11th International Conference on Higher Education Advances (HEAd'25)
Universitat Politècnica de València, València, 2025
DOI: https://doi.org/10.4995/HEAd25.2025.20162

"Computerised Medical Simulation Flipped Classroom" bridges the gap between university-based classroom teaching and hospital-based clinical training in Physiotherapy Education

Shirley P.C. Ngai[1,2], Jonathan Vincent[2]
[1]Department of Rehabilitation Sciences, The Hong Kong Polytechnic University, Hong Kong SAR, China.
[2]Educational Research Department, Lancaster University, United Kingdom.

How to cite: Ngai, S. P. C.; Vincent, J. (2025). "Computerised Medical Simulation Flipped Classroom" bridges the gap between university-based classroom teaching and hospital-based clinical training in Physiotherapy Education. In: 11th International Conference on Higher Education Advances (HEAd'25). Valencia, 17–20 June 2025. https://doi.org/10.4995/HEAd25.2025.20162

Abstract

Clinical education is an essential component of physiotherapy education. Students often report stress during hospital-based clinical training due to perceived learning gaps between university-based education and real-world practice. These gaps may stem from factors such as unfamiliarity with clinical environments, inexperience, challenges in integrating theory into practice, and underdeveloped communication skills. To address this, the concepts of medical simulation (technology) and the flipped classroom approach (pedagogy) were integrated into cardiopulmonary physiotherapy education (content), developing the Computerised Medical Simulation Flipped Classroom. This study evaluates the effectiveness of this approach and explores students' learning experiences using a mixed-methods design. A total of 166 students participated. All reported significantly improved self-perceived competency and confidence in performing assessments, delivering treatments, setting clinical priorities, and responding to dynamic patient condition changes. Focus group interviews revealed that students valued the simulation experience, particularly because it mimicked real clinical scenarios. Participants highlighted opportunities to familiarize themselves with ward environments, practice communication and hands-on skills with the simulated patients, and deepen their understanding in clinical reasoning and theoretical principles during facilitator-guided debriefing sessions. These findings suggest that the Computerised Medical Simulation Flipped Classroom effectively bridges the gap between academic training and clinical practice. Future studies should explore how this approach influences objective performance metrics, such as summative grades during clinical placements.

Keywords: *Simulation; flipped classroom; physiotherapy education*

1. Introduction

Clinical education is an essential component of physiotherapy education. Students enrolled in physiotherapy programmes must complete a specific number of clinical training hours to meet the licensure registration criteria or qualify to sit for the licensure examination upon graduation. Although programme curricula and required clinical hours vary across countries, competency standards exist to ensure graduates meet basic entry-level professional requirements.

Traditionally, students acquire theoretical knowledge, practical skills, and clinical reasoning through "paper" case studies during university tutorials or practical sessions. They later integrate this knowledge into real-world practice during hospital-based clinical placements. At university, hard skills (e.g., clinical techniques) are typically practiced on healthy peers, while soft skills (e.g., clinical reasoning) are developed through discussions of hypothetical cases. Consequently, students often struggle to observe, feel, or differentiate between "normal" and "abnormal" signs, symptoms, and tactile feedback during subjective and objective assessments.

While the clinical reasoning process for "paper" cases and real patients is similar—involving reviewing bednotes, extracting key information, selecting assessments, devising management plans, and adjusting based on condition changes of the patients—the lack of direct patient interaction leaves students unprepared for real-world pressures. Inexperienced in observing and responding to real-time changes in vital signs or conditions, students may become anxious, hindering their ability to make quick decisions. Additionally, task-focused mindsets can lead to poor communication, causing students to overlook critical patient-reported information essential for effective care. These challenges, compounded by psychological stress, often impede learning and performance. Thus, there is an urgent need to develop modules that bridge the gap between classroom teaching and clinical training.

