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Research paper

The Effectiveness of Virtual Patient Simulations in Enhancing Medical Education: A Systematic Literature Review with A Focus on Bahrain and The GCC

Fayzeh Abdulkareem Jaber [1, 2] *, Hani Al-Balasmeh [3], Nour Abdulkareem Jaber [4], Ahmad AbdulKareem Jaber [4], Saeed Serwan Abdulsattar [4], Asif Mahmood [1]

[1] *Dept. of Technology Management and Innovation, Arabian Gulf University, Bahrain*
[2] *College of Computer Studies, University of Technology, Bahrain (UTB), Bahrain*
[3] *Dept. of Informatics Engineering, University of Technology Bahrain (UTB), Bahrain*
[4] *Dept. of Health Services Management, University of La Verne, America*
**Corresponding author E-mail: fayzehasj@agu.edu.bh*

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Abstract

This systematic literature review assesses the efficacy of Virtual Patient Simulations (VPS) in enhancing essential learning outcomes in medical education, particularly regarding clinical reasoning, communication skills, and information retention. The evaluation, conducted per PRISMA principles, combined information from 18 eligible studies published between 2014 and 2024. The results indicate that VPS significantly improves clinical reasoning (66.7%), communication (44.4%), and information retention (88.9%) relative to conventional techniques. Tutorials, feedback, and debriefing exercises enhance critical thinking and student engagement.
The research highlights advanced modalities that augment immersion and student involvement, such as first-person perspectives, natural language processing, and voice input. Despite its promise, current research indicates limitations in generalizability, standardization, and long-term impact evaluation, especially in the GCC context. Institutions like Arabian Gulf University (AGU) in Bahrain now use technology like Body Interact, underscoring the region's urgent need for culturally tailored VPS solutions. This report provides evidence-based insights for educators, curriculum creators, and policymakers seeking to improve medical teaching using immersive technology in Bahrain and the GCC area.

Keywords: *Virtual Patient Simulation (VPS); Medical Education; Clinical Reasoning; Communication Skills; Knowledge Retention; Arabian Gulf University (AGU); Bahrain; GCC Healthcare Education; Simulation-Based Learning; Virtual Reality in Medical Training.*

1. Introduction

Medical schools in the GCC, particularly in Bahrain, emphasize good communication, critical thinking, and fundamental medical knowledge. Students are equipped to fulfill different healthcare requirements by completing rigorous training and hands-on experience [1]. Enhancing clinical reasoning is crucial for accurate diagnostic, prognostic, and therapeutic decision-making. This involves identifying knowledge gaps and understanding cognitive processes to reduce errors through practical training. Cognition, which is determined by clinical reasoning, is substantially affected by complex mental processes. [2], [3] Identify over 40 cognitive biases that can affect this process. The complexity of diagnoses and decision-making contexts increases the probability of error. In Careful Nursing, reasoning and decision-making are viewed as an integrated skill that employs nursing knowledge to guide patient care [4], [5]. This entails utilizing various forms of reasoning to formulate strategies and assess care. Cognitive skills and argumentation are essential elements of medical education; nevertheless, their assessment is frequently insufficient, especially in standard clinical environments. Emphasizing scientific argumentation improves students' ability to effectively apply clinical concepts [6-14].
Medical education includes various disciplines, including cognitive and social psychology, sociology, anthropology, ethics, and economics. Health professions education (HPE) incorporates aspects of general education and social sciences within a distinct framework. While traditional lectures continue to be common, there is a significant shift towards active learning strategies that promote self-directed and lifelong education. Accreditation bodies highlight the importance of active learning in improving critical thinking, knowledge synthesis, and professionalism, which diminishes emphasis on core sciences [15].
Problem-Based Learning (PBL), initiated at McMaster University in 1969, remains a key methodology that promotes integrating foundational and clinical knowledge through student-centered, small-group learning. Models like Team-Based Learning (TBL) and Case-Based Learning (CBL) enhance clinical reasoning and foster collaboration. CBL encourages peer interaction facilitated by instructors, while TBL structures large classes into teams that tackle clinical cases through pre-reading and organized feedback [16], [17], [18-20].

The COVID-19 pandemic significantly transformed medical education, leading to a shift towards virtual content delivery and limited clinical exposure for students. While video conferencing and social media have enhanced preclinical learning, replicating hands-on clinical training remains a considerable challenge. Many institutions have shifted to virtual patient updates and online platforms; however, effective implementation requires strong technological support and thorough faculty training. Current challenges include balancing home and work responsibilities while adequately developing clinical skills [21-26].

Virtual Patients (VPs) are computer-generated simulations of clinical scenarios that allow learners to take on the role of healthcare providers, aiding in collecting patient histories, performing examinations, and developing clinical decisions. Over the past decade, virtual patients (VPs) have gained prominence for offering personalized, safe, and interactive learning experiences, alongside performance assessment, reflection, feedback, and standardized patient (SP) encounters [27].

Simulation-based medical education (SBME) and virtual teaching are crucial components of clinical training in Bahrain and the GCC. Arabian Gulf University utilizes tools like Body Interact to enhance diagnostic and decision-making skills within a secure, interactive framework. The COVID-19 pandemic expedited the integration of virtual patients (VPs) and virtual reality (VR) within the region. Although virtual patients assist in clinical reasoning, they do not possess the emotional realism found in standardized patients. Virtual reality tools are increasingly advancing, fostering innovation and facilitating interprofessional learning. Integrating technology with traditional methods is essential for enhancing the quality of medical education [28-36].

Virtual patient simulations (VPS) enhance clinical reasoning and other essential learning outcomes by providing safe and controlled environments for practice. They facilitate active learning in students, providing opportunities for learning from errors while ensuring patient safety. The effectiveness of VPS tools in achieving these outcomes, particularly in the GCC, requires further validation. A systematic review is necessary to evaluate the existing research on VPS, emphasizing their effects on clinical skills and associated outcomes. This will provide insights to inform evidence-based medical education in the region [33-46].

This evaluation evaluates the impact of Virtual Patient Simulation (VPS) technology on the clinical abilities of medical students. With the inclusion of digital technologies into medical education across the GCC, notably in Bahrain, it is critical to understand the influence of VPS and VR simulations on clinical skill development. This research examines the existing literature to assess the effectiveness of VPS in improving medical education and preparing students for practical application in real-world circumstances. This book covers three key issues to help educators, developers, and researchers use VPS to enhance clinical reasoning among medical students.

1.1. Review of Recent Research on Medical Education's AI Evolution

AI is transforming a wide range of sectors, including medical education. AI can alter how GCC students learn, practice, and prepare for clinical roles. This report digs into recent research on AI's role in medical education, highlighting its current impact and forecasting future trends relevant to the region's increasing healthcare training systems. Despite the promising findings across the reviewed studies, several methodological limitations must be acknowledged. Many investigations relied on relatively small sample sizes ([1], [58]), which reduces statistical power and limits the generalizability of their conclusions. Moreover, inconsistencies were noted in reported outcomes; for instance, while some studies emphasized VPS's role in reducing stress and enhancing confidence, others reported minimal or inconclusive effects ([1] vs. [58]). Such variability highlights the importance of cautious interpretation and demonstrates the need for large-scale, multi-institutional studies. Additionally, the predominance of short-term evaluations restricts understanding of the long-term impact of VPS on clinical performance. These methodological shortcomings reinforce the necessity of region-specific research in the GCC to generate more contextually valid insights.

