nursing students' empathy and future dementia care.	Second year undergraduate nursing students (n=45): • Female (n=42) and Male (n=3) • Mean age: 18.96	Mixed method: • One group pre/post tests • Individual interviews	• Movie 'Still Alice' • Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Survey (Pre/Post):** • Jefferson Scale of Empathy-Health Profession Students (JSE-HPS) : Assess empathy in the context of health professions education. **Individual Interviews:** • Semi-structured with questions focusing on VDT experiences, benefits of VDT, impact of VDT experience on future practice and practical recommendations – analysed via NVivo 11 software.	Significant improvement on participants' empathy. **Improved Empathy (JSE-HPS):** • Pre (*M*=106.69; *SD*=9.49) • Post (*M*=115.51; *SD*=10.16) • Significance (*p*<.01) **Interviews:** • Program is effective but VDT more so than the movie. • Satisfied and would recommend the program to others. • Experienced challenges to tasks completion and feelings of frustration, helplessness and anger. • Increased awareness to help and be patient with people with dementia, as well as avoid asking them to do multiple task and provide some time to do tasks.	• Small sample size. • Limited integration of quantitative results and qualitative findings.
18	Slater et al. (2019), Ireland	To explore the impact of an interactive training experience on moral, emotive, behavioural, and cognitive elements of empathy.	Participants (n=18): • Frontline Staff (i.e., Registered Nurses and Healthcare Assistants) (n=5) • Carers and Befrienders (n=4) • Senior Management (i.e., Service Managers and Director of Nursing) (n=6) • Allied Health Professionals (n=1) • Medical/Psychiatry Staff (n=1) • Others (i.e., Educationalists and	Qualitative Individual face-to-face or telephone interviews.	Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Individual Interviews:** • Thematic analysis of interview questions focusing on the four elements of empathy (i.e., emotive, moral, cognitive, and behavioural) and guided by three broad aspects: 1) VDT experience; 2) benefits of VDT; and 3) impact of VDT on practice.	Participants perceived VDT to be useful and provided an emotional insight into what it is like to be living with dementia that enables reflection on a cognitive, moral and behavioural level, leading to empathy. **Emotive Component:** • Induced feelings of frustrating when performing daily activities and fear and concerns of developing dementia. **Moral Component:** • Self-reflection led to guilt and shame for how care had been previously provided to people with dementia.	• Met all criteria.

			Dementia Service Managers) (n=1) • Female (n=15) and Male (n=3)				**Cognitive Component:** Awareness of dementia manifestations other than memory impairments. • Reasoning of dementia-related behavioural and psychological responses such as wandering, aggression and agitation. **Behavioural Component:** • Improved overall quality of care delivery. • Enhanced communication and confidence. • Less judgement in managing challenging behaviours. • Reduced fear, stress, and frustration to inform future care options.	
19	Werner et al. (2014), United States of America	To explore the effects of an experiential learning technique to improve social work students' empathy toward and understanding of older adults with dementia.	Social Work students (n=95) who are studying either one of the following subjects: • Introduction to Social Work • Human Behaviour and Social Environment • Females (n=85) and males (n=10) • Age range: 19-22	Mixed method: • One group pre/post tests • Qualitative open-ended question	Beville et al. (2002) - ***Virtual Dementia Tour (VDT)***.	**Survey (Pre/Post):** • Modified version of Beville et al. (2002) VDT survey plus two open-ended questions seeking reflection on VDT experience.	Improvements on participants' empathy and understanding of adults with dementia were found. Feelings of vulnerability and confusion occurred during VDT. **VDT Survey:** • Significant change ($p < .001$) from pre (M=12.98; SD=1.77) to post (M=15.49; SD=2.05) where majority of participants has an increase in understanding and empathy (n=58, 62.3%). **Potential behaviour changes resulting from VDT:** • Increased patience and understanding. • Increased need for more training and education. • Importance of sharing their VDT experience with others.	• Nonresponse bias; the number of participants who did not complete the post VDT survey was not reported. • Face validity/internal consistency of VDT survey was not clearly reported.