Virtual simulation tools for communication skills training in healthcare professionals: an integrative review of the literature

Sofia Garcia-Sanjuan Sr, Silvia Escribano 2nd, Rocio Julia-Sanchis 3rd, Ana Castillo 4th, A Pérez-Manzano 5th, A Krauss 6th, M Macur, S Kalender-Smajlovic, S Kalender-Smajlovic, Maria José Cabañero-Martínez

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Table of Contents

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Sofia Garcia-Sanjuan Sr[1]; Silvia Escribano 2nd[1]; Rocio Julia-Sanchis 3rd[1]; Ana Castillo 4th[2]; A Pérez-Manzano 5th[1]; A Krauss 6th[3]; M Macur[4]; S Kalender-Smajlovic[4]; S Kalender-Smajlovic[4]; Maria José Cabañero-Martínez[1]

[1]University of Alicante San Vicente del Raspeig ES
[2]University of Murcia Murcia ES
[3]Institut fur Sozialwissenschaftliche Beratung Germany DE
[4]Faculty of Health, Fakulteta Za Zdravstvo Angele Boskin Slovenia SI

Corresponding Author:
Sofia Garcia-Sanjuan Sr
University of Alicante
Ctra. San Vicente del Raspeig
San Vicente del Raspeig
ES

Abstract

Background: Knowledge of virtual simulation and its uses in training health professionals and students is still growing rapidly.

Objective: the objective of this study was to review the current academic literature to identify the virtual simulation tools used to train communication skills in student and professional healthcare personnel.

Methods: This review was carried out in June 2023 by collecting data from the MEDLINE/PubMed and Web of Science electronic databases.

Results: We found 35 articles that had developed and/or applied a virtual environment for training communication skills aimed at patients, in which 24 different learning tools were identified. Most had been developed to independently train communication skills in English, either generally or in the specific context of medical history (anamnesis) interviews. Many of these tools had used a virtual patient that looked like a person and had the ability to vocally respond. Almost half of the tools analysed allowed the person being trained to respond orally using natural language. Of note, not all of these studies described the technology they had used in detail.

Conclusion: Many different learning tools with very heterogeneous characteristics are being used for the purposes of communication skills training. Continued research will still be required to develop virtual tools that include the most advanced features in order to achieve high-fidelity simulation training.

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Original Manuscript

Virtual simulation tools for communication skills training in healthcare professionals: an integrative review of the literature

Abstract

Background: Knowledge of virtual simulation and its uses in training health professionals and students is still growing rapidly.

Objective: The objective of this current study was to carry out an integrative review to identify the virtual simulation tools currently available and aimed at training communication skills in healthcare professionals from the level of students up to post-graduate personnel in clinical practice.

Methods: This review was carried out in June 2023 by collecting data from the MEDLINE/PubMed and Web of Science electronic databases.

Results: We found 35 articles that had developed and/or applied a virtual environment for training communication skills aimed at patients, in which 24 different learning tools were identified. Most had been developed to independently train communication skills in English, either generally or in the specific context of medical history (anamnesis) interviews. Many of these tools had used a virtual patient that looked like a person and had the ability to vocally respond. Almost half of the tools analysed allowed the person being trained to respond orally using natural language. Of note, not all of these studies described the technology they had used in detail.

Conclusion: Many different learning tools with very heterogeneous characteristics are being used for the purposes of communication skills training. Continued research will still be required to develop virtual tools that include the most advanced features in order to achieve high-fidelity simulation training.

Keywords: communication skills; virtual patient; virtual simulation; healthcare professionals

Virtual simulation tools for communication skills training in healthcare professionals: an integrative review of the literature

Effective patient-centred communication is one of the key components of quality clinical care (Kaploni et al., 2017). Thus, it is vital that healthcare professionals adequately manage their communication skills. This involves mastering the transmission of information, listening and comprehensively understanding all the issues related to the health of each patient (Kleinsmith et al., 2015), and responding appropriately to the physical and emotional needs of patients (Stehr et al., 2022). Hence, acquiring good communication skills improves patient health outcomes (Kee et al., 2018). As a specific example, better communication when supporting decision-making means that patients are better able to understand their situation, feel better informed, and are more active in the decision-making process (Stacey et al., 2017).

However, despite recognising the importance of communication, health professionals are not always sufficiently skilled in this area (Synnot et al., 2018). Therefore, it is advisable that both health and educational institutions introduce different means of supporting the development of communication skills into their training plans as a priority objective. Furthermore, this training must also be implemented through effective educational strategies (Gutiérrez-Puertas et al., 2021). It has previously been shown that simulation-based learning is an effective means of acquiring communication skills (Gutiérrez-Puertas et al., 2021). Specifically, simulation with a standardised or simulated patient—which consists of using trained people to realistically portray a patient within learning contexts (Lewis et al., 2017)—is widely used to train communication skills (Kaploni et al., 2017).

