Artificial intelligence-driven virtual patients for communication skill development in healthcare students: A scoping review

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This study presents a scoping review of research on artificial intelligence (AI)- driven virtual patients (VPs) for communication skills training of healthcare students. We aimed to establish what is known about these emergent learning tools, to characterise their design and implementation into training programmes. The preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews framework was consulted. Searches occurred in six online databases to capture relevant articles from 2014 to 2024. Eight articles from five disciplines met inclusion criteria. A variety of design approaches, creation tools and VP appearances exist. Educational considerations such as consultation of educational theory, curricular integration and provision of feedback was overall lacking. Neutral to positive evaluations of satisfaction and acceptance of the VPs were provided by most students. Emerging literature suggests AI-driven VPs are increasingly being utilised for communication skills training, although their effectiveness is not established. Careful consideration of technological design features, educational theory and evidence regarding communication skill development should occur by clinical educators wishing to include AI-driven VPs in their training programmes. Further empirical research involving key stakeholders is needed to learn more about this technology.

Implications for practice or policy:

- Students may find benefit from having opportunities to use AI-driven VPs for communication skill development.
- Developers could avoid some criticisms of AI-driven VPs by carefully addressing technical issues
- Educators should consult evidence on educational and communication theories when utilising AI-driven VPs.
- Researchers should consider increasing the involvement of key stakeholders in the design and evaluation of communication skill focused AI-driven VPs.

Keywords: virtual patient, virtual simulation, conversational agent, artificial intelligence, communication, non-technical skills, scoping review

Introduction

The ability of health professionals to communicate effectively with patients is tantamount to the care a patient receives. Clinicians need to be clear and concise, display active listening, demonstrate empathy and compassion and should be able to educate patients effectively about health conditions and treatment options (Henry et al., 2013). Ineffective patient-provider communication can have a range of consequences including poor patient satisfaction, inadequate recall, poor adherence and lack of understanding of health advice (King & Hoppe, 2013). In turn, this may lead to negative health outcomes, over-prescription of drugs, increased costs to the individual and health system and even malpractice claims (Henry et al., 2013; King & Hoppe, 2013). Patient reports of negative communication experiences such as feeling judged, disregarded or dictated to exist across various health disciplines (Fico & Lagoe, 2018; Sladdin et al., 2018), and literature indicate clinicians' communication skill levels may decline over time (Bachmann et al., 2017). This evidence highlights a need to continually ensure that teaching programmes are teaching communication in effective ways. There needs to be a focus on guaranteeing graduates maintain their skill level well into their professional practice years, given the profound impacts of the health professional who communicates poorly.

Best practice for communication training in healthcare education is theory based and offers incremental, longitudinal and experiential learning to students (Bachmann et al., 2022; Cushing, 2015). Communication curricula in the medical and health professions traditionally incorporates lectures, workshops, role-plays, standardised patient encounters and ultimately clinical placements (Henry et al., 2013). Transferring what is learnt in the classroom into the clinic, receiving direct observation by an expert in the field and being given feedback on performance are all key for students to reach proficiency (Bachmann et al., 2022; Henry et al., 2013). Although supervised clinical experience is effective, there are obstacles to each student receiving equivalent targeted instruction. A lack of clinical placement opportunities and a lack of staff able to properly supervise students have been well documented through the past decade; many health disciplines have called for more student placements or other opportunities that afford equivalent patient exposure (Folkvord & Risa, 2023; Pearce et al., 2022; Smith et al., 2010). In addition to well-crafted and evidence-based communication curricula, there needs to be solutions to address the evident clinical placement shortage in allied health.

A potential supplement for experiential learning despite a paucity of student-patient encounters is simulated interaction with virtual patients (VPs). VPs are a form of hands-on learning tool that typically allow healthcare and medical students to interact with a computer in the place of a patient (Kononowicz et al., 2015). As they are highly repeatable and can be redeployed, some evidence suggests that these virtual simulations could provide equivalent experience to all students and be a cost-effective option for skill development. Positive to neutral effects from their use have been reported when compared to traditional teaching methods such as lectures and group discussions (Kononowicz et al., 2019). Although some systematic or scoping review papers indicate that VPs can be efficacious for communication training in the medical field (Kelly et al., 2022; Lee et al., 2020), there is a lack of similar research in the allied health professions. Furthermore, allied health professions may stand to benefit the most from the use of VPs, given the documented challenges with sourcing clinical experiences for students (Folkvord & Risa, 2023; Pearce et al., 2022; Smith et al., 2010) and evidence of differing levels of communication training being delivered across disciplines (Zota et al., 2023). One review of VPs used to teach medical students communication skills found a lack of integration of VPs into curricula and highlighted the diverging ways VPs were designed and created (Kelly et al., 2022).

An emerging design of VPs used for communication development is to employ natural language processing (NLP) in the aim of improving the fidelity of the student-VP interaction and present a fully automated encounter. Recent advances in this subfield of artificial intelligence (AI) that focuses on understanding and producing human language content have seen large language models such as ChatGPT emerge, demonstrating impressive language ability and offering vast opportunities for teaching and learning (Hirschberg & Manning, 2015; Kasneci et al., 2023). VPs that leverage NLP may take on different presentations and be referred to by a variety of names, such as virtual simulations, conversational agents, chat bots or voice bots, acknowledging their design being akin to other virtual assistants. A systematic review of AI conversational agents in the healthcare field found only 10% of included articles described agents for training students, with the rest for use by a patient or professional to assist screening, diagnostic or treatment processes (Milne-Ives et al., 2020). Another scoping review of AI tools used for communication development in healthcare reported on some AI-driven VPs, yet an in-depth exploration of educational considerations and a synthesis of technological design features of these tools are yet to occur (Stamer et al., 2023).

