Conference Paper

Revolutionizing Healthcare Education: Mobile Virtual Patients for Digital Problem-Based Learning

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ABSTRACT

The move to a student-centered medical curriculum places greater emphasis on active learning and the development of clinical reasoning skills. Virtual Patients, defined as computer-based programs that simulate real-life clinical scenarios, have become increasingly popular as an enhancement to medical training. This study explores the usability and effectiveness of Mobile Virtual Patients (MVPs) in supporting healthcare professionals and medical students in developing skills related to symptom management, diagnosis, and treatment in the context of the H2020 SHAPES project for older adults. Fourteen participants, divided into two groups of seven each from the University of Nicosia and Aristotle University of Thessaloniki, respectively, participated in PBL sessions using MVPs. These cases encompassed various conditions, from neurodegenerative diseases to chronic conditions, focusing on participants active engagement and inquiry-based learning. The System Usability Scale (SUS) and the Electronic Virtual Patients (eViP) toolkit were applied, which brought usability, technology acceptance, and clinical reasoning into perspective. Results showed high usability, with healthcare professionals giving an SUS of 86.2, compared to 77.5 for medical students. Both groups reported positive experiences, but medical students rated the learning effect and coaching higher than healthcare professionals. This suggests that MVPs are valuable instruments in enhancing clinical reasoning and knowledge acquisition. It further emphasizes the customization of MVPs for the various needs of a medical student and a healthcare professional to realize optimized educational outcomes. Future studies should address scalability, infrastructure needs, and inclusion in broader medical curricula to further advance the spread within healthcare education.

Keywords—*Mobile virtual patients (MVPs), Problem-based learning, Clinical reasoning, Usability, Healthcare education.*

INTRODUCTION

Medical education has shifted towards a student-centered approach, placing greater importance on active learning and the development of clinical reasoning skills rather than relying solely on passive information absorption and unproductive memorization.[1,2] Several studies have demonstrated the efficiency of simulation for knowledge acquisition and for technical[3] and nontechnical[4,5] skills training in healthcare. Indeed, the rapid advancement of dependable information technologies has made it possible to develop contemporary learning activities that were previously unattainable. These innovations now have the potential to significantly enhance medical education and training in healthcare.[6]

Under this perspective, Virtual Patients (VPs) are often defined as "specific types of computer-based programs that simulate real-life clinical scenarios where learners emulate the roles of health care providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions"[7], have seen a growing adoption as educational tools in numerous medical institutions.[8] One of the fundamental features inherent to VPs is their capacity to furnish a secure and risk-free environment for medical practice and also offer clinical skills learners the invaluable opportunity for repeated utilization, completely unhindered by the constraints of time and place. This multifaceted functionality not only ensures a safe learning environment but also promotes accessibility and convenience.[9]

There has certainly been a noticeable trend toward VPs creation and use among academic institutions as a result of the opportunities that they offer in contemporary medical education.[10] In fact, the encouraging evaluation results of studies showed that VPs are highly accepted by both medical teachers and students, and also may improve cognitive and behavioral skills more effectively than traditional approaches do.[2,10] In recent years, the School of Medicine of the Aristotle University of Thessaloniki (AUTH) has undertaken significant initiatives to enhance medical education by embracing contemporary educational approaches and modernizing the curriculum.[11]

As a result of these efforts, a comprehensive and accessible VPs repository has been established.[12] This accomplishment has been further strengthened with more VPs, resulting from the sustainable exploitation of the outcomes of medical-oriented research projects, to support students and healthcare professionals in developing practical knowledge, clinical reasoning skills, and professional behavior. All these VPs have also been adapted and seamlessly integrated into a mobile environment functioning as Mobile Virtual Patients (MVPs).[13] Furthermore, these educational resources have been fully incorporated into Problem-Based Learning (PBL) sessions within the medical curriculum, serving both undergraduate and postgraduate students[2] and supporting healthcare professionals' innovative learning.

RATIONALE OF THIS STUDY

MPVs were utilized within the context of the H2020 SHAPES project[14] aimed to establish a European open ecosystem enabling the deployment of a large-scale, EU standardized open platform for supporting and extending healthy and independent living for older adults. The SHAPES Pan-European Piloting Campaign was launched in fifteen pilot sites, including six European Innovation Partnership on Active and Healthy Ageing (EIP on AHA) Reference Sites, and involved hundreds of key stakeholders, such as older adults, their families, caregivers, and healthcare professionals.[15] The deployment of MVPs served a specific purpose within this broader project. They were employed to support healthcare professionals and medical students in enhancing their skills related to older adults' symptoms management, diagnosis, and treatment as well as refining their reasoning and decision-making capabilities, contributing to improved healthcare practices for older individuals.

