

Official Title: The Impacts of Immersive Virtual Reality (iHealthEd-IVR) and a Mobile Online Game (V-Care) on Interprofessional Education: A Multi-Methods Study

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Project Proposal

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Introduction

Interprofessional education (IPE) is essential in healthcare education, promoting effective collaboration and improving health outcomes [1]. IPE encourages collaborative practice by having students from various healthcare fields learn with, from, and about each other [2]. Research shows that IPE enhances patient care, teamwork, and recognition of professional roles, crucial for managing complex health issues collaboratively [3]. As IPE is integral to the curriculum, exploring diverse pedagogical approaches for its implementation is vital.

Immersive virtual reality (IVR) creates an artificial environment that convincingly replaces users' real-world surroundings, allowing full immersion in the simulation. Rapid advancements in IVR technology have increased its use in healthcare education. As a form of simulation-based learning, IVR enables students from different disciplines to share knowledge and perform activities together based on real clinical cases, consistently showing positive outcomes in IPE [3]. A recent scoping review of 12 studies concluded that VR for IPE effectively promotes interprofessional (IP) collaboration and communication [4]. A systematic review of 11 studies involving 1,711 undergraduate students from diverse healthcare backgrounds further revealed that simulation positively impacts team-based and IP communication practices, and the acknowledgment of values, ethics, roles, and responsibilities of IP team members [5].

Game-based learning is another approach to IPE. Evidence suggests that gamification enhances engagement and is an effective learning strategy [6]. In game-based learning, shared goals, meaningful narratives, autonomy, and relevance anchor learning in context. Students can problem-solve through collaboration and competition, motivating them to engage and achieve learning outcomes [7]. In game-based IPE, students engage in interactive activities with gamified elements like earning trophies and leaderboard rankings, fostering a fun, competitive, and engaging environment that promotes both discipline-specific and IP learning outcomes. Gamification has positively impacted healthcare education, showing increased motivation and engagement in learning [8] and improved competence [9].

While both IVR and game-based training have shown potential in IPE, it remains unclear which is a more effective pedagogical approach. This study aims to compare the effectiveness of IVR and game-based learning in IPE, with significant implications for IPE delivery.

Research Design

This study will use a multi-methods design, involving knowledge checking games, surveys and focus groups, to gain a comprehensive understanding of the effectiveness of both IVR training and a mobile gaming platform in promoting IPE.

For the quantitative component, a between-group design (IVR training vs. mobile game training) with pre- and post-measurements will investigate the students' outcomes after the programs. Data will be collected at two time points: T0 (before the program) and T1 (after the program). Focus groups will explore students' experiences within one week after the program, providing in-depth insights to complement the quantitative findings. This multi-methods approach

will enable a comprehensive evaluation of the IVR and game-based learning training in facilitating IPE.

Study Participants and Setting

For the quantitative component, we will recruit undergraduate and pre-registration master's nursing students, as well as undergraduate physiotherapy students, from the School of Nursing and the Department of Rehabilitation Sciences at the Hong Kong Polytechnic University. The programs will be embedded within a nursing subject (SN 402/5012). Nursing students will need to take this course to fulfill their normal credit requirements, while physiotherapy students can earn practicum hours by participating. Students in both training conditions will be assigned to small IP groups comprising 7-8 student nurses and 1-2 student physiotherapists.

A power analysis determined the sample size. Previous studies of similar educational interventions reported medium to large effect sizes in learning outcomes from pre- to post-intervention [10-12]. Adopting a conservative approach, we based our power analysis on detecting a medium effect using a 2 x 2 mixed multivariate analysis of variance (MANOVA). Results indicated a sample size of 128 is sufficient to detect a medium two-tailed effect at a significance level of $p < 0.05$ with 80% power. We anticipate a sample size of around 150-160 to account for potential missing data. Based on the nurse-physiotherapist ratio, this would translate to approximately 112-128 student nurses and 32-38 student physiotherapists.

For the qualitative component, we will use stratified purposive sampling to include students from different study years and academic majors. This will help explore their perspectives on both the iHealthEd IVR and V-Care training in the context of IPE. According to Hennink, Kaiser [13], four focus groups typically suffice to reach data saturation. With 4 to 5 students in each semi-structured focus group, we anticipate a total of approximately 16-20 students from different disciplines or study years. The selected sample will be in proportion to the ratio of nursing to physiotherapy students.

Programs

Both training programs will be integrated into the nursing subject. The program content was collaboratively developed by faculty from nursing and rehabilitation sciences. The training will feature the theme of managing fall-related risks in the care of older adults with frailty. The scenario is structured across three levels, progressively building students' knowledge and skills related to fall prevention. Level 1 focuses on addressing patient concerns and identifying fall risk factors, Level 2 involves conducting a comprehensive fall risk assessment and evaluation, and Level 3 covers discharge planning and implementing fall prevention strategies in the community setting. The IP team will comprise approximately 7-8 nursing students and 1-2 physiotherapy students, which will enhance their understanding of values, ethics, and the roles and responsibilities of IP team members, aiming to establish core IPE collaborative competencies.

In the Inter-professional Healthcare Education (iHealthEd-IVR) Training, the learning will take place in a classroom at the School of Nursing using IVR technology. Students will collaborate within the virtual environment to locate items and complete tasks based on the above scenarios. Minimal instructions will be provided, allowing students to come together experientially and function as an IP team. All activities will involve group work, enabling students to collaborate and communicate with all team members via live audio chat and group text chat. Finally, the IP team

will interview a virtual client to discuss discharge management and care goals, then create an educational pamphlet about a care plan based on the client's health needs.