Although there is promise that AI-driven VPs may present a learning experience that is closer to an encounter with a real patient than what was previously possible, further investigation into their usefulness and acceptability as tools for communication skill development is needed. Using AI in the creation of VPs promises to allow for smarter VPs that provide a more natural style of conversation, whereby VPs are able to generalise better and handle a wider range of unforeseen enquiries than more traditional designs (which employ narrowly defined branching architectures) (Kelly et al., 2022). Previous designs would require careful scripting of all possible user inputs and responses, with pre-written responses which lack flexibility or ability to deliver contextually relevant responses. Generative AI may also afford expedited training and creation of VPs, meaning that multiple new scenarios of interest can be presented to students. Despite this, an exploration of their place in clinical training programmes (as a supplement to clinical placements) and of what educational theories are being employed in the design of these innovations is necessary. Whether the VPs described are effective in achieving their intended outcomes in this context is currently unknown. Our aim here is to understand the current use of these educational innovations in the health disciplines and how this may inform further research. Given this field is of research is emerging and diverse, a scoping review was selected to investigate the following research question: “What is known about AI conversational VPs used to facilitate communication skill development in healthcare students?”

Methods

We selected a scoping review to offer an insight into the current state of research in the field and identify gaps in the literature, in turn informing further work in the area. As this is an emerging area of research, we were less concerned with critically appraising the quality of each piece of evidence, as a systematic review may require. In developing a protocol for this scoping review, we used the preferred reporting items for systematic reviews and meta-analyses extension for scoping reviews framework (Tricco et al., 2018). Our research question was formed by initial review of the literature and using the population, concept and context (PCC) framework. Our protocol was registered in Open Science Framework (https://osf.io/fzc64).

Eligibility criteria

Literature published between January 2014 and January 2024 were included in the review, given the recency with which AI has developed in this context. To be included for review, articles need to describe a VP that used AI in its creation and had a communication focus. Articles had to be in English language and be either published in journals or grey literature (including pre-prints) available online. We chose to include grey literature given that, in computing sciences, innovations such as AI-driven VPs may be in development and their design and use circulated via conferences or free distribution repositories prior to being formally submitted and accepted as peer-reviewed journal articles. To exclude this literature may have meant we were neglecting a proportion of VPs that are in use and highly relevant to this review. Studies employing various methodologies and outcome measurements were included, provided they described a VP designed by using AI and intended to be used by students in a tertiary healthcare discipline from allied health, nursing and dentistry. Given previous reviews focusing on the medical field (Kelly et al., 2022; Lee et al., 2020), articles describing VPs for medical student use only were excluded, as were review articles, articles lacking full text or sufficient detail to determine inclusion and chatbots or conversational agents used by other populations such as patients or clinicians.

Information sources

Databases that were consulted to identify relevant articles were MEDLINE, CINAHL, ERIC, Scopus, IEEE Xplore and medRxiv. These databases were chosen because they comprise a significant amount of literature indexed from medical and health and educational journals. The search terms and strategy were developed in collaboration with an experienced subject matter librarian (using the PCC framework) and refined through preliminary trial searches and discussion among the research team. Reference lists of studies identified through database searches were also checked for additional articles to be included.

Search

The complete final search strategy (including terms used) can be found in Appendix A. Exemplars of how this strategy was implemented in MEDLINE and a Boolean search string from the search performed in ERIC are provided in Appendix B and C, respectively. All searches occurred in January 2024.

Selection of sources of evidence

After the database searches were complete, results were imported into Covidence software (Veritas Health Innovation, n.d.) for screening, and duplicates were automatically removed. Each abstract was then double-screened in Covidence by PB and KG to determine whether it met inclusion criteria. Only abstracts that we deemed to meet the inclusion criteria proceeded to the full-text screening stage. Following this, all sources of evidence were screened for eligibility using a process whereby we read the full text to ascertain whether it met the inclusion criteria. Initially, there was 92% agreement established between the two of us. All disagreements over study eligibility for the remaining 8% were resolved through discussion between the two of us. Full texts were included after this point only if consensus was reached.

Data charting process

A data charting form was developed by PB and KG, using Microsoft Excel. The form was designed to capture data relevant to our research question. As the authors independently recorded data into the form, we discussed the results and refined the form where needed, in an iterative process. Data were charted into a single spreadsheet based on key characteristics of the articles and the AI-driven VPs described in them.

Data items

We extracted data on important details of the included articles such as publication details (author, year, country of origin), study characteristics (design, data collection methods) and population details (discipline, sample size, degree level). Additionally, detail about the VPs was charted, including characteristics, methodologies used and findings of each study. Technological design data such as the communication scenario presented in each VP, along with who was involved in the VP creation, and how each VP was developed, presented, used and costs gathered. Furthermore, data were extracted on educational considerations such as theoretical frameworks, learning objectives, implementation with students and study outcomes.

Synthesis of results

We summarised the important aspects of each article in tables and text according to relevant data items. An inductive approach to results synthesis was used, similar to a previous scoping review in this field (Stamer et al., 2023). Categorical style information about the studies, including their characteristics and design (in addition to key findings) were put into tables, while a narrative synthesis of other important results and evaluations based on recurring patterns and themes in the data was included in the text.