1.1.1. The Application of AI in Paramedic Education

Studies (Michael Birti, James King & Simpson, 2023; Rees, 2020; Wheeler & Dippenaar, 2020) indicate the prospective applications of augmented reality (AR) and virtual reality (VR) in paramedic education. ParaVR exemplifies the efficacy of virtual reality in facilitating skill acquisition and retention. Machine learning systems are poised to provide real-time recommendations for point-of-care decisions [50]. Challenges, including cost, data authenticity, and the necessity for additional research, persist [48], [51].

AI-driven platforms enhancing paramedic communication skills, particularly in dementia care, demonstrate potential [52]. Further research is required to evaluate their overall effectiveness.

1.1.2. AI in Medical Education: Ethics and Effectiveness

Responsible Implementation: [53] discusses ethical and legal challenges in artificial intelligence, emphasizing the significance of continuous training, algorithm openness, and data protection. Integrating responsible AI requires striking a balance between ethical concerns and compassionate care.

Personalized Learning and Assessment: A study of 42 papers [54] demonstrates AI's importance in individualized learning, real-time feedback, and improved evaluations. However, issues persist in ethical data handling and maintaining constant learning and development.

Chatbots for Patient Education: [55] investigated the usage of Bing Chatbot in radiology teaching and found that it was mainly accurate and thorough.

Surgical Simulation: AI improves surgical training quality and competence [56], and AI tutors outperform human professionals [57]. Regulatory and financial constraints continue to impede broad use.

Virtual Patient Simulations (VPS): VPS offers safe, engaging settings for developing clinical skills, confidence, and stress management. Many studies have studied the influence of VPS on medical education, and further research is required to improve knowledge and broaden its application in GCC curricula.

1.1.3. Impact on Clinical Skills

[1] performed a comprehensive evaluation of 51 studies, including over 4,600 participants and discovered that Virtual Patient Simulations (VPS) are as successful, if not better, than conventional techniques for improving clinical reasoning, procedural, and collaboration abilities. However, their influence on student stress and confidence is uncertain.

[58] examined papers from seven central databases using GRADE, PRISMA, and Cochrane methods. Meta-analyses demonstrated that virtual simulation enhances clinical performance and applied knowledge. Like previous studies, the research did not analyze the impact on stress or confidence levels.

[59] examined many perspectives on AI in medical education. While some stakeholders regarded AI only as data tools, others considered it critical in clinical decision-making. There was agreement that students should comprehend AI ethics, algorithmic functions, and data literacy.

The study emphasizes the necessity for GCC schools, particularly in Bahrain, to equip students to understand AI outputs, promote ethical usage, and adapt to AI-driven platforms. The debate regarding the necessity of coding in education persists, with many advocating for a hybrid curriculum that integrates traditional methods with AI technologies to accommodate diverse learning styles.

Research published in Hospital & Healthcare Management (2021) emphasizes the necessity of inclusive AI integration, engaging students, educators, decision-makers, and patients. Customizing AI education for various technologically proficient learners will equip future healthcare professionals for environments influenced by AI in medicine.

Artificial intelligence has profoundly influenced medical education by improving learning opportunities, assessment techniques, and skill acquisition. Ethical concerns, regulatory constraints, and data privacy issues persist, accompanied by a lack of empirical evidence regarding AI's safe and effective integration into healthcare training. [59] emphasize the significance of incorporating diverse stakeholder perspectives in developing AI competencies and curriculum design. In the GCC, including Bahrain, engaging multiple sectors and considering local contexts is crucial to ensure equitable and effective AI adoption in medical education, preparing future healthcare professionals for a rapidly evolving environment.

Table.1: Summary of Key Research Themes in Medical Education and AI

Theme	Key Findings	Studies	Strengths	Limitations	Future Research
Paramedic Education – Skills & Decision-Making	AR/VR can improve clinical skills and decision-making.	[47], [48], [49], [50]	Practical use cases; supports long-term skill retention	High costs, data quality issues, and limited research scale	Assess long-term effects on specific skills
Paramedic Education – Communication & Empathy	AI tools enhance communication in dementia care.	[52]	Unified and structured training platform	Limited evaluation of understanding and practical use	Evaluate emotional applicability and communication outcomes
Medical Education – Ethics & Regulation	Responsible AI use requires ethical and regulatory attention.	[53]	Identifies core challenges (ethics, privacy, training)	Lacks actionable solutions or frameworks	Develop GCC-specific ethical AI guidelines
Effectiveness – Personalized Learning & Assessment	AI supports personalized learning, real-time feedback, and better assessments.	[54]	Strong evidence base (42 studies); covers all learning stages	Concerns about data ethics and tracking progress	Long-term effectiveness and cost analysis in regional contexts
Effectiveness – Chatbots For Patient Education	Chatbots provide accurate, accessible patient info.	[55]	Tested by radiology staff; high content accuracy	Narrow focus; lacks broader clinical context	Expand to different medical fields and user groups
Effectiveness – Surgical Simulation	AI tutors significantly enhance surgical skills.	[57]	AI outperformed human tutors in controlled trials	Regulatory and cost barriers; limited scalability	Research on long-term retention and wide-scale adoption
Effectiveness – Virtual Patient Simulations (Vps)	VPS improves competence and confidence and reduces stress.	[1], [58]	Controlled studies; strong evidence for clinical reasoning	Small samples; short-term outcomes	Study long-term impacts, stress reduction, and GCC-based implementation
Stakeholder Views & Ai Curriculum Development	Stakeholders support AI integration; a hybrid curriculum is needed.	[59]	Highlights diverse views and key competencies (ethics, literacy, tools)	Small sample; lacks clear implementation strategies	Develop inclusive GCC-relevant AI curricula with cross-sector input

1.2. Immersive Learning in Medical Education: VR, AR, and MR in the GCC Context

This section of the Literature Review describes the quick invasion of virtual reality (VR), mixed reality (MR), and augmented reality (AR) into medical educational technology. They establish that using these technologies positively impacts learning and teaching environments.

1.2.1. VR for Evaluation and Skill Development

Virtual reality-based laboratory training enhanced task execution; however, it also resulted in prolonged restocking times, indicating the presence of a learning curve associated with new systems [60].

Virtual reality training demonstrated consistently superior performance across all student levels compared to traditional methods [61].

A meta-analysis indicated that VR training enhanced pass rates, particularly for complex tasks, irrespective of the student group size or skill levels [62].

Virtual reality operating rooms are recognized as efficient training tools that save time, particularly in podiatry and surgical skills [63].

1.2.2. Enhancing Knowledge and Patient Education Through VR

Students utilizing virtual reality demonstrated enhanced comprehension and improved explanatory abilities regarding cardiac anatomy [64].

Students reported greater satisfaction with VR anatomy, particularly visual aspects, indicating enhanced motivation and interactivity [65].

Ninety percent of patients utilizing virtual reality for abdominal aortic aneurysm education indicated an improved comprehension of their condition [66].

1.2.3. Exploring AR and The Potential of Immersive Learning Beyond VR

Highlighted the importance of simulation in mastering complex tasks and advocated for improved feedback and alignment with adult learning principles [67]. Emphasized the interactive and engaging characteristics of AR/VR as revolutionary instruments in healthcare education [68]. Augmented Reality facilitates tailored learning via realistic 3D settings and simulations, particularly in surgical and anatomical instruction [69]. Institutions in Bahrain and the broader GCC are progressively integrating immersive learning technology such as

VR laboratories, AR simulators, and tools like Body Interact to enhance their courses. These technologies provide skill enhancement, patient education, and active learning, per regional goals to improve healthcare worker preparedness.