Previous reviews indicate that simulation in medical education improves procedural task performance (Okuda et al., 2009), scenario-based training (Okuda et al., 2009), clinical competency (Alrashidi et al., 2023) and communication between healthcare professionals and patients or relatives (Blackmore et al., 2018). These findings suggest that simulation not only improves/ refines clinical skills but also enhances interpersonal competencies. However, simulations are typically conducted in small groups to optimize hands-on learning experience. Given constraints such as limited class time, large student cohorts, inadequate simulation facilities, and insufficient staffing, integrating this approach into existing curricula has proven challenging. To address these barriers, the concepts of medical simulation (technology) and the flipped classroom approach (pedagogy) were integrated into cardiopulmonary physiotherapy education (content) (Mishra & Koehler, 2006), developing the Computerised Medical Simulation Flipped Classroom. This model shifted case-based discussions to online platforms, freeing in-class time for small-group, hands-on simulation practice and facilitator guided debriefing. The simulations dynamically replicate patient scenarios encountered during clinical

placements, allowing students to respond to evolving conditions in real time. This study aims to examine whether this integrated pedagogical approach enhances learning outcomes in physiotherapy education.

2. Methodology

A mixed-methods approach was adopted, incorporating quantitative and qualitative evaluations.

2.1. Procedures

Physiotherapy students enrolled in the subject of Cardiopulmonary Physiotherapy in undergraduate-entry physiotherapy programme (i.e., BScPT) and postgraduate entry-level physiotherapy programme (i.e., MPT) were invited to participate in the study. The information sheet and consent forms were distributed to one cohort of BScPT students and two cohorts of MPT students. Study details were thoroughly explained, and written informed consent was obtained before the commencement of the study. 166 out of 229 students (response rate of 72.5%) participated in this study. In brief, the Computerised Medical Simulation Flipped Classroom consisted of five key steps:

1) Online Problem-Based Case Discussion: Designed to promote self-directed active learning through independent research and peer collaboration.
2) Online Pre-Quiz: Prepared students to critically think and rehearse necessary assessments and/or treatments for case management with the manikin.
3) On-Site Hands-On Simulation Practice (Simulation Laboratory): Enabled students to practice case management using a computer-controlled manikin, featuring dynamic condition changes based on student performance.
4) On-Site Facilitator-Guided Debriefing: Allowed students to reflect on their performance and address gaps through in-depth peer/faculty discussions guided by facilitators.
5) Online Post-Quiz: Consolidated acquired knowledge and reinforced learning outcomes.

2.1.1. Quantitative evaluation

Participants were asked to complete a survey assessing their self-perceived competency and confidence across various stages of case management. The survey utilised a 5-item Likert scale, with responses ranging from 1 indicating “not at all”, 2 indicating “somewhat”, 3 indicating “moderately”; 4 indicating “highly” and 5 indicating “extremely”. Participants were asked to complete this survey before and after simulation to evaluate its effectiveness in enhancing students’ self-perceived levels of self-confidence and preparing them for clinical placement.

2.1.2. Qualitative evaluation

Eighteen participants were randomly selected for four focus group interviews (3–5 per group; 60–75 minutes each). A facilitator guide, with questions exploring students' learning experience, perception to this approach, preference of using simulation or traditional case-based discussion, challenges that they faced during clinical placement and the solutions that they adopted to solve the learning challenges faced in clinical placement, was set and used throughout the interviews. All focus group interviews were audio-recorded, transcribed verbatim, and anonymized for thematic analysis.

2.2. Statistical analysis

All continuous data were presented as mean ± standard deviation (SD). Categorical data were presented as median with interquartile range or percentages. Changes between pre- and post-module self-perceived confidence and competency were compared by paired t-test. Significance was set at $p < 0.05$. All data were analysed by statistical package (IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp).

Audio recordings of all focus group interviews (n=4) were transcribed verbatim and anonymized before analysis. The data were analysed based on the 6-step analysis framework including 1) Data familiarization and writing familiarization notes, 2) Systematic data coding, 3) Generating initial themes from coded and collated data, 4) Developing and reviewing themes 5) Refining, defining and naming themes, and 6) Writing the report (Braun & Clarke, 2021).