Nonetheless, although the use of simulation methodologies has greatly advanced training in communication skills, its implementation also has limitations. For example, in terms of the human resources used in this type of training, it is particularly difficult to recruit actors able to simulate patients precisely and consistently in a completely standardised way (Nestel et al., 2011; Quail et al., 2016). Other difficulties include temporal–spatial issues because the availability of simulations with standardised patients is limited to a specific physical space and time (Padilha et al., 2018). A training alternative that could overcome these limitations is the use of standardised virtual patient programmes that use computerised characters rather than real actors (Yang et al., 2023).

Indeed, compared to standardised patients, there are significant advantages to the use of virtual patients, including the need for fewer staff and resources once developed (Urresti-Gundlach, 2017), unlimited availability, and the fact that they are highly customisable (Yang et al., 2023). Additionally, these tools provide highly interactive, engaging, and more standardised experiences because educators can control their design, programming, delivery, and use (Yang, 2023). It is also worth noting that these solutions can be personalised according to specific individual needs, given that they are not limited by time or space and so students can repeatedly engage in training in more clinical scenarios than is possible through traditional methods (Urresti-Gundlach., 2017). In addition, this technology also allows students to learn in a safe environment with low levels of risk and anxiety, which encourages them to gain greater personal awareness of their learning processes (Plotzky et al., 2021).

Virtual simulation is currently the subject of numerous studies because it is considered a powerful tool for training both undergraduate and graduate students as well as healthcare professionals (Bategazzore et al., 2021). However, there is still little knowledge of these technologies and their use in training health professionals and students. Notwithstanding, several reviews on virtual simulation and learning non-technical skills such as communication are available (Bategazzore et al., 2021; Lee et al., 2020; Peedle et al., 2016). For example, in their integrative review, Peedle et al. (2016) examined how interactions with virtual patients impacted non-technical skills in general, without exclusively focusing on communication skills or technical and instructional design characteristics. Subsequently, both the systematic review by Lee et al. (2020) and the literature review by Bategazzore et al. (2021), examined the technical characteristics of virtual learning applications aimed at improving communication skills. Nonetheless, these reviews did not include any information published after December 2018 and May 2020, respectively.

Thus, given the growing number of technological innovations in this field, continued examination of the virtual human applications used at an international level will be required to identify the strategies developed and challenges faced in their use. Therefore, the objective of this study was to review the current academic literature to identify the virtual simulation tools used to train communication skills in student and professional healthcare personnel.

Method

Design

We completed a literature review to identify virtual simulation tools designed to train communication skills in healthcare professionals, both in students in training and practicing professionals. The inclusion criteria were studies that examined (a) virtual simulation tools and/or those based on artificial intelligence (AI); (b) tools used to train communication skills in health professionals; and (c) tools targeting training in communication skills and/or therapeutic relationships with patients. Studies were excluded in which (a) the tools were designed to train interprofessional communication; (b) the objective was non-educational; and (c) the tool was designed to train patients in social and/or communication skills.

Search strategy

The search for studies was conducted in June 2023 in the MEDLINE/PubMed and Web of Science electronic databases. As part of the search strategy, we consulted the PubMed thesaurus using the following Medical Subject Headings (MeSH) terms: ‘Artificial Intelligence’, ‘Machine learning’, ‘virtual reality’, and ‘social skills’. The natural language search terms included in the title and/or abstract fields were: ‘artificial intelligence’, ‘machine learning’, ‘virtual reality’, ‘e-simulation’, ‘web-based simulation’, ‘virtual simulation’, ‘virtual patient’, ‘social skills’, ‘interpersonal skills’, ‘social ability’, ‘social competences’, and ‘communication skills’. The complete search strategy was: ((("Artificial Intelligence"[MeSH Terms] OR "Machine Learning"[MeSH Terms] OR "Artificial Intelligence"[Title/Abstract] OR "Machine Learning"[Title/Abstract])) OR (("Virtual Reality"[MeSH Terms] OR "Virtual Reality"[Title/Abstract] OR "e-simulation"[Title/Abstract] OR "web-based simulation"[Title/Abstract] OR "virtual simulation"[Title/Abstract]) OR ("virtual patient"[Title/Abstract]))) AND (("Social Skills"[MeSH Terms] OR "Social Skills"[Title/Abstract] OR "interpersonal skills"[Title/Abstract] OR ("social ability"[Title/Abstract] OR "social abilities"[Title/Abstract]) OR ("social competence"[Title/Abstract] OR "social competences"[Title/Abstract]) OR "communication skills"[Title/Abstract])). No temporal restrictions were applied in any of these cases. The eligibility of the studies was independently assessed by two of the authors (MJCM and RJS) and any discrepancies were resolved by another author (SE).

Data extraction

Data related to the characteristics of the studies (publication year, country, language, objective, and type) as well as data related to the outcome of the use of the digital/virtual training tool for improving communication skills in healthcare professionals were recorded. Specifically, we noted the tool name, training language, learning objective, degree of learning autonomy (fully autonomous versus instructor-mediated training), patient type (avatar/doll, virtual patient with a human-like appearance, real person, etc.), type of answers given by the trainee (written or oral conversation), and type of technology used.