Table.2: Summary of Categories and Details in VPS Research

Category	Description
Learning Theories	Based on PBL, SDT, adult learning, mastery, and clinical reasoning theories.
Innovation Theories	Informed by gamification, diffusion, and disruptive innovation models.
Research Methods	Surveys, interviews, focus groups, case studies, mixed methods, and literature reviews.
Conditions	Topics include HIV/AIDS, smoking, pediatrics, physiotherapy, and general reasoning.
Participants	Mainly medical students, nurses, residents, and veterinarians; usually small samples.
Place Of Experiment	Studies in Saudi Arabia, Scotland, Thailand, Nigeria, the USA, hospitals, and medical schools.
Key Findings	VPS boosts engagement, reasoning, and learning vs traditional methods.
Key Limitations	Small samples, limited generalizability, weak theoretical base, short-term focus.
Future Research	Long-term impact, facilitator role, patient input, wider application in healthcare.
Focus Of Research	VPS effectiveness, reasoning, specific conditions, integration factors, and experiences.
Compared To	Traditional teaching and other simulations, such as standardized patients.

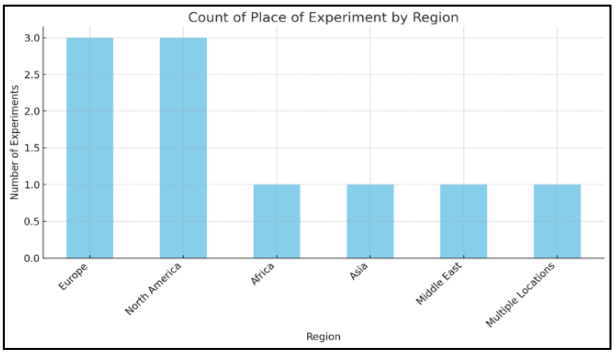

Fig. 1: Places of Experiment.

2. Literature Research Questions

This systematic study aims to evaluate the effectiveness of virtual patient educational tools in enhancing medical students' learning outcomes. This study focuses on three principal research concerns:
Overall Impact on Learning Outcomes: How can virtual patient simulation (VPS) technologies affect medical students' learning, particularly clinical reasoning abilities? This study investigates the effectiveness of VPS tools in improving various learning outcomes, with a primary focus on clinical reasoning. Comparison with Traditional Methods: VPS tools against traditional pedagogical methods for improving clinical reasoning in medical students? This inquiry explicitly compares the effectiveness of VPS tools with conventional techniques (e.g., lectures, textbooks) in developing clinical reasoning abilities. Beyond Clinical Reasoning: Besides enhancing clinical reasoning skills, what impact can VPS tools have on the learning outcomes of medical education? This inquiry examines the broader effects of VPS tools on several learning objectives, including student engagement with the content, self-efficacy in clinical decision-making, and information retention.

3. Methods

This review adheres to the standards of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

3.1. Search Strategy

A comprehensive search was conducted across four relevant databases: PubMed, EBSCOhost, Scopus, with a librarian specializing in medical education research. The investigation was conducted from 2014 to 2024 to provide the most up-to-date findings. This research boosted the results using Boolean operators (AND, OR) in a triadic search methodology. The categories and search terms are as follows:

Table.3: The Categories and Search Terms

Category 1: Virtual Patient Tools	Key Terms: Virtual Patient, Vp Tool, Virtual Clinical Simulation. Derivatives: Computer-Assisted Learning, Simulated Patient, Case-Based Learning.
Category 2: Medical Education	Key terms: medical education, medical curriculum. Derivatives: undergraduate & graduate medical education, medical student learning.
Category 3: Learning Outcomes	Key terms: clinical reasoning skills, knowledge retention, self-efficacy, student engagement. Derivatives: clinical decision making, diagnostic reasoning, problem-solving, information retention, confidence in clinical skills, and motivation.

Boolean operators combined terms from each category in the search methodology. (virtual patient OR VPS tool OR virtual clinical simulation OR computer-assisted learning OR simulated patient OR case-based learning) (medical education OR medical curriculum) (clinical reasoning abilities OR knowledge retention OR self-efficacy OR student engagement) AND This search methodology was customized for each database using MeSH keywords in PubMed and pertinent subject headings in alternative databases. The researcher examined the selected articles' reference lists to identify more relevant studies.

Table.4: Inclusion and Exclusion Criteria

Studies Were Considered If They Matched The Following Requirements.	
Participants	Students Enrolled In Undergraduate Or Graduate Medical Programs.
Intervention	Using Virtual Patient Education Tools As Part Of The Curriculum.
Comparison	Traditional Teaching Methods (E.G., Lectures, Textbooks) Or Alternative Educational Interventions.
Outcomes	Assessed Clinical Reasoning Skills, Knowledge Retention, Self-Efficacy, Or Student Engagement.
Study Design	Randomized Controlled Trials, Quasi-Experimental Studies, Or Observational Studies With Pre- And Post-Intervention Assessments.
Language	English
Publication Date	Published Within The Last Ten Years (2014-2024)
Studies Were Excluded If They	
Focused On Non-Medical Student Populations (E.G., Nursing Students).	
There Was No Straightforward Research Question On The Impact Of Virtual Patients.	
Employed Interventions Solely Based On Traditional Methods (E.G., Lectures, Textbooks) Without A Virtual Patient Component.	
Did Not Assess Any Of The Pre-Defined Learning Outcomes.	
We're Not Published In English.	

3.2. Data extraction

Scopus, EBSCOhost, and PubMed produced 137 articles. After the screening procedure, 46 duplicate papers were eliminated, leaving 91 titles and abstracts for further review. After evaluating abstracts and titles, 50 submissions were disqualified based on predetermined criteria. Forty-one articles were assessed. The final synthesis consists of 18 qualitative and quantitative research articles. This is a reduction from 23 papers removed during comprehensive text evaluation for diverse reasons. Two independent assessors gathered data on study design, sample size, intervention specifics, outcomes, and primary findings. The dialogue addressed the issues. The data were evaluated using narrative synthesis.

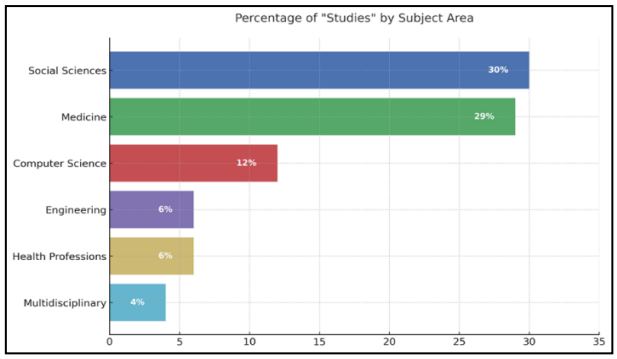

Fig. 2: Studies by Subject Area in VPS Research. Includes Identified Disciplines and a Category of "Unidentified" Studies (18%).

Figure 3.1 summarizes the distribution of research on the usefulness of Virtual Patient Simulations (VPS) on medical students' learning outcomes. The chart shows that the most significant proportion of studies was conducted in Biochemistry, Genetics, and Molecular Biology (29%), suggesting a predominance of VPS applications supporting knowledge acquisition in basic sciences. Other categories, such as Decision Sciences (12%) and Nursing (6%), indicate that VPS is also being investigated beyond core medical disciplines, demonstrating its interdisciplinary relevance. However, 18% of studies fell into an "unidentified" category, representing research that could not be clearly aligned with a single discipline. This lack of clarity reduces the interpretability of the overall distribution and highlights the need for more standardized classification in future VPS research. Addressing this issue would provide a more comprehensive understanding of how VPS tools are applied across educational domains and ensure that cross-disciplinary contributions are better captured.