3. Results

166 participants with a mean age of 22.01 ± 2.58 years consented to join the study. Of these, 55% of participants were male and 60% were from undergraduate-entry programme.

3.1. Quantitative analysis

A paired t-test revealed significant increases in self-perceived confidence in case management, competency in providing assessment and treatment, and competency in clinical reasoning throughout the management process following the entire practice of Computerised Medical Simulation Flipped Classroom. Figure 1 illustrates the self-reported levels before and after the practice.

Figure 1. Changes in self-perceived responses before and after simulation.
*Note. Data were presented as mean ± standard deviation (SD). Significance was set at $p<0.05$; * indicates $p<0.05$, ** indicates $p<0.01$*

3.2. Qualitative analysis

A total of 18 participants (half male and half female) took part in four focus group interviews. The first three sessions comprised five participants each, while the final session involved three. Interviews lasted 60–75 minutes, depending on the level of engagement and interaction among participants.

3.2.1. Feelings when participating the simulation

All participants reported positive experiences with the simulation, particularly valuing its realistic, real-time exposure to ward environments, which helped them prepare for clinical placements. However, participants expressed mixed emotions. Despite initial confusion and helplessness during their first hands-on practice with a high-fidelity manikin in a simulated ward setting, they channelled these challenges into motivation to improve their skills and readiness for cardiopulmonary physiotherapy coursework and subsequent clinical training.

3.2.2. Personal experience across various components in the practice

Participants identified hands-on simulation practice and facilitator-guided debriefing as the most beneficial components. Debriefing was especially praised for its divergence from traditional tutorials, offering opportunities to articulate thoughts, reflect on performance, and identify areas for growth. During hands-on sessions, students valued experiential learning, which enabled them to integrate fragmented knowledge from lectures and practical classes, develop clinical reasoning skills, practice time management under pressure.

3.2.3. Perceived benefits of the "Computerised Medical Simulation Flipped Classroom"

Participants treasured the experience as it allowed them to synthesise disjointed theoretical knowledge from lectures, tutorials, and practical classes into holistic patient management. They

commended the approach for fostering familiarity with clinical equipment and environments, interaction with simulated patients (manikins), and enhancing verbal/non-verbal communication (e.g., using plain language, active listening, and allowing pauses for patient responses). Realistic patient interactions also improved their rapport-building skills.

4. Discussion

Clinical practice demands adaptability, as patients vary in age, cognitive status, disease severity, and presentation. Novice students often struggle to detect subtle changes in patient conditions and adjust management plans promptly. The current findings suggest that the Computerised Medical Simulation Flipped Classroom promoted active learning by requiring students to research case information and plan interventions pre-class, freeing in-person time for hands-on practice with simulated patients and debriefing.

In line with previous reports that simulation enhances procedural task performance (Okuda et al., 2009), clinical competency (Alrashidi et al., 2023), and communication skills (Blackmore et al., 2018), this study also demonstrated significant quantitative improvements in self-perceived competency in clinical skills (assessment and treatment), clinical reasoning, and confidence in case management, supporting its beneficial effects.

Beyond changes in "skills," the students' qualitative comments highlighted remarkable shifts in the "clinical reasoning" process and subsequent practices. In high-stakes clinical environments, errors are often corrected urgently through directive feedback without contextual explanation, limiting deeper understanding (single-loop learning) and failing to drive changes in cognitive and behavioural acts.