Results

Selection of sources of evidence

A preferred reporting items for systematic reviews and meta-analyses flow diagram outlining the screening process, including exclusions (with reasons) and final sources of evidence, is presented in Figure 1. Our search resulted in eight eligible articles to be included, following title and abstract screening of 2235 references (after de-duplication) and full-text screening of 110 articles.

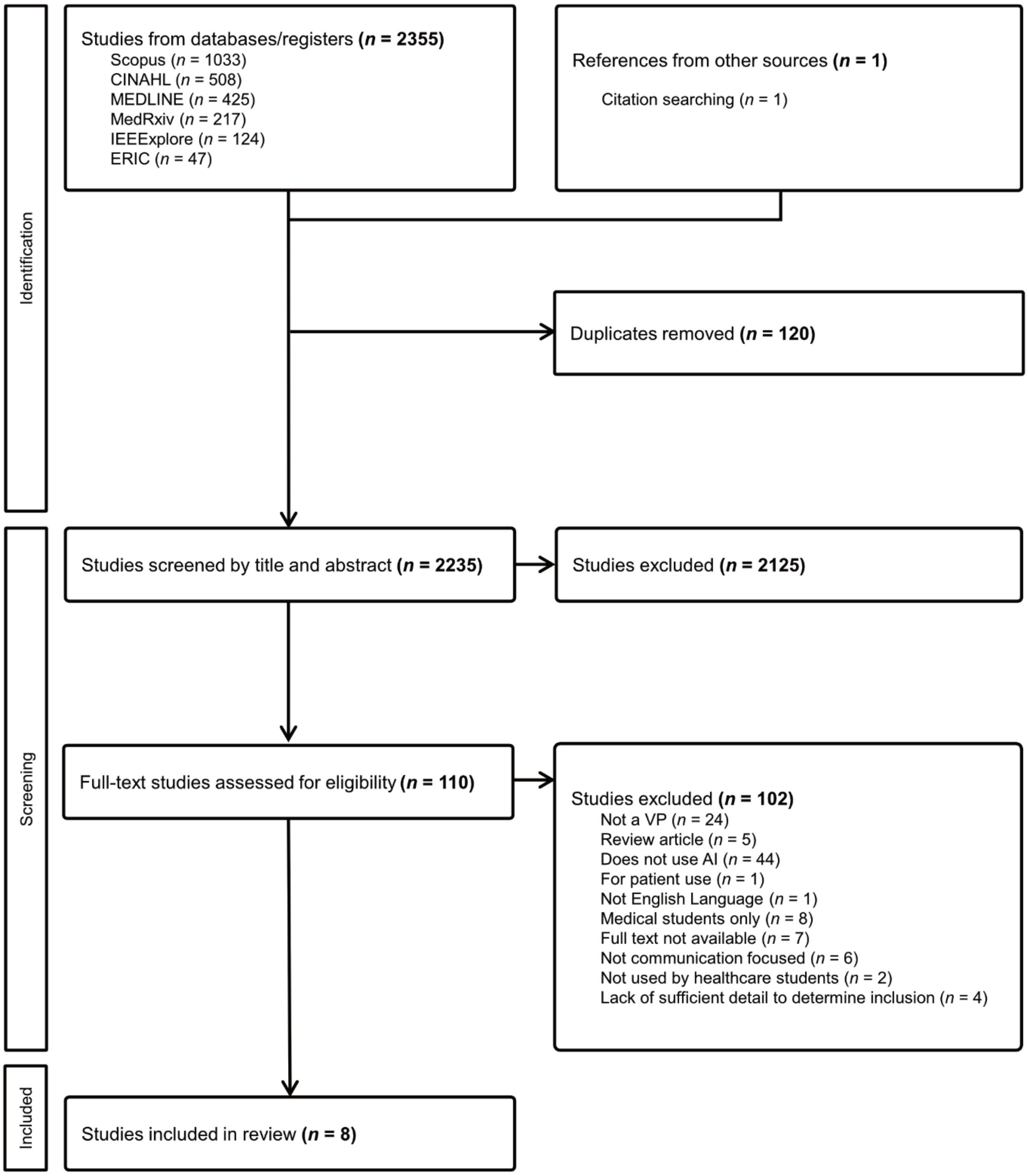

Figure 1. Preferred reporting items for systematic reviews and meta-analyses flow diagram

Descriptive characteristics of sources of evidence

Key characteristics of each study can be found in Table 1. Studies were published between 2019 and 2023 and comprised six journal articles and two conference papers. Articles originated mostly from Asia (*n* = 6), followed by North America (*n* = 1) and Europe (*n* = 1). Of the 8 studies included, most came from the nursing field (*n* = 3), followed by dentistry (*n* = 2), pharmacy (*n* = 1), radiotherapy (*n* = 1) and social work (*n* = 1). Six distinct research groups authored the included articles (with one group authoring three of the eight papers, each focusing on a different aspect of the same VP). A variety of study designs were used: three were case studies that discussed the design and development of an AI-driven VP for a healthcare field and five were empirical studies that evaluated AI-driven VPs by implementing the VP in an educational setting and measuring students' perceptions or outcomes.