Results

The studies were manually screened and coded. Our search of PubMed and the Web of Science produced 681 records, of which 23 duplicates were eliminated. During the screening process, two of the authors independently analysed 658 studies based on their titles and the abstracts (figure 1). After this initial screening, the full text of 61 records were obtained for analysis. We requested the full texts of a further 2 articles from the corresponding authors by email and through ResearchGate; of these we obtained and included 1 of the articles in this review. Of these 60 studies, 25 were excluded because they did not meet the inclusion criteria. Specifically, 11 articles had not directly trained clinical communication skills with patients (criterion 1), 1 had not studied virtual training (criterion 2), and 13 had not used a tool designed to for training purposes (criterion 3). Therefore, a total of 35 articles were finally included in the review. Finally, one of the authors extracted the relevant data from these 35 studies and entered them into a database following the coding manual we had prepared for this purpose.

Characteristics of the studies included

A total of 35 articles were obtained that had developed and/or applied a virtual environment for training communication skills that would be directed towards patients; 42.86% (*n* = 15) were articles published in the United States and 17.14% (*n* = 6) were from Australia, with the remaining articles having been published in Europe and Asia (table 1). All the articles had been published in English and their objectives are shown in table 1.

Features of the virtual tools

After reading the full text of the 35 articles, we identified 24 different learning tools that had been developed to train communication skills in students or health professionals (table 2). Most of them (62.5%; *n* = 15) had provided training in English (Ali et al., 2020; Bánszki et al., 2018; Bearman, Margaret et al., 2001; Borja-Hart et al., 2019; Courteille et al., 2014; Deladisma et al., 2008; Guetterman et al., 2019; Jacklin et al., 2018; Kleinsmith et al., 2015; Maicher, Kellen R. et al., 2019; Perez et al., 2022; Real, Francis et al., 2017; Rouleau et al., 2022; Sapkaroski et al., 2022; Shorey et al., 2023). Regarding the learning objective of the virtual environment, (a) 41.67% (*n* = 10) had aimed to train communication skills in the

specific contexts of a clinical history and/or anamnesis interview (Deladisma et al., 2008; Du et al., 2022; Hwang et al., 2022; Jacklin et al., 2021; Kleinsmith et al., 2015; Maicher, Kellen R. et al., 2019; Plass et al., 2022; Rouleau et al., 2022; Sezer & Sezer, 2019; Shorey et al., 2023); (b) 41.67% (*n* = 10) general communication skills (Bánszki et al., 2018; Bearman, Margaret et al., 2001; Borja-Hart et al., 2019; Chae et al., 2023; Courteille et al., 2014; Mayor Silva et al., 2023; Nakagawa et al., 2022; Perez et al., 2022; Sapkaroski et al., 2022; Şimşek Çetinkaya et al., 2022); and (c) 8.33% (*n* = 2) in giving bad news (Ali et al., 2020; Ochs et al., 2019). There was also a tool that had been specifically developed to train communication skills to address flu vaccination hesitancy (Real, Francis et al., 2017; Real, Francis J. et al., 2022; Real, Francis J., MD et al., 2017). Another tool that had been used to train communication skills focused on empathy is also worth highlighting (Guetterman et al., 2019).

Some 79.17% (*n* = 19) of the tools had allowed students to train completely autonomously, whereas 20.83% (*n* = 5) had required an online instructor to mediate the training and respond during the interactions (Bánszki et al., 2018; Mayor Silva et al., 2023; Ochs et al., 2019; Real, Francis J., MD et al., 2017; Şimşek Çetinkaya et al., 2022). One of the tools could be defined as partially autonomous because a trained instructor had had to perform some of the functions (Ochs et al., 2019). Regarding the patient type employed for the training, the vast majority of the tools had used virtual patients (*n* = 19; 79.17%) with the appearance of a real person (Ali et al., 2020; Bánszki et al., 2018; Borja-Hart et al., 2019; Chae et al., 2023; Deladisma et al., 2008; Du et al., 2022; Guetterman et al., 2019; Hwang et al., 2022; Jacklin et al., 2021; Kleinsmith et al., 2015; Maicher, Kellen R. et al., 2019; Ochs et al., 2019; Perez et al., 2022; Plass et al., 2022; Real, Francis J., MD et al., 2017; Rouleau et al., 2022; Sapkaroski et al., 2022; Sezer & Sezer, 2019; Shorey et al., 2020). Of these, 94.74% (*n* = 18/19) had responded with a voice (*n* = 18/24; 75%), except for the tool published by (Du et al., 2022). Two tools (8.33%) had used videos recorded with real people (Bearman, Margaret et al., 2001; Courteille et al., 2014). Regarding the types of responses the user could give during the training, almost half of the tools analysed (*n* = 11, 45.83%) had allowed the user to respond orally using natural language (Ali et al., 2020; Bánszki et al., 2018; Borja-Hart et al., 2019; Deladisma et al., 2008; Du et al., 2022; Guetterman et al., 2019; Maicher, Kellen R. et al., 2019; Nakagawa et al., 2022; Perez et al., 2022; Real, Francis J., MD et al., 2017; Shorey et al., 2020; Şimşek Çetinkaya et al., 2022).