In the V-Care Training, the IPE can take place remotely at a predefined timeslot among the group, as V-Care is an online mobile game environment. The game features interactive elements, including avatar customization, virtual clinical rounds, IP clinic scenarios, knowledge checks, assignment submissions, peer evaluations, and leaderboards. These components are intended to engage students, reinforce learning, and promote IP collaboration.

Data Collection

Quantitative Methods

All nursing students enrolled in the course will be invited to join the study. Physiotherapy students will be invited to fulfill practicum hours. These two teaching innovations are embedded in the nursing subject (SN 402/5012) and a PT practicum. Due to the restructuring of the students' timetable, randomization is impossible. Both nursing and PT students will be assigned to either the (iHealthEd) IVR training or the V-Care training based on their tutorial timetable. They will be grouped based on a nurses to PT students ratio mentioned above.

Participation in this study is voluntary and anonymous. Subject lecturers will not be involved in data collection. An information sheet about the research project will be provided to students, and any questions will be thoroughly addressed by the research personnel. Once students understand the project, they will provide informed consent via the Qualtrics XM Online Surveys Platform. Data will then be collected through this platform.

Research personnel will assign unique codes to each participant's information, ensuring anonymity. Only these codes will appear in the dataset for analysis, preventing subject lecturers from knowing which students participated. All collected data will remain confidential, accessible only to research personnel. Aggregated data will be reported or published without including personal information.

Measures

The Intrinsic Motivation Inventory (IMI) is a multidimensional measure used to assess participants' subjective experience related to a target activity in laboratory experiments [14]. The IMI evaluates several subscales, including interest/enjoyment, perceived competence, effort, value/usefulness, pressure/tension, perceived choice, and relatedness. The interest/enjoyment subscale is considered the self-report measure of intrinsic motivation, while perceived choice and perceived competence are theorized to be positive predictors, and pressure/tension a negative predictor, of intrinsic motivation. The IMI consisted of 18 items scored on a Likert scale from 1 (not at all true) to 7 (very true). The overall IMI scale had strong internal consistency, with a Cronbach's alpha of .85.

The Readiness for Interprofessional Learning Scale (RIPLS) was used to measure the "readiness" of healthcare students for shared IP learning [2]. The RIPLS comprised a 19-item, 3-factor scale assessing students' perceptions of: 1) teamwork and collaboration, 2) professional identity, and 3) professional roles and responsibilities. The RIPLS uses a 5-point Likert scale for responses, ranging from 1 (strongly disagree) to 5 (strongly agree). Overall, higher total and subscale scores on the RIPLS would demonstrate greater "readiness" and more positive

perceptions towards the value of IPE and collaborative practice among healthcare students. The overall RIPLS scale demonstrated strong internal consistency reliability ($\alpha = 0.90$).

The Brief Sense of Community Scale (BSCS) is an 8-item scale designed to measure the dimensions of sense of community as defined by the McMillan and Chavis [15] model [16]. The BSCS includes items representing the four dimensions of needs fulfillment, group membership, influence, and emotional connection. Participants responded to the BSCS items using a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). A higher score on the BSCS indicates a stronger sense of community. The BSCS demonstrated strong internal consistency reliability, with Cronbach's alpha of .92.

Multiple choice questions (MCQs) were developed as a measure of student learning outcome on the knowledge of IPE. The questions and answers were collaboratively developed by academics from nursing and rehabilitation sciences.

The socio-demographic variables included gender (male, female), age, online gaming experience (whether participants had any prior experience playing online games, yes vs. no), and for those with gaming experience, total play time per day (less than 1 hour, 1-10 hours, or 10 or more hours). Participants also identified their specific program of study.

Data Analyses

Data cleaning and statistical analyses will be conducted using IBM SPSS. A mixed 2 x 2 MANOVA will explore the interactions between group differences (iHealth-IVR vs. V-Care) and the within-subject factor (pre vs. post) for our outcome measures.

Qualitative Methods

To ensure representativeness and comprehensiveness of the qualitative data, participants will be recruited using stratified purposive sampling based on characteristics relevant to their learning experiences, such as field and year of study [17]. The questionnaire will include demographic questions to facilitate cluster sampling. The researcher will conduct face-to-face semi-structured focus group interviews. A senior research assistant and another research assistant, both trained in conducting focus group interviews with students, will help facilitate sessions. The assistant will take notes during each focus group. The focus group will begin with a guiding question: "What was your IPE learning experience?" Participants will then discuss how the experience impacted their studies, elements they liked or disliked, and skills, knowledge, and benefits gained.

Data Analyses

The interviews will be transcribed verbatim and processed using Atlas.ti. A three-level coding and thematic analysis approach will be employed [18]. First, in open coding, distinct concepts and categories in the transcripts will be identified, forming preliminary themes for analysis. Second, axial coding will categorize the themes defined in the initial phase and explore their interrelationships. Third, selective coding will formulate core themes, integrating and refining other sub-themes, and establishing their connections to the core themes.

Project Significance

More evidence is needed to understand how technology-based strategies can enhance IP learning. Managing patient conditions from multiple perspectives and engaging in IP interactions is vital for students to achieve program/course outcomes and improve patient outcomes. Evaluating the proposed IPE approaches can facilitate integrating more effective IPE activities into the curriculum. Integrating this project into the learning activities of nursing and physiotherapy departments will provide a large and diverse sample, improving the generalizability of findings and their potential to influence IPE practices.

The study's findings can therefore refine and improve the pedagogical framework guiding the development of IPE learning activities, assessment rubrics, and innovative teaching methods, driving advancements in IPE design and delivery. Additionally, enhancing students' abilities to collaborate and deliver integrated, patient-centered care can ultimately improve overall patient outcomes.

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