Table 1
Characteristics of included studies

Author, year	Country	Discipline	Study design	Data collection method(s)	Sample
Azmi et al., 2022	Malaysia	Radiotherapy	Descriptive cross-sectional study	Survey (Likert and free text)	28 undergraduate diagnostic imaging and radiotherapy students (15 trial in Years 3 and 4 and 13 control in Years 1 and 2)
Chan & Li, 2023	China	Social work	Descriptive case study	Not applicable	Not applicable
Nakagawa et al., 2022	Japan	Pharmacy	Analytical cross-sectional study	Survey (Likert)	40 4th year (of a 6-year undergraduate degree) pharmacy students (10 trial, 30 control)
Ngantcha et al., 2021	USA	Dentistry	Descriptive case study	Not applicable	Not applicable
Shorey et al., 2019	Singapore	Nursing	Descriptive case study	Not applicable	Not applicable
Shorey et al., 2020	Singapore	Nursing	Descriptive qualitative study	Focus groups with students and interviews with clinical facilitators	24 penultimate and final-year undergraduate nursing students and 6 clinical facilitators
Shorey et al., 2023	Singapore	Nursing	Pretest and post-test quasi-experimental study	Student surveys before and after VP session (Communication Skills Attitude Scale and Communication Self-efficacy Subscale), communication skill performance instrument by facilitators after clinical practicums	93 undergraduate penultimate and final-year nursing students
Suarez et al., 2022	Spain	Dentistry	Descriptive cross-sectional study	Survey (Likert) and free text	58 penultimate and 135 final-year dental students

Synthesis of results from sources of evidence

The following sections present a synthesis of results relating to the technological design elements of VPs, their educational objectives and their implementation. Due to the different research objectives of the three case studies as compared to the empirical studies (i.e., the former did not include implementation considerations), we have separated out the synthesis of results in several of these areas. More specifically, the Technological design elements: All studies section presents a synthesis of the technological elements of VPs from all studies; the Case studies: Key findings section presents key findings relating to case studies only; and the Empirical studies: Educational considerations and the Empirical studies: VP implementation sections present findings relating to VPs in empirical studies only.

Technological design elements: All studies

A range of technological design elements were reported on by the included studies, as presented in Table 2. The overarching design process varied across the literature. Some research groups created their VP by using real clinical cases as a base (Azmi et al., 2022; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023), while others reported that subject matter experts developed scenarios without further detail as to how (Chan & Li, 2023; Ngantcha et al., 2021; Suárez et al., 2022). One did not provide any detail about how their VP scenario was designed (Nakagawa et al., 2022). Overall, detail about what data were used to train the AI models to respond appropriately was missing across the studies. A range of mostly readily available software was used in the design of the VPs, although one group created their own software engine for development (Ngantcha et al., 2021), and one did not specify what was used to create theirs (Nakagawa et al., 2022). Although none of the included articles reported on the cost of creating their VP, one group mentioned that as healthcare academics they were able to use free tutorials and software to create their VP (Suárez et al., 2022). Of the included articles, none reported the development time of their VP, nor how many test rounds occurred before VP deployment.

In all studies, students had free choice during conversations with the VP. As this approach affords a dialogue style that mimics real clinical practice, it appears that the fidelity of the simulated experiences was high. The degree of fidelity varied more with respect to input and response options; a mix between voiced and text-based conversation was reported. Aspects of real conversations with patients that were not well replicated in the VPs were non-verbal cues; use of appropriate eye contact, gestures and facial expression was not required of the students and not generated by most VPs either, given only half presented an avatar to represent the patient.

Appraisal of technological design features was not a focus of any of the evaluations by students in empirical articles; however, student criticisms mostly focused on technological limitations rather than educational value (Azmi et al., 2022; Shorey et al., 2020; Suárez et al., 2022). These included VP systems not interpreting the students' intent correctly, a lack of realism and poor ease of navigation (Azmi et al., 2022; Shorey et al., 2020). Amongst the lowest rated items for survey studies were questions on interface quality, the ability to cover all the desired questions with the VP and ease of use (Azmi et al., 2022; Suárez et al., 2022). No study presented an evaluation of how well particular design elements were received over others (e.g., avatar vs no avatar, voiced vs text). When inspecting features across empirical studies, there were no clear elements which appear to lead to more favourable evaluations – these mostly related to how well the elements worked together to present a cohesive learning experience.

Table 2
Technological design features of VPs

Category	Subcategory	No. of studies (%)
Design team members	Health academics and/or clinician(s) and software developer(s)	4 (50%) (Chan & Li, 2023; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Software developer(s) only	2 (25%) (Nakagawa et al., 2022; Ngantcha et al., 2021)
	Health academics and/or clinician(s) only	1 (12.5%) (Suárez et al., 2022)
	Not reported	1 (12.5%) (Azmi et al., 2022)
Creation tools	Google Cloud Dialogflow	4 (50%) (Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023; Suárez et al., 2022)
	Unity 3D	3 (37.5%) (Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Blender 3.0	1 (12.5%) (Azmi et al., 2022)
	Bot Libre	1 (12.5%) (Azmi et al., 2022)
	Conversational Ontology Operator, which consists of various software libraries including Stanford Core NLP, OWL-API, rdf4j, Hermit reasoner library and some utility libraries	1 (12.5%) (Ngantcha et al., 2021)
	draw.io	1 (12.5%) (Ngantcha et al., 2021)
	Protégé 5.50	1 (12.5%) (Ngantcha et al., 2021)
	Telegram BotFather	1 (12.5%) (Suárez et al., 2022)
	Yuan 1.0	1 (12.5%) (Chan & Li, 2023)
	Not reported	1 (12.5%) (Nakagawa et al., 2022)
Input option	Free choice	8 (100%) (Azmi et al., 2022; Chan & Li, 2023; Nakagawa et al., 2022; Ngantcha et al., 2021; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023; Suárez et al., 2022)
Input type	Voice	4 (50%) (Nakagawa et al., 2022; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Text	3 (37.5%) (Chan & Li, 2023; Ngantcha et al., 2021; Suárez et al., 2022)
	Unclear	1 (12.5%) (Azmi et al., 2022)
Response type	Voice with accompanying text	4 (50%) (Nakagawa et al., 2022; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Text	3 (37.5%) (Chan & Li, 2023; Ngantcha et al., 2021; Suárez et al., 2022)
	Unclear	1 (12.5%) (Azmi et al., 2022)
Appearance	Human avatar	4 (50%) (Azmi et al., 2022; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Message or text thread	4 (50%) (Chan & Li, 2023; Nakagawa et al., 2022; Ngantcha et al., 2021; Suárez et al., 2022)
Application type	Standalone	4 (50%) (Ngantcha et al., 2021; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Web-based	2 (25%) (Azmi et al., 2022; Nakagawa et al., 2022)
	Both web-based + standalone (WeChat)	1 (12.5%) (Chan & Li, 2023)
	Telegram	1 (12.5%) (Suárez et al., 2022)