In the context of our broader project, we deployed MVPs to assist healthcare professionals and medical students in enhancing their skills related to older adults' symptom management, diagnosis, and treatment, while improving their reasoning and decision-making capabilities. Within this framework, the present study endeavors to address the following research question:

How do healthcare professionals and medical students experience PBL with MVPs, while considering factors

such as usability, technology acceptance, and their clinical reasoning perspectives on MVPs?

METHODS AND MATERIALS

Participants

Participants' recruitment and pilot activities were supported by the Thessaloniki Action for Health & Wellbeing Living Lab (Thessaloniki Active and Healthy Ageing Living Labs, Thess-AHALL)[16], which operated since 2014 under the auspices of the Lab of Medical Physics and Digital Innovation, School of Medicine, AUTH. Multifaceted recruitment strategies have been implemented within the Thess-AHALL ecosystem (municipalities and public entities, hospitals, rehabilitation centers, and nursing homes, as well as a great number of individuals/beneficiaries) to approach and recruit eligible participants.

A total of fourteen participants were recruited for the pilot activities, and divided into two distinct groups. One group consisted of medical students at the University of Nicosia Research Foundation (UNRF) (N = 7) and the pilot activity was conducted in Cyprus, while the other group comprised healthcare professionals (N = 7) and took place at AUTH in Greece (Table 1). The sample size was regarded as appropriate given the iterative approach guiding this preliminary investigation.

TABLE 1. Participants' demographics.

Groups	Healthcare Professionals (N = 7)	Medical Students (N = 7)
Age	M = 29.9 ± 10.9	M = 22.2 ± 2.3
Gender	85.7% Female 14.3% Male	71.4% Female 28.6% Male
Level of education	57.1% Bachelor's degree 28.6% Master's degree 14.3% Ph.D. or higher	71.4% Lower secondary school certificate 28.6% Bachelor's degree
Level of digital literacy	42.8% Basic 14.4% Intermediate 42.8% Advanced	28.5% Basic 28.5% Intermediate 43% Advanced

Intervention

During their engagement with the scenarios, participants were exposed to interactive computer simulations replicating real-life healthcare and medical training scenarios, primarily designed for educational assessment and training purposes. Within this context, participants were provided with the opportunity to interact with a diverse array of virtual cases through the Mobile Virtual Patients App (Figure 1), allowing them to gain familiarity with a spectrum of neurodegenerative diseases, such as Alzheimer's, Parkinson's, dementia, and stroke, alongside other chronic diseases like diabetes and heart diseases. This interactive approach facilitated an inquiry-based learning methodology, fostering a deeper understanding of these medical conditions. In particular, both two groups interacted autonomously with virtual scenarios divided into four categories:

- Diagnosis & Treatment Scenarios (55 scenarios) aimed to simulate various medical conditions and their corresponding treatment plans.
- Educational Scenarios (7 scenarios) focused on providing educational content to learners about new medical techniques, procedures, or guidelines.
- Symptoms Management (3 scenarios) is designed to simulate patients' symptoms and enable learners to practice managing and treating them effectively.

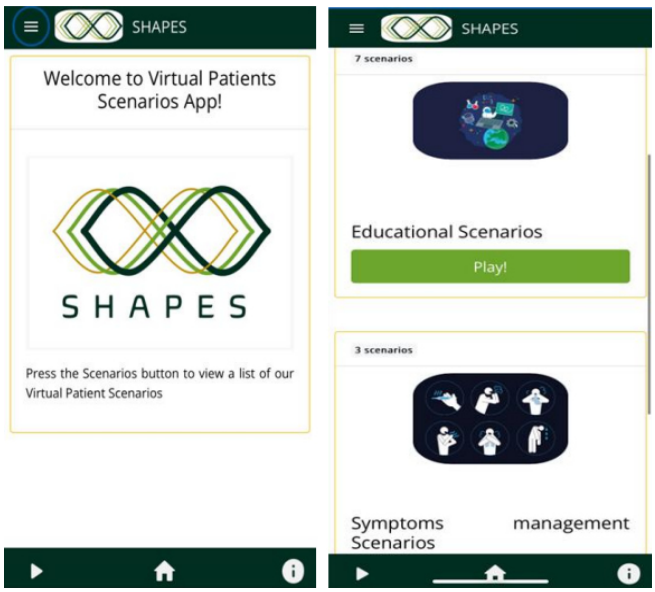

FIGURE 1. Mobile Virtual Patients App interface.

- Empowerment Category (4 scenarios) aimed to help learners familiarize themselves with patient empowerment and active participation in their healthcare.

Overall, the study adhered to General Data Protection Regulation (GDPR) regulations, obtaining the necessary bioethics approval from the Aristotle University of Thessaloniki Bioethics Committee. Informed consent was obtained from all participants, ensuring their understanding of the study's scope and their rights as participants.