Discussion

The objective of this present review was to identify the virtual simulation tools used to train communication skills, both in health professionals and in undergraduate and graduate health sciences students. A total of 35 studies were identified that had used 24 tools, which had taken different approaches and had been applied in differing work environments. Firstly, it is important to highlight the large number of different applications we identified that had been used to improve communication skills (either in basic or more specific situations) through virtual environments. Similarly, other reviews have also concluded that the use of virtual patients for clinical communication training has grown exponentially over the last decade (Battegazzorre et al., 2021; Lee et al., 2020), which has been driven by rapid technological advances (Mendez et al., 2020), also providing further evidence of the benefits associated with this type of resource (Lee et al., 2020).

Most of the applications we considered in this review had worked in English, which could represent an obstacle for professionals and students who do not know this language. Indeed, only one of the tools identified had worked in Spanish and in this case, it was also mediated by an instructor, thereby making it difficult for students to use it autonomously and independently (Mayor Silva et al., 2023). Therefore, there is still a long way to go to make these tools highly accessible at an international level. Regarding the more technical characteristics, we observed visible heterogeneity in the types of technologies used, including in the different types of patients used for training—for example, the use of chat bots, images, and/or recordings of real people and virtual patients. However, our results showed that almost all the applications we identified had designed virtual environments using virtual patients that looked like a person and could vocally respond and receive oral responses to simulate a real conversation (Ali et al., 2020; Bánszki et al., 2018; Borja-Hart et al., 2019; Deladisma et al., 2008; Guetterman et al., 2019; Maicher, Kellen R. et al., 2019; Nakagawa et al., 2022; Perez et al., 2022; Real, Francis J., MD et al., 2017; Shorey et al., 2020; Şimşek Çetinkaya et al., 2022).

Training in simulation environments that assume an appropriate level of fidelity (a three-dimensional term that includes physical/environmental, psychological, and conceptual elements), increases realism (Cant et al., 2019) and influences learning engagement (INACSL Standards Committee et al., 2021). For example, in their systematic review, Kaplonyi et al. (2017) reflected how simulations with the use of standardised patients are considered realistic environments and an effective means for learning communication skills. Indeed, the academic literature proposes that virtual patients can be used as a complementary alternative to work with standardised patients (Maicher, Kellen et al., 2017) and can represent patients in a realistic clinical environment (Battegazzorre et al., 2021) to effectively help students to acquire or improve their communication skills (Lee et al., 2020). Nonetheless, it will be important for future lines of research to use standardised tests to evaluate the beneficial effects of training with this type of virtual tool before fully integrating them into training plans (Lee et al., 2020; Mendez et al., 2020).

In terms of the fidelity of these tools, increasing the immersion of virtual simulations—defined as the psychological state of the perception of being inside or surrounded by something (Witmer & Singer, 1998)—by using virtual patients with natural language processing and auditory and visual behaviour (Battegazzorre et al., 2021; Zielke et al., Apr 2017), is positively related to better communication skills performance (Battegazzorre et al., 2021; Peddle et al., 2016). However, we must not forget that realism and authenticity, which are both relevant factors in design, are not only achieved through physical resemblance (physical fidelity) but rather, also require other fidelity factors (Peddle et al., 2016). Hence, future research in this field should be designed to also consider conceptual fidelity (scenarios and cases consistent with reality) and psychological fidelity (the ability to provoke emotional responses similar to reality) in the design of virtual simulations (Peddle et al., 2016), factors that were not taken into account in this current review.

Nevertheless, we identified two tools that had specifically used recordings of real people in the clinical situations being trained, which could have generated a greater feeling of immersion among students because of the increased physical, auditory, and visual fidelity of these tools. However, in the interactions with the simulation developed by Bearman et al. (2001), users had to respond from a pool of pre-established options, limiting the immersion experience because the participant had been unable to develop their own communication skills in the way they would have to face real situations. In the other tool developed by Courteille et al. (2014), although the user had been allowed to issue a natural language response, this had to be done in writing, which also reduced the degree of reality and spontaneity one would expect from a real conversation. Therefore, highly immersive technologies must be designed to overcome these ongoing technological challenges, such as how to integrate effective natural language processing systems and natural conversation flows into these tools (Stamer et al., 2023) and how to best capture non-verbal communication (Battegazzorre et al., 2021; Lee et al., 2020). For example, in this current review we only identified two applications that could detect gestures and/or emotions (Deladisma et al., 2008; Guetterman et al., 2019).

Of note, most of the tools we identified were based on autonomous learning and therefore represented promising applications with potential great benefits such as high accessibility levels, the possibility of repeating the experience multiple times, and cost reduction once running (Battegazzorre et al., 2021; Plotzky et al., 2021). In this sense, technological advances that can integrate systems that provide feedback to participants—such as AI and machine learning (ML)—without the need for an instructor/teacher to mediate the learning, stand out in particular (Stamer et al., 2023). For example, compared to a previous literature review (Lee et al., 2020), we found more tools in which the feedback had been conducted by the virtual system itself. However, as discussed, despite cataloguing the existence of various patient simulation tools with interesting characteristics, we did not identify any that had simultaneously integrated the use of a real person (a standardised patient) with the objective of increasing the environmental fidelity, to allow the user to train through an oral conversation employing natural language and using complex technology such as AI and ML, with the ability to detect, encode, and respond to complex communication structures (Stamer et al., 2023).