Category	Subcategory	No. of studies (%)
Access device	Computer	6 (75%) (Azmi et al., 2022; Nakagawa et al., 2022; Ngantcha et al., 2021; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)
	Phone	1 (12.5%) (Suárez et al., 2022)
	Both	1 (12.5%) (Chan & Li, 2023)
Duration	3–5 mins	1 (12.5%) (Nakagawa et al., 2022)
	1hr	1 (12.5%) (Shorey et al., 2023)
	Not reported	6 (75%) (Azmi et al., 2022; Chan & Li, 2023; Ngantcha et al., 2021; Shorey et al., 2019; Shorey et al., 2020; Suárez et al., 2022)
Cost	Not reported	8 (100%) (Azmi et al., 2022; Chan & Li, 2023; Nakagawa et al., 2022; Ngantcha et al., 2021; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023; Suárez et al., 2022)

Case studies: Key findings

Of the three case study articles, only one reported on the use of educational frameworks to develop their VP learning experience (Shorey et al., 2019). This research group consulted two different learning theories – Bandura's (1977) self-efficacy theory and Herrington et al.'s (2010) authentic learning concept – as well as profession-specific conversation guidelines (Master Interview Rating Scale; Character, Onset, Location, Duration, Severity, Pattern, Associated Factors; Situation, Background, Assessment and Recommendation; Name, Understand, Recognise, Support; and Ideas, Function and Expectations) to create their VP. Further details about the VPs presented in case study articles can be found in Table 3.

Table 3
VP details and key findings from case studies (n = 3)

Reference	Name and scenario of VP	Key findings
Chan & Li, 2023	Huang Xi: Communication scenario not described in detail; however, VP plays the role of a help-seeker.	VP could generate natural, continuous conversation & be accessed easily online; however, generated a name for itself & discussed issues that were not related to prompts set by the creators. There is room for further improvement of the VP & a need for partnerships between social workers & computer programmers to further the field.
Ngantcha et al., 2021	Two unnamed test VPs: Communication scenario not described in detail – involves asking the VP about their personal health information.	VP was able to handle 62% of dialogue links to transition from one statement to another. Modification of the VP dialogue system could address some identified gaps. Future goals aim to further enhance the realism of the VP by testing with dental students & adding more varied and tailored dialogue into the model (including more small talk).
Shorey et al., 2019	Virtual counselling application using artificial intelligence with 4 communication scenarios: 1. History-taking with a pregnant woman experiencing pain	Further refinement & improvements are needed to train the VPs to better represent real-life conversations before implementation.

Reference	Name and scenario of VP	Key findings
	2. History-taking with a depressed patient 3. Practising hands-off interdisciplinary communication for a post-operative patient 4. Showing empathy to a stressed fellow nursing student	More frequent & open communication between the design team would benefit the design process. Better reactivity to context, handling of typical conversations & improved capability of detecting accented speech are all areas to address.

Empirical studies: Educational considerations

Of the five empirical studies, two did not report the use of educational frameworks or theories to develop their VP learning experience (Azmi et al., 2022; Suárez et al., 2022). The VPs reported in Shorey et al. (2019) were the same as reported in Shorey et al. (2020) and Shorey et al. (2023), with the same theories and guidelines applicable to the latter two empirical studies as in the former case study. Another research group consulted a country-specific framework for communication skill development (the ENcode, Decode, Control, and REgulate system (Fujimoto & Daibo, 2007, as cited in Nakagawa et al., 2022). Only one research team reported learning objectives associated with their VP (Shorey et al., 2023). This group reported two or three specific objectives for each VP encounter, which related to wider learning outcomes of the related course subject.

Empirical studies: VP implementation

The five empirical studies had a range of ways in which they implemented VPs and measured outcomes (Table 4). All included students in undergraduate degrees only and had samples ranging from 24 to 193. Student participants were in the middle-to-final part of their degree in all studies. Curricular integration of the VPs was widely lacking across research groups, with three reporting use of their VP as a pilot activity without detail of how the activity was framed or any relevant briefing or debriefing (Azmi et al., 2022; Nakagawa et al., 2022; Suárez et al., 2022). Alternatively, one group mapped their four VPs to their existing communication curriculum and discussed detail about the facilitation of the VP interaction (Shorey et al., 2023). This group had students attend a 1-hour session at an on-campus computer laboratory and interact with VPs prior to their clinical postings. Students first completed a core module that reviewed content related to each VP. Prior to the VP interaction, the system provided students with instructions on how to navigate the scenario and recapped the corresponding communication framework they had learned in the core module. These students also received immediate formative feedback on their communication skills at the end of each VP interaction, in the form of a performance checklist (Shorey et al., 2023). This was automatically compiled and presented within the VP software (Shorey et al., 2019). No other groups reported on provision of feedback. How students evaluated the VP as a learning experience was explored in various ways.