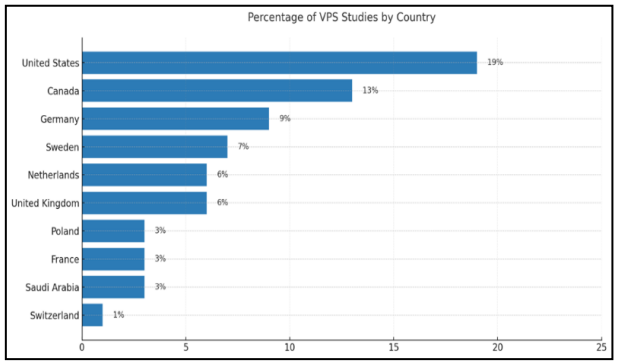

Fig. 3: Percentage of' Studies on VPS' by 'Country'.

Figure 3.2 illustrates the distribution of VPS studies by country. The United States accounts for the highest proportion (19.12%), followed by Canada (13.24%), while European countries such as Germany, Sweden, and the Netherlands also contribute substantially. In contrast, GCC representation is minimal, with only 4.41% of studies originating from Saudi Arabia and none from Bahrain or other Gulf states. This imbalance highlights a critical gap in regional research output, particularly considering the growing emphasis on digital health and medical education reform in the GCC. The heavy reliance on data from North America and Europe raises questions about the transferability of findings to culturally distinct contexts. Future studies in the GCC should prioritize collaborative, multi-institutional projects that adapt VPS technologies to local languages, healthcare systems, and patient demographics to address this gap. Such efforts would ensure that global evidence can be meaningfully applied within regional medical curricula.

3.3. Study selection

The preliminary search produced 137 articles. After eliminating duplicates and evaluating abstracts, 18 out of 91 full-text publications satisfied the inclusion criteria.

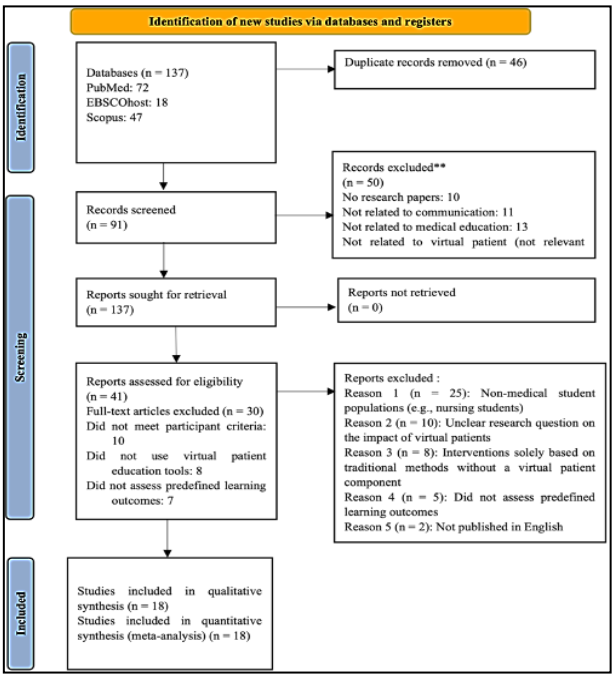

Fig. 4: Prisma Trial flow for a Systematic Review of Virtual Patient Simulation Tools.

4. Results

4.1. Test Procedure

Scopus, EBSCOhost, and PubMed yielded 137 articles. After eliminating 46 duplicates, 91 possibly relevant articles remained for title and abstract evaluation. Following the assessment of titles and abstracts, 50 papers were removed. The selected 41 articles underwent a comprehensive full-text analysis. The final qualitative and quantitative synthesis includes 18 publications, while 23 were removed during full-text screening for various reasons. Refer to Figure 4.4 for the exclusionary approach.

4.2. Q1-1: Overall Impact on Learning Outcomes: Simulated Scenarios

The study examined the impact of various simulated environments on the outcomes of Virtual Patient (VP) training. Among the 18 investigations [70], 33.3% concentrated on the historical records of a vice president and included the distribution of adverse information to the vice president or their family. Three studies (16.7%) evaluated the danger of suicide and concentrated on the revelation of medical mistakes. The declining rates of influenza vaccine refusal were the focus of [71], at 11.1%. Gulati et al. (2021) emphasized the cultivation of connections with patients displaying signs of depression, comprising 22.2%, while 22.2% of scenarios were included to clarify and strategize therapy. The aggregation of patient data and the focus on culturally competent communication were the distinguishing features of Saniya Raghib Sabzwari (2023), at 27.8%.

The diversity of VP study environments illustrates the efficacy of VP training for medical students. The results indicate that VP systems may assist medical students in enhancing their technical and interpersonal skills by focusing on various clinical and communication competencies. Students' readiness and confidence for clinical practice may be augmented by VP training, which encompasses sensitive topics such as delivering unfavorable news and assessing suicide risk. Beyond these measurable improvements, learners also reported that engaging with emotionally challenging scenarios—such as disclosing medical errors or addressing vaccine hesitancy—helped them develop empathy, resilience, and ethical sensitivity. These qualitative outcomes suggest that VP simulations prepare students for technical competence and the emotional and interpersonal demands of real-world medical practice.

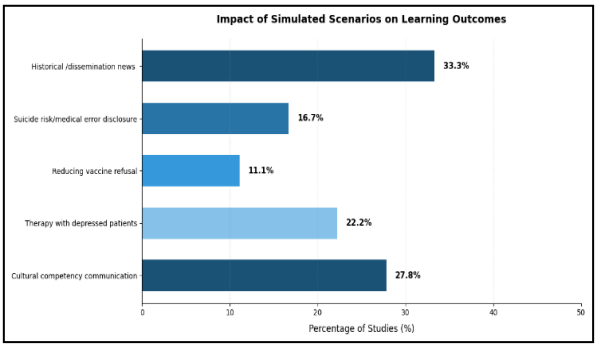

Fig.5: Distribution of Simulation Modalities, User Inputs, and Responses in Virtual Patient Systems.

Figure 4.1 demonstrates that Virtual Patient (VP) training scenarios predominantly focus on communicating adverse news (33.3%), reflecting the central importance of communication skills in emotionally charged clinical encounters. Other commonly explored scenarios include cultural competence and patient communication (27.8%), rapport-building with patients suffering from depression (22.2%), and treatment planning (22.2%), all of which underscore the emphasis on patient-centered care and empathy in VPS research. In contrast, relatively few studies addressed critical but sensitive areas such as suicide risk assessment and disclosure of medical errors (16.7%), or public health concerns like vaccine refusal (11.1%). This imbalance suggests that VPS has been primarily applied to interpersonal and diagnostic skills rather than broader ethical or societal issues. Such a reduced focus may limit the comprehensiveness of VPS training, particularly in the GCC context, where vaccine hesitancy and mental health disclosure remain pressing challenges. Future VPS development should therefore expand to include these underrepresented domains, ensuring a more holistic training experience that prepares students for clinical reasoning and addressing culturally sensitive and public health–oriented challenges.