Facilitator-guided debriefing is a common approach in simulation, though various multi-staged debriefing models and feedback delivery methods exist (Şahin & Başakk, 2021). This study adopted a multi-staged debriefing model comprising 1) a reaction phase, 2) an understanding phase, and 3) a summary and take-home message phase. This model allowed facilitators to explore students' feelings (e.g., internal frustration with their performance or external frustration with peers) and identify key themes for student-centred debriefing agendas. Negative emotions, if unaddressed, could impede learning during debriefing. Thus, it is important to explore if any emotions issue to be handled before the next phase. In the understanding phase, the "Plus-Delta" and "Advocacy Inquiry-Focused Facilitation" approaches were used to guide students in reflecting on their performance, identifying discrepancies between expected and actual outcomes, and addressing gaps. This double-loop learning approach (Greenwood, 1998; Tagg, 2010) bridges clinical reasoning gaps and fosters lasting changes in cognitive and behavioural practices. Students valued this structured debriefing, emphasizing how reflection and discussion consolidated their learning.

Our quantitative and qualitative findings complemented each other, validating the efficacy of the "Computerised Medical Simulation Flipped Classroom". The approach enabled risk-free, repeated practice with simulated patients, ensuring competency development before real-world application.

5. Conclusion

The **Computerised Medical Simulation Flipped Classroom** effectively bridged gaps between university-based training and clinical training at hospital. Future studies should assess its impact on objective performance metrics, such as summative clinical placement grades.

6. Ethical approval

Study approval was obtained from the Research Ethics Committee of Lancaster University (EdRes-2024-4258-EdAp-2) and the institutional review board of The Hong Kong Polytechnic University (HSEARS20240117002).

Acknowledgement

The study was supported by the internal grants from The Hong Kong Polytechnic University.

References

Alrashidi, N., Pasay an, E., Alrashedi, M.S., Alqarni, A.S., Gonzales, F., Bassuni, E.M., Pangket, P., Estadilla, L., Benjamin, L.S., & Ahmed, K.E. (2023). Effects of simulation in improving the self-confidence of student nurses in clinical practice: a systematic review. *BMC Medical Education* 23, 815. https://doi.org/10.1186/s12909-023-04793-1

Blackmore, A., Kasfiki, E.V., & Purva, M. (2018). Simulation-based education to improve communication skills: a systematic review and identification of current best practice. *BMJ Simulation & Technology Enhanced Learning*, 4, 159–164.

Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328-352. https://doi.org/10.1080/14780887.2020.1769238

Chen, J. Y., Chin, W. Y., Tiwari, A., Wong, J. E., Wong, I. C. K., Worsley, A., Feng, Y. B., Sham, M. H., Tsang, J. P. Y., & Lau, C. S. (2021). Validation of the perceived stress scale (PSS-10) in medical and health sciences students in Hong Kong. *Asia Pacific Scholar*, 6(2), 31-37. https://doi.org/10.29060/Taps.2021-6-2/Oa2328

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behaviour*, 24(4), 385-396. https://www.ncbi.nlm.nih.gov/pubmed/6668417

Greenwood, J. (1998). The role of reflection in single and double loop learning. *Journal of Advanced Nursing,* 27(5), 1048-1053. https://doi.org/10.1046/j.1365-2648.1998.t01-1-00579.x

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054. https://doi.org/DOI 10.1111/j.1467-9620.2006.00684.x

Okuda, Y., Bryson, E.O., DeMaria. S. Jr., Jacobson, S., Quinones, J., Shen, B., & Levine, A.I. (2009). The Utility of Simulation in Medical Education: What Is the Evidence? *Mount Sinai Journal of Medicine*, 76,330-343

Şahin, G., Başak, T. (2021). Debriefing Methods in Simulation-Based Education. *Journal of Education and Research in Nursing*, 18(3), 341-346

Tagg, J. (2010). The learning-paradigm campus: from single- to double- loop learning. *New directions for teaching and learning*, 123, 51-62.

Wu, Y. F., Qi, L., Liu, Y., Hao, X. Y., & Zang, S. (2021). Development and psychometric testing of a Learning Behaviour Questionnaire among Chinese undergraduate nursing students. Bmj Open, 11(6). https://doi.org/ARTN e04371110.1136/bmjopen-2020-043711