Data collection methods for student evaluations included surveys (*n* = 4) (Azmi et al., 2022; Nakagawa et al., 2022; Shorey et al., 2023; Suárez et al., 2022) and focus groups (*n* =1) (Shorey et al., 2020). Mostly, researchers reported on students' experiences (acceptance, attitudes, engagement, satisfaction) with using the VPs (*n* = 3) (Azmi et al., 2022; Shorey et al., 2020; Suárez et al., 2022). Most students expressed neutral to positive evaluations of satisfaction and acceptance of the VPs. Praise of the VPs typically centred on their ability to increase confidence with communication and preparedness before clinical placements, as well as being a useful learning tool that presents a safe environment to in which to practise (Azmi et al., 2022; Shorey et al., 2020; Suárez et al., 2022). Students were mostly supportive of VPs forming part of the curriculum; however, some expressed that they should not replace current learning activities or interaction with real patients (Shorey et al., 2020; Suárez et al., 2022). Two studies did not assess student experience but instead used student self-reports of their communication with the VPs (Nakagawa et al., 2022; Shorey et al., 2023). For some communication aspects, higher self-efficacy and learning attitudes were reported (Shorey et al., 2023), yet overall results suggest similar self-rated communication ability as prior to VP interactions or in comparison to controls (Nakagawa et al., 2022; Shorey et al., 2023).

Aside from student reports, two articles collected data from clinical educators. One study conducted interviews with clinical educators to seek their perspectives on the communication skills of students having used the VPs (Shorey et al., 2020). They reported students had mostly acceptable communication skills and suggested that more support and training for students to develop communication skills earlier in their studies as well as more diversified VP scenarios would be of benefit. Another study used a formal educator communication skill assessment of students who had interacted with VPs, based on their performance in clinical practicums (Shorey et al., 2023). In that study, scores were mostly lower than previous cohorts not receiving VP training.

Table 4
VP details and key outcomes for empirical studies (n = 5)

Reference	Name and scenario of VP	Outcomes assessed	Main results
Azmi et al., 2022	SCIMORT: Multiple cases focusing on communication, e.g., first-time, anxious, paranoid & claustrophobic patients all undergoing breast cancer identification and treatment	User acceptance & engagement	Neutral acceptance & engagement. Ease of navigation rated poorly. SCIMORT prototype (while effective for pre-clinical learning) needs further refinement & development.
Nakagawa et al., 2022	6 unnamed communication scenarios: 1. Medication guidance to patients 2. Prescription inquiry with physicians 3. Over the counter (OTC) drug counselling for obtaining patient's information 4. OTC sales according to the patient's information 5. Dosing regimen guidance & reparation of medication history at a community pharmacy 6. Medication guidance & preparation of medication history at a hospital	Self-reported communication skills including 24-item ENcode, Decode, Control, & REgulate survey	Management & expression skills were enhanced by communication training with standardised patients but not significantly enhanced following AI-driven VP training. Positive effect in almost all skills observed for students who used VPs in comparison to those who did not. Further research with a larger sample & for a longer period is desired.
Shorey et al., 2020	See Shorey et al., 2019, in Table 3.	Usefulness of VP on communication skills, exploration of student experiences, perspectives from educators on students' communication skills	Students reported being fairly satisfied with VPs' ability to refresh communication skills, prepare for clinical placements & increase confidence in interviewing patients. Favourable evaluations focused on ease of accessibility & availability, the presentation of a safe environment in which to practice communication & provision of instant objective feedback. Students suggested the VPs be introduced in Year 1 to assist foundational skill development,

Reference	Name and scenario of VP	Outcomes assessed	Main results
			with new scenarios to be used in each year following. Students criticised the VPs lack of emotion, speech recognition ability & disjointed conversation flow.
Shorey et al., 2023	See Shorey et al., 2019, in Table 3.	Attitudes towards learning communication skills, perceived communication self-efficacy & clinical communication skill scores	For 2 scenarios (pregnant woman and depressed patient), students' learning attitudes towards communication skills were significantly improved. Perceived self-efficacy was significantly improved following use of the same 2 scenarios. Clinical evaluation scores by educators were lower for paediatric, obstetric & medical practicums compared with a previous cohort who received no training. VPs presented can provide a valuable & cost-effective communication learning resource for the nursing curriculum.
Suarez et al., 2022	Julia: Have a conversation with the VP to determine a correct diagnosis of reversible pulpitis.	Satisfaction, attitudes. Ability to reach correct diagnosis.	A large majority of the students were satisfied with the interaction (mean score 4.36/5). Fifth-year students rated the interaction better & showed higher satisfaction values. Students who reached a correct diagnosis rated the VP more positively. The incorporation of VPs in dental curricula would be valued by students.

Discussion

This scoping review investigated what is known about AI-driven VPs for communication training in healthcare. Through this review, we aimed to provide a summary of the current state of the research. The literature revealed several key findings, which mostly reiterate the concept that the field is in its infancy. Here we discuss key themes around technological design, educational framing, implementation within healthcare training programmes and evaluation by students.