Finally, it is important to note that there were a number of limitations to this current review. Firstly, we only consulted two medical databases—MEDLINE/PubMed and the Web of Science. Despite being a specific health sciences and a multidisciplinary database respectively, having replicated the search in more technological databases may have provided some additional studies for consideration. Therefore, it is possible we did not recover all the relevant records on virtual simulation tools to train communication skills in healthcare professionals registered in the academic literature. Secondly, there is still inadequate standardisation in academic and scientific fields regarding the term 'virtual simulation' (Cant et al., 2019; Foronda et al., 2020; Plotzky et al., 2021). Thus, different terms in the academic literature are all used to refer to the concept of virtual simulation including 'serious games', 'virtual worlds', 'virtual patients', and 'virtual reality' (Cant et al., 2019) which may have also caused us to miss certain relevant records.

In conclusion, this current review identified and analysed the 24 main virtual tools described in the academic literature that have been used to date to train communication skills in the context of health sciences. The high heterogeneity in terms of their characteristics means that tools based on AI and ML that contribute to training both students and practicing health professionals with as high a fidelity as possible to real life remain to be developed.

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Table 1. Description of the studies (N = 35)

Articles	Country	Language	Objetive
(Ali et al., 2020)	USA	English	Describe the iterative participatory design of SOPHIE, an online virtual patient for practice based on feedback from sensitive conversations between patients and clinicians and discuss an initial qualitative evaluation of the system by professional end users.
(Bánszki et al., 2018)	Australia	English	Explore a novice clinical educator's experience in training essential communication and interpersonal skills using a virtual patient.
(Bearman & Cesnik, 2001)	Australia	English	Assess students' attitudes toward learning communication skills through a virtual patient; and compares the acceptability of the two distinct types of virtual patient designs.
(Bearman, Margaret et al., 2001)	Australia	English	Compare these two types of virtual patients to understand how different virtual patient designs affect the student learning experience.
(Bearman, Margaret, 2003)	Australia	English	Explore the students' experience with the virtual patient.
(Borja-Hart et al., 2019)	USA	English	Assess students' confidence and impressions when using their communication skills with a virtual patient and evaluate their competencies in the use of this technology.
(Chae et al., 2023)	Korean	English	The purpose of this study was to describe the development of SimCARE and evaluate the feasibility of its use in nursing education.
(Courteille et al., 2014)	Sweden	English	To investigate the dynamics and congruence of interpersonal behaviors and socioemotional interaction exhibited during the learning experience in a virtual patient, and to evaluate which interaction design features contribute most to behavioural and affective engagement in the medical student.
(Deladisma et al., 2008)	USA	English	Develop a virtual training environment system that can be accessed independently.

(Dickerson et al., 2006)	USA	English	Provide information about the advantages and disadvantages of using synthesized speech and evaluate the fidelity necessary for the training of communication skills.
(Du et al., 2022)	China	English	To evaluate the history-taking skills of nursing undergraduates using a VSP, and to explore its independent influencing factors.
(Guetterman et al., 2019)	USA	English	To investigate the differential effects of a virtual patient-based simulation developed to train healthcare professionals in empathetic patient-provider and interprofessional communication.
(Hwang et al., 2022)	Taiwan Japan	English	A virtual patient (VP)-based social learning approach is proposed to enhance nursing students' performance and clinical judgment in education programs.
(Jacklin et al., 2018)	United Kingdom	English	Create a virtual patient that simulates a primary care consultation, offering the opportunity to practice decision-making. A second objective was to involve patients in the design of a virtual patient simulation and inform the design process.
(Jacklin et al., 2021)	United Kingdom	English	This study aims to evaluate a VP workshop for medical students aimed at developing the communication skills required for SDM.
(Kleinsmith et al., 2015)	USA	English	Develop this understanding of whether students can respond empathically to expressions of concern from a virtual patient.
(Lok, 2006)	USA	English	Teach communication skills using virtual humans.
(Maicher, Kellen R. et al., 2019)	USA	English	Describe a virtual standardized patient system that allows students to practice their history-taking skills and receive immediate feedback.
(Mayor Silva et al., 2023)	Spain	English	The objective was to develop a virtual reality simulator to improve communication skills and compare its results with a traditional workshop based on cases and theoretical content explained through video.
(Nakagawa et al., 2022)	Japan	English	The objective structured clinical examination (OSCE) is among validated approaches used to assess clinical competence through structured and practical evaluation.