4.3. Q1-2: Overall Impact on Learning Outcomes: Instructional Interventions

Most of the research included instructional interventions to enhance the learning experience. Of the 18 studies, lessons were incorporated in eight instances (44.4%) before the contact. ([74], 55.6%) Engaged human facilitator or virtual trainer feedback. According to [75], 44.4% of the participants engaged in debriefing sessions, reflective activities, and cooperation. Implementing instructional interventions such as debriefing sessions, tutorials, and feedback signifies the successful completion of VP training. Such interventions aim to facilitate reflective practice, immediate correction, and the consolidation of learning. The system's ability to receive feedback from physical facilitators and virtual mentors allows for delivering personalized recommendations to students, significantly enhancing their learning process and results. In addition to these measurable outcomes, several studies also emphasized the qualitative benefits of VPS interventions. Learners frequently reported increased confidence, stronger empathy toward patients, and reduced anxiety in clinical settings after practicing with virtual patients ([70], [71]). While less frequently quantified, these subjective gains highlight VPS's holistic role in shaping professional identity and communication sensitivity, complementing the measurable performance improvements.

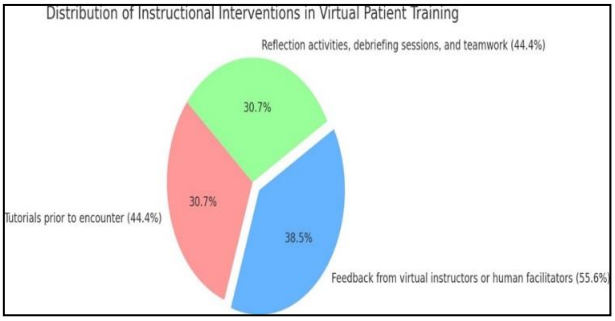

Fig. 6: Distribution of Instructional Interventions in Virtual Patient Training.

Figure 4.2 presents a scatterplot depicting the instructional approaches used in Virtual Patient (VP) training across 18 studies. The lesson was used in 44.4% of the experiments, primarily for pre-VP contacts. Feedback from a virtual teacher or human facilitator was used in 55.6%, whereas 44.4% of the research included reflection activities, debriefing sessions, or collaborative practice. These treatments optimize learning performance by promoting self-reflection, timely feedback, and revisiting essential concepts to attain comprehensive and practical training.

Beyond these quantitative findings, several studies also highlighted the qualitative benefits of such instructional strategies. Students often reported that facilitator guidance and structured debriefing improved their technical accuracy and boosted their confidence, motivation, and preparedness for fundamental patient interactions. These experiential outcomes reinforce the idea that VPS instructional interventions shape both the measurable and personal dimensions of medical learning.

4.4. Q1-3: Overall Impact on Learning Outcomes: Modality of Simulation, User Input, and Response

The modalities of the VP systems were variable among the research. The 18 inquiries encompass: Students engaged directly with vice presidents from their standpoint using a first-person viewpoint (Dale MacLaine et al., 2021), 55.6%. Five people, representing 27.8%, used a third-person viewpoint. ([76], 16.7%) Executed immersive environments. Two people used static pictures, representing 11.1% of the total. ([77], 66.7%) Utilized animated visual presentations. Life-sized virtual figures were shown on a wall by (3.1, 16.7%). User engagements with VPs included:

- Voice input (n = [74], 55.6%).
- Text input (n = [75], 44.4%).
- Natural language processing (n = [77], 66.7%).
- Preprogrammed algorithms for text input (n = ([70], 33.3%).
- Human-controlled VP responses (n = Gulati et al., 2021, 22.2%).

The extensive use of modalities and interaction strategies makes learning in VP systems rewarding and engaging. Students may demonstrate increased interest and see the experience as more real when using immersive first-person perspectives with animated virtual characters. Using natural language processing and voice input augments the authenticity of the interaction. Students may use these sophisticated techniques in a controlled setting before using their learned knowledge in real clinical situations.

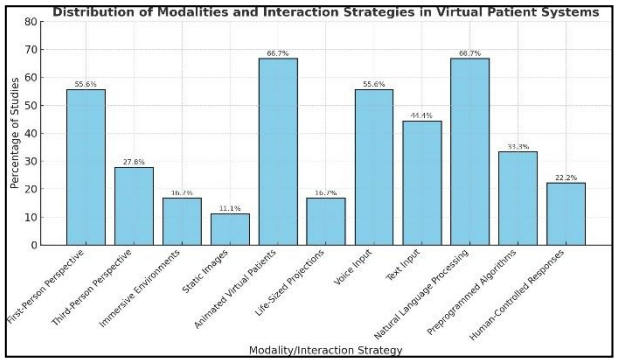

Fig.7: Distribution of Modalities and Interaction Strategies in Virtual Patient (VP) Systems.

Figure 4.3 illustrates the distribution of modalities and interaction tactics used in Virtual Patient (VP) systems across 18 studies. Each modality or interaction method is shown as a bar, illustrating the research's proportion. This variability underscores VP systems' complexity and captivating essence in medical education.

4.5. Q2-1: Comparison with Traditional Methods: Simulated Scenarios

Comparative research on traditional methodologies versus virtual reality (VR) systems. The reported scenarios highlighted information gathering from patients (n = Saniya Raghib Sabzwari1, 2023, 27.8%) and establishing relationships with patients (n = Gulati et al., 2021, 22.2%). Treatment planning (n = Gulati et al., 2021, 22.2%). Communicating negative information (n = Raafat et al., 2024, 33.3%). The rate of reported disclosure of medical errors is 16.7% [76]. Communication related to cultural competency (n = (Saniya Raghib Sabzwari1, 2023, 27.8%). Integrating VP systems with traditional approaches can establish an effective therapy practice. Furthermore, VP systems provide advantages, including the ability to rehearse scenarios repeatedly and obtain prompt feedback, a feature that is not consistently available through conventional methods. The focus on patient communication and relationship development underscores the importance of these skills in medical education. A VP system promotes standardized curriculum acquisition among students by establishing a more regulated classroom environment.

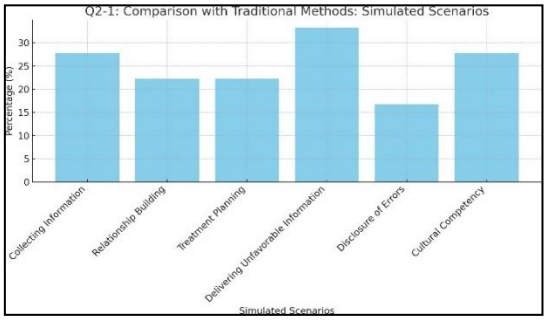

Fig. 8: Percentage of Studies by Simulated Scenario.

Figure 4.4 demonstrates the percentage distribution of attention received by various simulated scenarios in research studies. The scenario of “Delivering Unfavorable Information” is present in 33.3% of research studies, whereas the categories “Collecting Information” and “Cultural Competency” collectively account for 27.8%.

4.6. Q2-2: Comparison with Traditional Methods: Instructional Interventions

An examination of educational interventions in VP systems revealed that Tutorials and pre-activity guidance account for 44.4% of all occurrences, as noted by [75]. Feedback from human instructors and virtual systems (n = Dale MacLaine et al., 2021) was 55.6 percent. The research showed that the integration of debriefing and reflection sessions produced a result of 44.4% (n = [75]). Unlike traditional educational methods, training in virtual patient systems provides structured learning support via intervention approaches. Students' preparedness for simulations is enhanced by tutorials and pre-activity teaching, subsequently accompanied by chances for feedback and reflection to promote continuous advancement. These implementation strategies achieve educational and practical goals to improve learning and ensure students effectively use the skills they have gained in clinical practice.