A developing field

We identified trends with the characteristics of the eight included articles. Three (37.5%) were purely descriptive and presented more of an overview of the creation and functionality of the VP (Chan & Li, 2023; Ngantcha et al., 2021; Shorey et al., 2019), sometimes through quite a technical lens (Ngantcha et al., 2021). Although informative for researchers designing AI-driven VPS, these lacked detail on use and impact of VPs. It is possible that researchers first wish to disseminate information about their works before they fully implement and evaluate with students, as this affords an expedited creation-to-publication timeline. Notably, one group initially published a case study article (Shorey et al., 2019) and later followed up with student evaluation pieces (Shorey et al., 2020; Shorey et al., 2023), so it is entirely possible that other groups intend a similar dissemination approach.

Articles originated from Asia, Europe and North America only, reflecting a regional bias observed in other reviews of virtual simulations in healthcare (Duff et al., 2016; Wu et al., 2022). Low- and middle-income countries are currently under-represented in this research; however; the need for communication skill development is of international concern. It is likely that due to the costs associated with creating e-learning tools such as AI-driven VPs, high-income countries are at the forefront of developments. Furthermore, although we found five disciplines were represented in the literature, there are many other professions where communication training with AI-driven VPs could be implemented. Nevertheless, these disciplines could still find benefit from work in other fields, adapting features to suit their own professional contexts. When reporting on AI-driven VPs, a detailed description of the communication scenario being covered (e.g., taking a clinical history, breaking bad news) is beneficial for the reader to understand the learning objective(s). This was mostly difficult to ascertain from the included articles. In addition to this, an explanation of the technological design features of the VPs would benefit researchers wishing to implement such technology into their communication curriculum.

Design trends and key players

We found that to create AI-driven VPs, most studies assembled a multidisciplinary team of clinical and/or academic staff and software developers (Chan & Li, 2023; Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023). This is seemingly the best way to achieve both a clinically realistic scenario (which clinical and/or academic health professionals are expert in) that is translated into a fully functional VP (by software developers). However, as one article described, it appears possible that academic staff alone can create a VP without technical expert assistance (Suárez et al., 2022). This may become feasible on a more widespread scale with future technological advancements allowing novice creators to make basic VPs themselves. Of note is that no articles involved other stakeholders in the healthcare communication field, such as end users (students), or the population ultimately targeted by communication training of students (patients). Students were generally asked for their opinions following trial or full use of a VP – however, often at this stage in the process, many VP features are unchangeable. Future research investigating the involvement of students and patients in VP design may be of interest, as student needs and wants for certain features of the learning experience and what patients may view as important remain unknown.

Despite VPs often being discussed as cost-effective alternatives to other experiential learning tasks for communication development (e.g., standardised patients), we found there to be no reports of actual costs incurred by included studies. Researchers and educators may benefit from knowing how financially feasible creating an AI-driven VP would be before embarking on such an endeavour. In the design process, there should also be consideration of the limitations of AI-driven VPs in fully replicating the nuances of real-world conversation; non-verbal aspects of communication still seem difficult to replicate; however, student expectations of what this technology is capable of should be clearly set to not create conflict with expectations versus reality. It is possible that with further development of the field, non-verbal aspects of communication can be better represented by VPs; however, in the meantime, educators should consider how these skills are otherwise being developed by students.

Enhancing the educational experience

This review indicates that allied health, dentistry and nursing fields are increasingly exploring the use of AI-driven VPs for communication skill development. However, there is a notable lack of consideration for educational theory in their development, with only two research groups consulting educational theories or frameworks (Nakagawa et al., 2022; Shorey et al., 2019). Explicit use of frameworks contributes to evidence-based learning experiences, transparency and research repeatability (Mukhalalati & Taylor, 2019). Furthermore, our findings reflect the absence of considered and widespread curricular integration of AI-driven VPs. Most of the empirical studies had students use their VPs as once-off activities or pilots, so lacked scaffolding the experience around other concurrent course-related communication training (Azmi et al., 2022; Nakagawa et al., 2022; Suárez et al., 2022). Simulated learning activities such as AI-driven VPs should be accompanied by briefing and debriefing to be most effective (Jeffries et al., 2015). Furthermore, clear learning objectives should be formed when developing VPs and subsequently presented to the learner before their interaction (reported by only one research group in this review) (Shorey et al., 2023). This ensures students' skills can be better evaluated and their progress clearly appraised against tangible, specific metrics (Bachmann et al., 2022). A more considered approach should be encouraged for both development and implementation of AI-driven VPs into health professions curricula.

Student and educator feedback suggests that VPs should be implemented early and consistently throughout training, with scenarios increasing in complexity (Shorey et al., 2020; Suárez et al., 2022). These sentiments mirror literature regarding communication skill development – both reinforcing the fact that communication skills should be continuously refined to be maintained (Bachmann et al., 2022; Cushing, 2015). Repeated opportunities to build skills via clinical placements and experiential learning activities are therefore important. Despite AI-driven VPs' promise in presenting a somewhat similar experience to a patient encounter during a clinical placement, there was very little discussed by the articles around this topic. Some evaluations indicated VPs should not replace real patients (Shorey et al., 2020; Suárez et al., 2022); however, future research comparing student learnings from VP encounters compared to real patient encounters would be useful.