(Ochs et al., 2019)	France	English	Evaluate the virtual reality training platform in which the user experience is analysed based on the virtual environment.
(Perez et al., 2022)	USA	English	The purpose of this study was to explore the use of virtual simulation to experience difficult conversations and to evaluate differences in perceptions between nurse educator (NE), family nurse practitioner (FNP), and nurse anesthesia (NA) students.
(Plass et al., 2022)	EEUU Germany	Inglés	The purpose of this study is to evaluate the effectiveness of a brief virtual role-play MI-training program on MI-knowledge and skills in first-year undergraduate medical students, making use of both a pre-test and a then-test (retrospective pre- test) to check for response shift in evaluating the educational intervention.
(Quail et al., 2016)	Australia	English	investigate students' communication skills, knowledge, confidence, and empathy in simulated and traditional learning environments.
(Real, Francis et al., 2017)	USA	English	Develop an immersive virtual reality curriculum on addressing flu vaccine hesitancy using Kern's six-step approach to curriculum design. The goal of the program was to teach best communication practices in cases of questions about the flu vaccine.
(Real et al., 2017b)	USA	English	Create an immersive virtual reality curriculum to teach paediatric residents communication skills when discussing flu vaccination. Compare effectiveness with a control group.
(Real, Francis J. et al., 2022)	USA	English	We examined the acceptability and tolerability of the approach and the impact of deliberate practice using VR simulations on clinicians' confidence related to SDM communication skills.
(Rouleau et al., 2022)	Canada	English	This study aimed to assess the acceptability of a virtual patient simulation to improve nurses' relational skills in a continuing education context.
(Sapkaroski et al., 2022)	Australia n	English	The aim of this study was to establish whether the mode of delivery, VR SLE versus clinical role-play, could have a measurable effect on clinical empathic communication skills for MRI scenarios.
(Sezer & Sezer, 2019)	Turkey	English	Design, develop and evaluate a 3D virtual patient application that can move, has voice and lip synchronization, allows written communication, and is supported by a solid scenario to improve students' communication skills.

(Şimşek Çetinkaya et al., 2022)	Turkey	English	This study aimed to determine the effectiveness of two simulation types used for family planning consultation of midwifery students and to compare these methods.
(Shorey et al., 2019)	Singapore	English	Develop and evaluate the use of virtual patients to better prepare undergraduate nursing students to communicate with real-life patients, their families, and other healthcare professionals during their clinical stays.
(Shorey et al., 2020)	Singapore	English	To examine user attitudes and experiences and clinical facilitators' perspectives on student performance in the clinical environment following virtual patient training.
(Shorey et al., 2023)	USA	English	This study aimed to evaluate the effectiveness of this theory-based virtual intervention on nursing students' learning attitudes, communication self-efficacy, and clinical performance.
(Stevens et al., 2006)	USA	English	Create an interactive virtual clinical scenario of a patient with acute abdominal pain to teach medical students' history-taking and communication techniques.

Table 2. Virtual tools and their characteristics (*n* = 24 tools).

Articles	Tool name	Language	Study purpose	Degree of learning autonomy	Patient type	Type of student responses during training	Type of technology used
(Ali et al., 2020)	SOPHIE	English.	Train communication skills for the delivery of bad news. Aimed at health professionals.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice. The entire transcript can be seen.	Oral conversation.	Artificial intelligence.
(Bánszki et al., 2018; Quail et al., 2016)	Not specified.	English.	Training communication skills. Aimed at healthcare students.	An instructor mediated the training.	Virtual patient with the appearance of a person. Responded with a voice.	Oral conversation.	The instructor was in another room where they controlled everything and responded in the simulated interaction.
(Bearman, M. & Cesnik, 2001; Bearman, Margaret et al., 2001; Bearman, Margaret, 2003)	Not specified.	English.	Training in communication skills. Aimed at medical students.	Autonomous.	Real person speaking. Viewing of recorded videos.	Written. Choice of 3 or 4 written response options available after each video. The authors developed two types of responses in order to compare which was more effective: narrative (detailed communicative structures) and	A total of 154 recorded videos. The next video shown was adjusted depending on the response given. Therefore, the virtual patient became more or less satisfied according to responses chosen by the student.

						problem-solving (labels with possible actions).	
(Borja-Hart et al., 2019)	Used *Shadow Health* from Elsevier.	English.	Training in communications skills. Aimed at pharmacy students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice.	Natural language (written and spoken). Students could choose the interaction they would carry out: ask, empathise, or educate.	The *Shadow Health* web is simulation software that generates different scenarios. http://shadowhealth.com/health-assessment.html The article did not explain any more about the technology used.
(Chae et al., 2023)	SimCARE	Korean.	Training in intercultural communication skills. Aimed at nursing students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice.	They selected a written response from among those on offer.	A virtual reality headset. The authors described the technology used to generate the 3D graphics (Unity 2019.4.0f1 game engine), avatars (DAZ 3D software), and avatar animation (iClone 7).
(Courteille et al., 2014)	Not specified.	English and Swedish.	Training in communication skills. Aimed at medical students.	Autonomous.	Real person speaking. Viewing of recorded videos.	Written. Students replied in text written in natural language.	Interactive Simulation of Patients (ISP). A database with 200 videos for each case allowing the simulator to respond according to the question posed by the student.
(Deladisma et al., 2008; Dickerson et al., 2006; Lok, 2006; Stevens et al., 2006)	Not specified.	English.	Training in communication skills and anamnesis techniques. Aimed at medical students.	Autonomous but with availability of additional resources. The technology that drives this interaction largely	Virtual patient with the appearance of a person (an avatar called Diana) who spoke and produced natural gestures. The authors developed two	Oral conversation. The students could speak using natural language. The software also detected various gestures.	The speech recognition worked using *Dragon Naturally Speaking* by Scansoft. A database developed with content organised in semantic categories to detect the communicative structures used by the students.