Measures

System Usability Scale score (SUS score)[17] was used to measure the level of usability along with the electronic Virtual Patient evaluation toolkit (eViP toolkit) to explore participants' learning and clinical reasoning experiences with MPVs as well as their overall PBL experience. The eViP toolkit is an assessment tool for virtual patients created by the largest European program for virtual patients[18] serving as an evaluation tool for the achievement of educational outcomes resulting from the use of digital virtual patients. It is based on a set of Likert-type statement responses grouped clustered into five subsets: 1) Authenticity of the patient encounter and the consultation, 2) Professional approach in the consultation, 3) Coaching during consultation, 4) Learning effect of the consultation, and 5) Overall, judgment of case workup. Dimensions of Perceived Usefulness (PU), Perceived Ease-of-Use (PEU), and Intention of Use (IU) were also measured to explore the technology acceptance of MVPs.

RESULTS

Findings from the clinical reasoning tool analysis illuminated slight distinctions in the manner in which the two groups perceived their progress in achieving educational outcomes when utilizing MVPs. The analysis indicates that the coaching provided during consultation exhibits the most notable disparity, with medical students achieving significantly higher scores than healthcare professionals. In addition, the axis of learning effect within the consultation further underscores that medical students consistently achieve superior scores highlighting a clear difference in how they acquire knowledge. However, it is important to note that both groups' participants' overall evaluation of whether working through MPVs was a worthwhile learning experience remains favorable, as the scores in both groups exceed the M = 4 (see Figure 2).

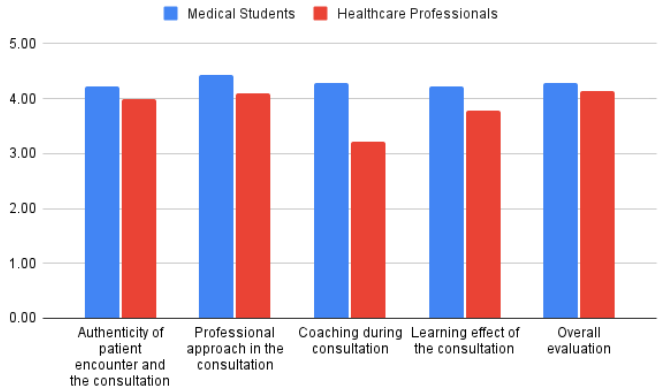

FIGURE 2. The e-ViP clinical reasoning results.

The exceptionally high SUS score of M = 86.2 ± 11.1 obtained from healthcare professionals undoubtedly validates the outstanding usability of the MVPs. This remarkable score underscores the system's user-friendliness and effectiveness in meeting the specific needs and demands of healthcare professionals, further enhancing its practical significance in the healthcare context. The SUS score derived from medical students' feedback (M = 77.5 ± 6.6), suggests a good level of usability for the proposed MVPs among participants. When comparing these results with those of healthcare professionals, it's notable that both groups reported above-average usability scores. While medical students' scores are slightly lower than those of healthcare professionals, the overall trend indicates a consistent perception of the system's usability across these different user groups, affirming its broad applicability within the healthcare domain (Table 2).

TABLE 2. Usability, technology acceptance, and clinical reasoning results.

	Healthcare Professionals (N = 7)	Medical Students (N = 7)
SUS	M = 86.2 ± 11.1	M = 77.5 ± 6.6

	Healthcare Professionals (N = 7)	Medical Students (N = 7)
PU	M = 4.57 ± 0.53	M = 4.29 ± 0.76
PEU	M = 4.71 ± 0.49	M = 4.43 ± 0.53
IU	M = 4.57 ± 0.79	M = 4.29 ± 0.76

DISCUSSION

This study sought to assess the level of usability and technology acceptance concerning the MVPs between medical students and healthcare professionals as well as discern potential different viewpoints between these two distinct participant groups. Across healthcare professionals and medical students, the MVPs demonstrated favorable ratings, demonstrating their effectiveness in facilitating learning experiences. The high SUS score suggests that the digital solution was user-friendly, while positive assessments in dimensions like PU, PEU, and IU emphasize its value and accessibility. Although subtle variations in perceptions exist, both groups viewed the MVPs as valuable resources for supporting clinical reasoning skills. These different perspectives emphasize the importance of tailoring MVPs to align with the distinct needs and expectations of each group, thereby optimizing their educational value and clinical reasoning development.

CONCLUSIONS AND FUTURE WORK

Overall, the results collectively underline the digital solution's potential to enhance healthcare education, catering to the needs of healthcare professionals and aspiring medical students alike. Future research could focus deeper on understanding the specific preferences and expectations of each group to tailor the MVPs cases accordingly. Exploring their scalability of implementation on a larger scale within healthcare education institutions could provide valuable insights into their practicality and sustainability for widespread adoption. This research could involve assessing infrastructure requirements, training needs, and the financial implications of integrating the MVPs into the curriculum.

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