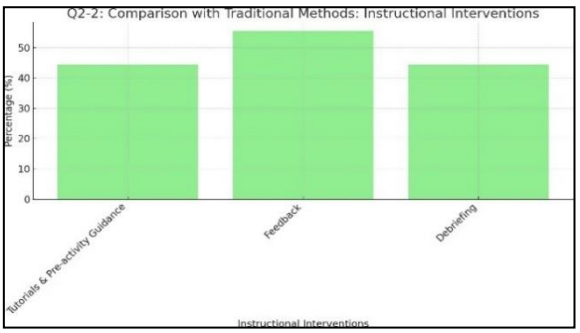

Fig. 9: Percentage of Studies by Instructional Intervention.

Figure 4.5 illustrates statistical data about the usage of instructional interventions in VP systems. Among the several intervention strategies used by 55.6% of teachers, feedback is the predominant strategy, followed by tutorials and debriefing, both adopted at a rate of 44.4%.

4.7. Q2-3: Comparison with Traditional Methods: Modality of Simulation, User Input, and Response

Virtual Patient (VP) systems provide enhanced interactive learning compared to conventional approaches, using first-person (55.6%) and third-person (27.8%) viewpoints (Dale MacLaine et al., 2021); (Saniya Raghib Sabzwari1, 2023). Most users choose voice input (55.6%) compared to text input (44.4%). Donald Combs (2019). Numerous systems use natural language processing (66.7%) for authentic engagement, although others depend on human-operated answers (22.2%) ([77]; [72]). These attributes augment immersion, clinical reasoning, and communication skills within a secure, standardized setting essential for advancing medical education in the GCC, particularly in Bahrain. In addition to these quantitative findings, students frequently reported that VPS provided a more engaging and motivating learning experience than traditional methods. Learners emphasized that features such as voice input and NLP increased realism, reduced hesitation during simulated consultations, and boosted their confidence in transitioning to real patient encounters. These subjective benefits underline that VPS outperforms traditional approaches in measurable outcomes and enhances learner satisfaction and preparedness.

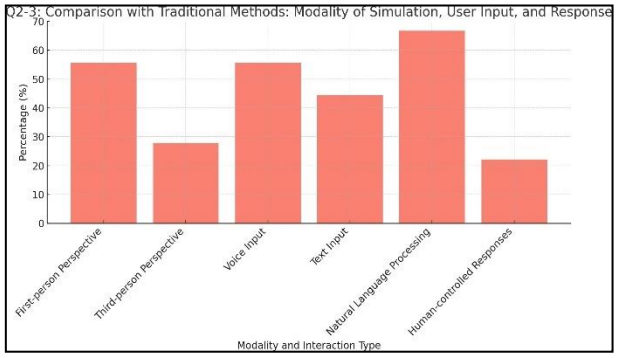

Fig. 10: Percentage of Studies by Modality and Interaction Type.

Figure 4.6 illustrates the distribution of various modalities and interaction mechanisms throughout VP systems. According to survey data, 66.7% of VP systems use natural language processing (NLP) features, enabling dynamic and authentic exchanges between students and virtual patients. The first-person viewpoint and voice input modalities represent 55.6%, reflecting the growing emphasis on immersive perspectives and spoken interaction to replicate real-world consultations. These design features enhance technical engagement and improve learner immersion, with students frequently reporting that NLP and voice-based communication increased the realism of scenarios and their confidence in conducting sensitive conversations. Such findings suggest that interaction modalities are pivotal in shaping the cognitive and emotional dimensions of VPS learning experiences.

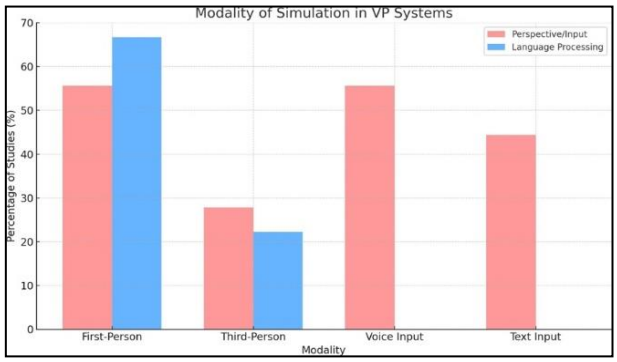

Fig. 11: Modalities Used in Virtual Patient (VP) Systems.

Figure 4.7 illustrates the many modalities used in Virtual Patient (VP) systems, including user perspective, input modality, and language processing. The Perspective/Input section specifies that systems use first-person views (experienced from the user's perspective) or third-person views (viewed externally), with interactivity enabled via voice or text input. Users may interact with the system directly or respond by typing. The Language Processing domain focuses on natural language processing (NLP), enabling genuine speech-based interactions and human-oriented virtual presence responses for complex scenarios. These modalities enhance the authenticity and effectiveness of VP systems in developing clinical and communication abilities. Qualitative reports further reveal that first-person perspectives and NLP features increased learners' sense of immersion, emotional engagement, and realism in training. Students noted that voice-based and dialogue-driven interactions felt closer to real clinical encounters, boosting their confidence and motivation. This suggests that the choice of modality affects measurable learning outcomes and shapes students' subjective experiences, which are critical for long-term adoption and effectiveness.

4.8. Q3-1: Beyond Clinical Reasoning: Simulated Scenarios

A Virtual Patient (VP) system was developed to enhance clinical reasoning and communication skills across various medical contexts, with 66.7% of studies focusing on clinical reasoning [77] and 27.8% investigating patient engagement and cultural competence Saniya Raghib Sabzwari1, 2023). These findings highlight the growing importance of VP technologies in teaching interpersonal and communication skills, especially in culturally diverse settings. The GCC countries, particularly Bahrain, have unique healthcare challenges, requiring the development of culturally appropriate VP scenarios. This would ensure medical students are prepared for genuine patient interactions within the region's unique social and cultural context. In addition to these measurable outcomes, qualitative findings suggest that students

valued scenarios involving cultural competence and patient engagement for their role in building empathy, improving confidence in sensitive conversations, and enhancing readiness for real-world practice. Such experiential benefits demonstrate that VPS contributes to technical proficiency and learners' emotional and cultural preparedness. These dimensions are particularly vital in GCC healthcare systems.

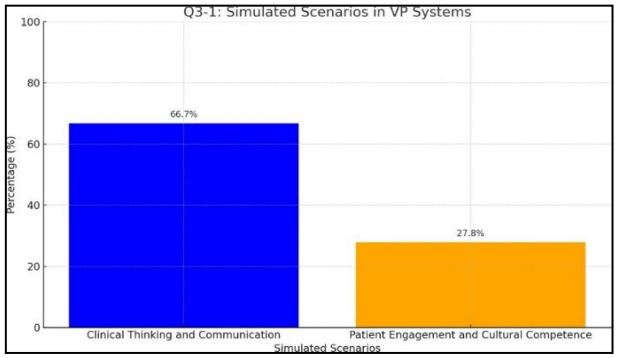

Fig. 12: Simulated Scenarios in VP Systems Focus on Clinical Thinking, Communication, and Cultural Competence.

Figure 4.8 illustrates the primary simulation scenarios used in Virtual Patient (VP) systems. Clinical reasoning and communication scenarios comprise 66.7% of the simulations, highlighting their critical significance in patient care. Patient participation and cultural competence account for 27.8%, indicating a growing recognition of their importance in medical education. VP systems have a dual function, enhancing clinical thinking and interpersonal abilities. The research underscores the need for tailored VP scenarios specific to the Gulf Cooperation Council (GCC) region to improve the congruence of training with local cultural and healthcare needs. Qualitative findings also revealed that students valued these scenarios for developing empathy and cultural awareness, reporting that such experiences enhanced their confidence in handling sensitive patient interactions. This suggests that beyond technical reasoning, VPS contributes to shaping professional identity and cultural competence, dimensions particularly vital for the GCC context.