				consisted of commodity hardware and software: two desktop computers, two cameras, a data projector, and a wireless microphone.	types of communication for the avatar in order to study which one was more effective: real recorded communication or virtual communication.		
(Du et al., 2022)	University A Virtual Patient (UA-VP, 2021)	Chinese.	Training in communication skills to carry out a nursing evaluation by following Gordon's Functional Patterns.	Autonomous.	A virtual patient with the appearance of a person. Responded with text based on a predefined chat.	Written and oral conversation.	Recognises structures and offers feedback based on the uploaded chat scripts (as bullet points and not reflecting the most important part of the interaction). Used WeChat, a social media application.
(Guetterman et al., 2019)	Used MPathic-VR	English.	Trained empathic communication skills. Aimed at medical students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice.	Oral conversation. It also detected gestures and movements.	Artificial intelligence.
(Hwang et al., 2022)	Not specified.	Chinese.	Trained students in diagnosis and treatment and has a specific medical history module which trains communication skills.	Autonomous.	Virtual patient with the appearance of a person. Responded with voice and text.	Did not specify.	Learning system designed as a decision tree.
(Jacklin et	Not specified.	English.	Training in	Autonomous.	Virtual patient	Written text. Choice	A web-based VP simulator.

al., 2018; Jacklin et al., 2021)			communication skills for shared decision making during clinical interviews. Aimed at medical and/or pharmacy students.		with the appearance of a person. Responded through a voice and with gestures.	of 3 answer options.	
(Kleinsmith et al., 2015)	Neurological Examination Rehearsal Virtual Environment (NERVE)	English.	Trained communication skills for use during clinical interviews. Aimed at nursing students.	Autonomous.	Virtual patient with the appearance of a person. A virtual patient responded with a voice and through text.	Written. The student inserted text written in natural language.	Virtual People Factory (VPF). A database used by the simulator to respond based on the student's question.
(Maicher, Kellen R. et al., 2019)	Not specified.	English.	Trained skills for performing a anamnesis (to collect medical information). It does not address communicative listening strategies such as empathy. Aimed at medical students.	Autonomous.	Virtual patient with the appearance of a person. Responded with voice and text.	Oral conversation. Text could also be written.	Artificial intelligence. The open-source NLP engine ChatScript is used for the conversion element. Unity gaming platform.
(Mayor Silva et al., 2023)	Not specified.	Spanish.	Training in communication skills. Aimed at nursing students.	An instructor mediated the evaluation.	Not specified.	Not specified.	A virtual reality headset.
(Nakagawa	Not specified.	Japanese.	Trained	Autonomous.	A chat bot.	Oral conversation in	Artificial intelligence.

et al., 2022)			communication skills such as desire suppression, expectation acceptance, facial expression, emotional communication, dominance, maintaining relationships, and dealing with disagreements. Aimed at pharmacy students.		Written and oral.	natural language.	If the artificial intelligence did not detect the keywords, the conversation did not continue. There was no direct feedback.
(Ochs et al., 2019)	ACORFORMed	French.	Training in the delivery of bad news. Aimed at medical practitioners (students and professionals).	Autonomous in some functions (e.g., dialogue generator). In others (e.g., categorising the response and sending it to the simulator), the instructor mediated the learning.	Virtual patient with the appearance of a person. Responded with a voice.	Oral conversation.	A virtual reality headset. The instructor categorised the response using a previously coded database and sent that information to the simulator.
(Perez et al., 2022)	Used the Mursion tool.	English.	Trained communication	Autonomous.	Virtual patient with the	Oral conversation in natural language.	Artificial intelligence (using the Mursion tool).

			skills for use in difficult conversations. Aimed at nursing students.		appearance of a person. Responded with a voice.		
(Plass et al., 2022)	Used the Kognito Conversarion Platform.	German.	Training in person-centred communication skills for motivational interviewing. Aimed at medical students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice.	Select between different answer options.	Artificial intelligence (using the Kognito Conversation Platform).
(Real, Francis et al., 2017; Real, Francis J. et al., 2022; Real, Francis J., MD et al., 2017)	Not specified.	English.	Training in communication skills to inform patients about vaccination. Aimed at medical residents.	An instructor mediated the training.	Virtual patient with the appearance of a person. Responded through a voice and with gestures.	Oral conversation and natural language.	Unity gaming platform. A virtual reality headset.
(Rouleau et al., 2022a; Rouleau et al., 2022b)	Not specified.	French. English.	Training in nursing relational skills for use in motivational interviews.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice.	Select between different answer options.	Used the MedicActiV platform.
(Sapkaroski et al., 2022)	Not specified.	English.	Training in communication skills. Aimed at medical	Autonomous.	Virtual patient with the appearance of a person.	Select from among answer options. This part of the case simulation was	Clinical Education Training Solution (CETSOL) VR Clinic software using the Oculus Rift CV1 virtual reality headset.