Although VPs present an opportunity for experiential learning, evidence has repeatedly reinforced that feedback on communication performance is a key part of the learning process when simulating patient interactions (Bachmann et al., 2022). In the current review, we found only one article reporting provision of feedback to learners following the VP interaction (Shorey et al., 2023). If AI-driven VPs continue to be used as part of communication training, there should be opportunities for students to reflect on their skills, receive constructive feedback then re-practise shortly after to optimise the integration of skills (Bachmann et al., 2022). If the AI-driven VP learning experience is scaffolded in this way, there is greater likelihood of communication skill acquisition.

Based on findings of the limited number of studies reviewed, it appears that using AI to create VPs results in a satisfying learning experience for students (Azmi et al., 2022; Shorey et al., 2020; Suárez et al., 2022). AI's ability to generate more natural conversations for VPs promises improvements over previous methods. Although length of VP development was broadly not described, the use of AI expedites creation compared to past methods of highly scripted branching dialogues. This in turn presents opportunity to create multiple scenarios for development of various communication skills. Given rapid developments in the NLP space, the full educational possibilities of leveraging this technology remain to be seen (Kasneci et al., 2023).

Future research

This review highlights the frequency of VPs used for communication development in the allied health, nursing and dentistry fields. A recent scoping review of AI tools for communication development included VPs where 50% of the included studies came from the medical field alone (Stamer et al., 2023), and most reviews of literature on VPs in general for communication training are medical or nursing focused (Kelly et al., 2022; Lee et al., 2020; Peddle et al., 2016). This is somewhat unsurprising and may be due to the institutional and resource advantages of these fields in terms of educational research. The importance of good patient-provider communication, however, does arguably not vary by healthcare profession. Future research on the use of AI-driven VPs across a range of other healthcare fields would therefore be beneficial.

Although the ways in which AI is used to create VPs for communication skill development were reported in the literature, there was very little relating to the use of AI specifically in creating the VPs. It would be useful to explore students' thoughts, biases and attitudes about educational interventions designed using AI, compared to those without AI. This may shed further light on the acceptance and applications of AI as viewed by healthcare students. Given the likelihood AI will be increasingly used as part of a health professional's job, the way students perceive this technology for work and learning is an area to be explored further. Furthermore, the ability of AI-driven VPs for communication skill development to deliver their main learning objectives should be established in future studies, by carefully designed assessment of students' clinical communication skills following VP training. Future studies may measure communication skills in a range of ways, including objective structured clinical examinations, analysis of videotaped encounters with real patients and student surveys on attitudes towards communication or communication self-efficacy (Bachmann et al., 2022). Finally, given the concern about the retention of skills (Bachmann et al., 2017), longitudinal empirical studies on healthcare professionals having used VPs as part of their communication skills training would also be of great benefit.

Limitations

Due to multiple terms being used in the literature to describe conversational VPs, it is possible that our search terms may have failed to capture every relevant source on this topic, despite our best efforts with search strategy creation. A further limitation of this review is that, due to the rapid pace of AI development, a review in this space in 5 years may look very different than what we present here. We also acknowledge that commercially available AI-driven VPs may be in development and not yet reported on in the literature. This further highlights the need for more research of these tools to inform clinical educators on best practice. Despite this, we expect the current review provides an effective summary of current research activity and a foundation for future research to build on.

Conclusion

This scoping review represents an overview of current research into AI-driven VPs for the communication skill development of healthcare students. We have found that although the field is an emerging one, there is promise in how these educational innovations may be leveraged for communication training. Specifically, we have established the many technological design trends of the field and noted that while AI-driven VPs can deliver more realistic opportunities for patient communication practice, student criticisms of technological features are important to consider. It appears that AI-driven VPs present educational tools that deliver neutral to positive evaluations; however, more consultation of educational theory and evidence on communication curricula is needed to unlock the full potential of these tools for skill acquisition. Furthermore, their ability to reach the objective of improving healthcare students' communication ability is yet to be established.

Author contributions

Author 1: Conceptualisation, Methodology, Investigation, Resources, Writing – original draft, Writing – review and editing, Visualisation; **Author 2:** Conceptualisation, Methodology Investigation, Writing – review and editing, Supervision; **Author 3:** Conceptualisation, Methodology Writing – review and editing, Supervision; **Author 4:** Conceptualisation, Methodology Writing – review and editing, Supervision; **Author 5:** Conceptualisation, Methodology Writing – review and editing, Supervision.

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Appendix A: Search terms used in all databases, as mapped to the PCC framework

Population	Concept	Context
Students	AI VP • Avatar • Chatbot • Conversational agent Voicebot • Virtual simulation • Virtual reality	Communication • Education • Learning • Teaching • Training

Appendix B: Full search strategy for MEDLINE (Ovid) database performed on 3 January 2024

Search item	Terms
1.	(virtual adj3 simulat*).mp
2.	(virtual reality or avatar*).mp
3.	artificial intelligence.mp
4.	(chat bot or chatbot or voice bot or voicebot or conversational agent).mp
5.	Patient.mp
6.	communicat*.mp
7.	(educat* or train* or student* or teach* or learn*).mp
8.	1 or 2 or 3 or 4
9.	5 and 6 and 7 and 8
10.	limit 9 to yr="2014 -Current"

Appendix C: Example Boolean search string, from search performed in ERIC database on 3 January 2024

TI,AB,IF(communicat*) AND TI,AB,IF(patient) AND TI,AB,IF(virtual OR simulat* OR “artificial intelligence” OR “virtual reality” OR avatar OR “chat bot” OR chatbot OR “voice bot” OR voicebot OR “conversational agent”) AND TI,AB, IF(learn* OR teach* OR train* OR educat* OR student*)