4.9. Q3-2: Beyond Clinical Reasoning: Instructional Interventions

Tutorials, feedback, and self-reflection were essential teaching tactics in Virtual Patient (VP) training, reported by 88.9% of participants (Tay et al., 2014). Teamwork and debriefing were used in 44.4% of instances (C. Donald Combs, 2019). These strategies transcend clinical reasoning by assisting students in comprehending training objectives, cultivating critical thinking, and internalizing knowledge via reflection. Team-based activities facilitate the development of vital communication and teamwork skills necessary for proficient patient care. In addition, learners often reported that structured feedback and collaborative debriefing increased their confidence, improved their preparedness, and fostered satisfaction with the learning process. These subjective outcomes illustrate VPS instructional interventions' broader value in shaping technical competence and professional growth.

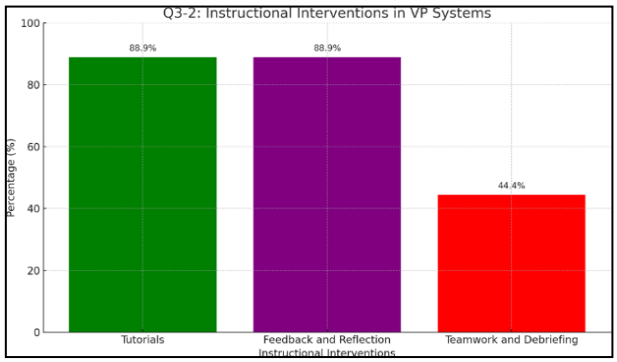

Fig. 13: Instructional Interventions Used in VP Training Go Beyond Clinical Reasoning.

The figure depicts the instructional strategies used in Figure 4.9 to improve VP training outcomes. The implementation rates demonstrate that tutorials and feedback/reflection exceed 88.9%. Students achieve training objectives via tutorial participation, while feedback and reflection sessions improve their critical thinking and self-analysis skills. The staff development strategy, teamwork, and debriefing improve cooperation among healthcare teams, which are used in 44.4% of educational contexts. VP systems use educational strategies that surpass medical reasoning characteristics to provide a collaborative curriculum while enabling students' self-assessment processes. In addition to these measurable outcomes, learners often described tutorials and debriefing as motivating and reassuring, noting that structured feedback enhanced their confidence and teamwork activities strengthened their sense of collaboration. These qualitative perspectives highlight that VPS instructional strategies contribute to knowledge retention, learner satisfaction, preparedness, and professional growth.

Table.5: Comparison of Scenarios, Instructional Interventions, and Evaluation Features in VPS Studies

Scenario	Instructional Intervention	Evaluation Features
Group 1 Studies (Where Vps Showed Effectiveness)		
Geriatric And Pediatric Vps	Positive feedback on realism and applicability, improved clinical reasoning, and knowledge retention.	CLINICAL REASONING, TRANSFERABILITY, NAVIGATION CLARITY, ENGAGEMENT, AND EDUCATIONAL EFFECTIVENESS FEEDBACK.
Decisionsim Platform For Trauma Scenarios	Performance metrics for clinical management skills.	OBJECTIVE EVALUATION OF VIRTUAL TIME, STEPS, POSITIVE AND DETRIMENTAL BEHAVIORS, AND THEIR RATIO.
Standardized Patients For Breaking Bad News	Assessment of communication skills.	REALISM, IMMERSION, FIDELITY OF SCENARIOS, USABILITY OF TECHNOLOGY.

Group 2 Studies (Where Vps Showed No Effect Or No Changes)		
Vizard 5.7 Platform For Breaking Bad News	Focus groups, improved communication skills.	FOCUS GROUPS WERE ANALYZED USING THEMATIC ANALYSIS.
High-Fidelity Hospitalist Simulation	Pre/post-assessment, improved clinical skills, teamwork, and communication.	ASSESSING REALISM, ENGAGEMENT, AND USABILITY.
Vr Technology For Psychiatric Intake	Usability and engagement, improved core knowledge and skills in psychiatry.	USABILITY, REALISM, ENGAGEMENT WITH VP SYSTEMS.
Vr Simulators For Orthopedic Arthroscopy	IMPROVEMENT IN TECHNICAL SKILLS AND SKILL RETENTION.	VALIDITY: CONSTRUCT, TRANSFERENCE, AND CONCURRENT VALIDITY ASSESSED.

4.10. Q3-3: Beyond Clinical Reasoning: Modality of Simulation, User Input, and Response

VP systems use several modalities to enhance learning. First-person (55.6%) and third-person (27.8%) perspectives ([74]; [73]), together with verbal (55.6%) and textual input (44.4%) [75], enhance immersion training. Natural language processing (66.7%) and human-mediated interactions (22.2%) ([75]; [72]) enable genuine dialogue. These methodologies improve student engagement, clinical reasoning, and communicative skills. They also advocate for standardized assessments and improved training outcomes.

Beyond the quantitative distribution of modalities, learners frequently emphasized how these features shaped their learning experience. First-person perspectives and voice-based inputs were often associated with stronger feelings of realism and emotional involvement, while natural language processing increased their sense of authentic communication with patients. Students also reported that these immersive features improved motivation, reduced hesitation in clinical conversations, and enhanced their satisfaction with learning. These qualitative insights highlight that the effectiveness of VPS depends not only on statistical performance gains but also on the subjective experiences that drive learner confidence and sustained engagement. Therefore, Future research must integrate quantitative outcomes and qualitative feedback to optimize VP design and maximize long-term skill retention.

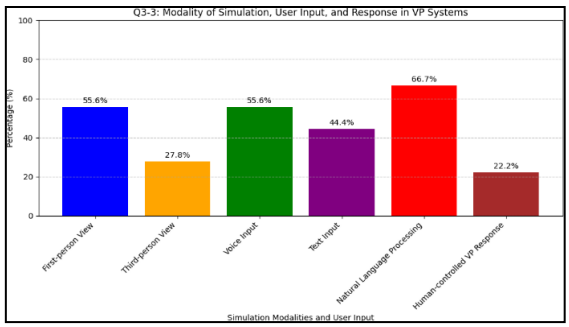

Fig. 14: Distribution of Simulation Modalities and Interaction Strategies in VPS Studies, Including Perspectives, Input Methods, and Response Types.

Figure 4.10 presents the distribution of simulation modalities and interaction strategies used in Virtual Patient (VP) systems across the reviewed studies. The data show that most systems incorporated first-person perspectives (55.6%) and third-person perspectives (27.8%), highlighting the importance of immersive viewpoints in enhancing learner engagement. Input methods varied, with voice input (55.6%) and text input (44.4%) supporting different interaction styles. In comparison, natural language processing (66.7%) emerged as a dominant feature that enables authentic, dynamic dialogue between students and virtual patients. Human-controlled responses (22.2%) were less common, though they provided an additional layer of realism. This diversity of modalities reflects the growing sophistication of VPS tools and their potential to replicate clinical communication in controlled environments. However, the lack of standardization across studies makes it difficult to compare outcomes reliably. Future research should evaluate which modalities contribute most effectively to improving communication, diagnostic reasoning, and decision-making skills, particularly in the GCC context, where technology adoption is accelerating. Still, resource limitations may constrain access to advanced VPS platforms.