			students.		Responded with voice and text.	mandatory. It was also capable of natural language oral conversation and the ability to ask alternative questions was optional.	
(Sezer & Sezer, 2019)	Not specified.	Turkish.	Training in basic communication skills for use in a medical interview. Aimed at training healthcare students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice and in writing.	Natural written text.	Virtual People Factory (VPF) for avatar and simulation generation. The scenario was created in Unity 3DTM. Different variations of the simulation interventions the students could apply at each stage were included and these answer combinations were compared to the closest pre-programmed scenario to give an answer.
(Şimşek Çetinkaya et al., 2022)	Not specified.	Turkish.	Training in communication skills for use in a family planning consultation. Aimed at midwifery students.	The instructor offered feedback after watching the simulation.	The patient type was not specified. Responded with a voice.	Oral conversation.	Not specified.
(Shorey et al., 2019; Shorey et al., 2020; Shorey et al., 2023)	Virtual Counselling Application using Artificial Intelligence (VCAAI)	English.	Trained basic communication skills for use in an interview. Aimed at nursing students.	Autonomous.	Virtual patient with the appearance of a person. Responded with a voice and in writing.	Oral conversation in natural language.	Artificial intelligence. Used the Dialogflow chatbot from Google Cloud to store and process natural language. The scenario was created in Unity

	3D.

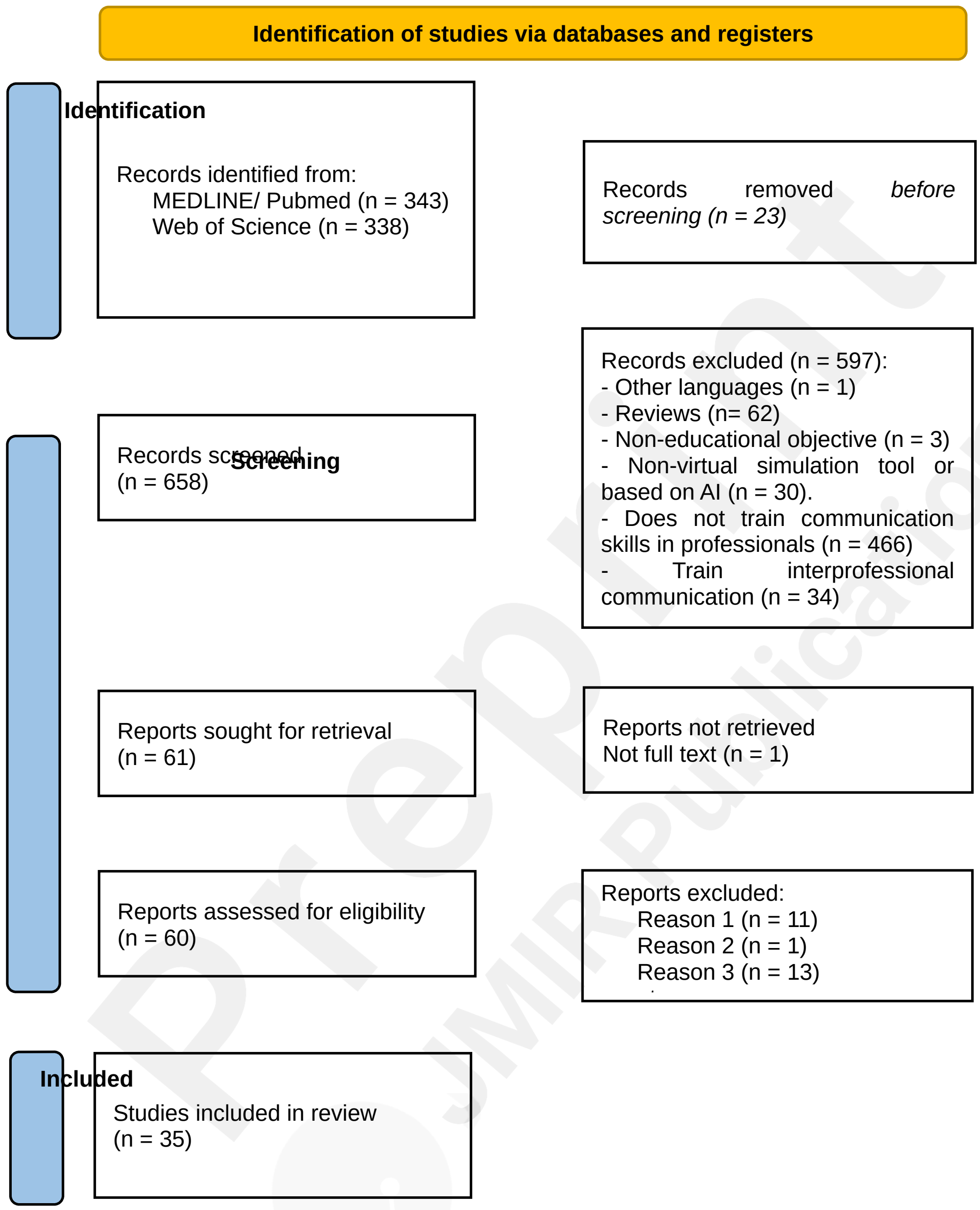

Figure 1. Flow chart