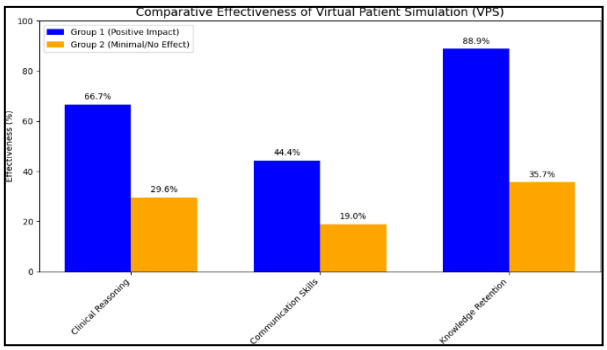

Fig. 15: Summary of VPS Effectiveness.

Figure 4.11 illustrates the significant effectiveness of Virtual Patient Simulation (VPS) in enhancing essential medical skills. Group 1, utilizing VPS, demonstrated markedly superior outcomes compared to Group 2, which did not employ this method. Clinical reasoning enhancement was observed at 66.7% in Group 1, whereas Group 2 exhibited an improvement of only 29.6%. Communication skills improved by 44.4% compared to 19%, while knowledge retention was highest in Group 1 at 88.9% effectiveness, in contrast to 35.7% in Group 2. The findings indicate that VPS effectively enhances clinical reasoning, communication, and knowledge retention, particularly when combined with conventional interactive learning methods. Beyond these measurable outcomes, learners in VPS groups often reported higher satisfaction with the learning process, greater confidence in applying skills during clinical encounters, and a stronger sense of preparedness for patient interactions. These qualitative perspectives reinforce the quantitative evidence, showing that VPS improves performance metrics and fosters motivation and professional growth.

5. Discussion and Conclusion

Various studies have investigated the effects of VP simulation technology on clinical competency training and student educational outcomes in medical education. An analysis of 18 research studies demonstrates the diverse advantages and obstacles to implementing virtual patient systems in medical education. The research indicates that VP systems are appropriate for educational settings requiring historical data management, addressing patient exposure to distressing content in suicide risk assessments, managing vaccine refusal, and supporting patients with depression. VP simulations effectively meet diverse educational requirements, encompassing technical skills and communication competencies.

Seminars combining in-person instructor feedback with subsequent debriefing sessions have enhanced reflective practice and improved therapeutic skills acquisition. In such settings, healthcare providers benefit from immediate feedback, strengthening their ability to transfer learning into clinical practice. A diverse range of learning systems and assessment methods is emerging, with research predominantly emphasizing technology development alongside simulation training and educational applications. Comprehensive evaluations often measure satisfaction, usability, and fidelity, incorporating authentic experiences from instructors and system performance metrics. These criteria for instructional effectiveness and usability align with evaluation standards for standardized and virtual patients, thereby improving the validity of VP systems in assessment. Moreover, VP training technology enables students to engage with realistic scenarios that generate authentic feedback, enhancing both learning satisfaction and the precision of clinical practice exercises.

However, the scarcity of GCC-specific studies is a notable limitation of the current evidence. As shown in Figure 3.2, only 4.41% of the reviewed research originated from Saudi Arabia, with no contributions from Bahrain or other Gulf states. This limited representation restricts the regional applicability of the findings and raises concerns about the direct transferability of global evidence to the GCC's cultural and healthcare contexts. While VPS has proven effective internationally, its impact may vary depending on local healthcare practices, language use, and patient expectations.

Therefore, future research in the GCC should prioritize collaborative, multi-institutional studies that adapt VPS scenarios to regional needs. This could include integrating culturally sensitive communication tasks, localized clinical case studies, and Arabic-language platforms to ensure contextual relevance. Such efforts would not only bridge the current gap in the literature but also provide educators and policymakers in the GCC with evidence-based insights that are directly applicable to their medical curricula.

6. Implications

The review demonstrates that Virtual Patient (VP) scenarios significantly enhance specialized clinical skills and communication abilities, surpassing traditional methods. To maximize benefits, institutions must align educational objectives with system functionalities and ensure that VP tools are accessible and effective. VP training enhances students' practical clinical skills, especially in communication, by providing standardized, realistic, and interactive practice environments that facilitate skill acquisition and readiness for genuine patient care.

7. Strengths and Limitations

The review provides utility in multiple aspects. The synthesis of results from various studies provides a comprehensive analysis of the implementation of VP systems and the measurement of performance in medical training. The training capability of VP is achieved by integrating various instructional modes with diverse simulated environments. Drawbacks have also been identified. The different approaches to system design, alongside diverse assessment measures and outcome methods, complicate the ability to draw definitive conclusions. The use of self-report measures in most studies undermines the reliability of results, as it may introduce potential research bias. Future studies should develop standardized measurements utilizing quantitative standards to enhance the rigor of VP system assessment methods.

8. Conclusion and Recommendations

Virtual Patient (VP) simulation is crucial to medical training by providing an interactive, adaptive, and realistic learning environment. Through rigorous critical examination and frequent use, along with an emphasis on learning communication techniques, VP systems appear to complement existing methods of instruction, enhancing both clinical student performance and readiness. To realize their full potential, addressing the issues outlined in this review, particularly those concerning standardization, long-term evaluation, and regional applicability, is essential.

According to the conclusions and recommendations of this review, several proposals are presented to close the gaps identified and improve the design, implementation, and testing of Virtual Patient Simulation (VPS) systems:

- Standardization of the Assessment Criteria: Establish a universally applicable framework to ensure uniform and comparable evaluation of VPS systems across studies.
- Application of Objective Measures: Incorporate self-report and objective measures of learning performance and system usability to maximize validity and reliability.
- Complete Training Programs: Conduct VPS simulations within full training programs, including tutorials, facilitator feedback, and structured debriefing sessions to maximize learning outcomes.
- Highlight Communication Skills: Expand VPS scenarios to include sensitive communication tasks such as breaking bad news and addressing cultural competency, ensuring students develop strong interpersonal and ethical skills.
- Regional Studies in the GCC Context: Address the critical research gap in GCC countries, where only 4.41% of studies originate from Saudi Arabia and none from Bahrain. Region-specific, culturally adapted VPS research is urgently needed to enhance contextual relevance and applicability.
- Long-Term Effect Studies: Conduct longitudinal investigations to assess the sustained impact of VPS training on clinical performance and patient outcomes beyond immediate learning gains.

9. Addressing Technical Barriers

To maximize the adoption and effectiveness of VPS, practical steps must also be taken to mitigate technical and operational challenges:

1) Faculty Development and Training – Implement structured workshops and continuous professional development to prepare educators for VPS integration.
2) Pre-Simulation Orientation for Students – Offer short introductory sessions and trial runs to improve usability and reduce technical anxiety.
3) Investment in Infrastructure – Prioritize cost-effective, cloud-based VPS systems and scalable licensing models to reduce financial burdens and broaden institutional access.
4) Technical Support and Maintenance – Establish dedicated support teams to troubleshoot errors and minimize interruptions during training sessions.
5) Localization of Platforms – Customize VPS software to local healthcare systems, including language adaptation, culturally relevant case scenarios, and alignment with regional clinical protocols.

By implementing these recommendations, stakeholders can enhance VPS systems' design, deployment, and evaluation. Such measures will strengthen the integration of simulation-based learning within medical curricula, improve clinical reasoning and communication skills, and ensure that VPS tools are adapted effectively to meet the needs of students in the GCC and beyond.

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