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Acceptance and Continuance Usage Intention of Mixed Reality for Australian Healthcare Interprofessional Education

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Abstract

Virtual-Reality and augmented-reality are becoming innovative teaching and learning approaches across many industries, including healthcare, especially during the COVID-19 pandemic. However, the adoption rate of this technology is very low, especially in Australian healthcare Interprofessional Education. This study investigates factors influencing adoption and use of mixed-reality technology for Australian healthcare IPE. In this study, a theoretical model based on the Expectation and Confirmation Model and Task Technology Fit is developed and will be tested to determine Australian healthcare professionals' intentions to continue using mixed-reality for Interprofessional Education through three validated surveys using a voluntary non-probability sampling strategy, over a 10-week period, targeting 124 healthcare professionals at the Tweed hospital, NSW Australia. The research outcome will assist in determining the validity of the proposed hybrid model in the context of MR healthcare training. It may assist in developing a more suitable theoretical framework and future characteristics of MR for healthcare training.

Keywords

Mixed-Reality, Simulated-Learning, Healthcare-Training, Interprofessional-Education, Task-Technology-Fit.

1 Introduction

The modern healthcare industry is complex, with different technologies, professionals and support services involved in the care of patients (Bomba, D. T., & Prakash, R. 2005). The medical industry contains many specialised skill sets, each with a broad field of knowledge and expertise. As a solution to promoting better collaboration between the many professional counterparts Interprofessional Education (IPE) was implemented into the Australian healthcare curriculum (Bridges et al., 2011) and practice. Training together to develop fluent communication and respect for each other's individual capabilities can increase shared decision-making skills within a healthcare team. These skills are vital in an emergency involving the safety and management of deteriorating patients and are critical for creating a safe patient environment. Insufficient communication has been recognised as a significant component of treatment delays and poor or fatal outcomes (Bomba, D. T., & Prakash, R., 2005). Newman (2022) stated that improved workplace culture, effective teamwork, and communication were key factors relating to successful IPE training.

Simulated learning is effective and should be considered for IPE training to improve healthcare workers' performance in caring for deteriorating patients (Newman et al., 2022). Virtual Reality (VR) and Augmented Reality (AR) have inspired new teaching and learning approaches across many industries, with increased interest in the technologies, post Covid-19 (Martin et al., 2020). Specifically, Mixed Reality (MR) is evolving to perform an integral role in training and research (Moser et al., 2019). MR technology has been utilised during infectious disease pandemics to educate people on the prevention, response and management of SARS, Ebola, and now Covid-19 (Martin et al., 2020; Asadzadeh et al., 2021). As mixed reality systems improve and become more accessible, the ability to provide healthcare workers with early team-based opportunities to develop their communication, collaborative skills and awareness of other professions' capabilities in their industry will increase (Liaw et al., 2014). MR applications have helped prepare healthcare professionals for a wide variety of future challenges, including preoperative planning, intraoperative assistance, increased procedural accuracy, surgical confidence, rehabilitation, surgical simulation, basic bedside manner, and communication training (Rad et al., 2021). Research has demonstrated that mixed reality helps free learning from the classroom, allowing students to immerse themselves into authentic situations, develop competencies and learn from mistakes in a safe and controlled environment (Pottle, J. 2019). These training experiences enable medical professionals to encounter simulated real-life scenarios, improve situational awareness, and draw from concrete situations to provide emergency medical care when needed (Lange et al., 2020). The potential for multiple healthcare workers taking part in immersive life-like simulations, unbound by geographic restrictions, could revolutionise how we deliver IPE beyond recognition (Pottle, J. 2019).

The extent to which the use of MR in the education of healthcare professionals is successful depends on the level of user acceptance (Davis, F. D. 1993). Users of technology will have initial expectations before using it, and after using the technology, they will form perceptions about its performance that either confirm or reject their original expectations. If the expectations are confirmed, they will be satisfied with the technology and continue using it (Bhattacherjee, 2001). Interest in the use of MR in the medical industry is increasing. However, it is far from being used daily (Chen et al., 2017), especially in the Australian medical sector. Early medical MR developments mostly integrated images of "x-ray vision" projections displaying organs and surgical targets inside a human body. While helpful, superimposing a simple x-ray projection over a patient is not optimal (Peters et al., 2018). Healthcare professionals need training designed for their medical task requirements (Pottle, J. 2019). There remain numerous development and design challenges to achieving MR training outcomes, including cost, usability, intrusiveness, workflow integration, validation, user perceptions of technology relating to gender, age, experience, and user comfort. Common complications with MR educational applications include proving its effectiveness, inconsistent frame rates resulting in motion sickness, and a lack of spatial consideration resulting in fear of collision (Boletsis. C., Cedergren, J. E., 2019). Krajčovič (2021) proposed that MR training should authentically reproduce the true-to-life environment whilst providing precise and user-friendly experiences. Only when the technology fits the tasks that users are performing will it be adopted (Zhang et al., 2017); otherwise, users will not continue using it long term, resulting in low acceptance and absence of MR, as seen in the Australian healthcare IPE practice (Nisbet et al., 2011).

We still have much to learn about what specific characteristics and factors influence Australian healthcare professionals to accept and continue using MR technology for IPE. Little research has been conducted into the acceptance of current MR technologies for Australian healthcare IPE training; therefore, this research aims to address this gap by investigating the following research questions. What factors influence Australian healthcare professionals to accept and continue using MR technology in the IPE setting? How does utilising MR technology impact Australian healthcare professionals' longitudinal training experience? What improvements could be made to current MR technology characteristics to confirm user's expectations of MR for Australian healthcare IPE, if any?

The remaining format of this paper is as follows. A brief description of the IPE project is presented in Section 2. We discuss the development of the theoretical framework in Section 3, followed by a detailed description of the methodology in Section 4. Section 5 presents preliminary results (demographic data). A discussion of demographic outcomes is presented in Section 6, followed by a conclusion and future research in Section 7.

2 The MR based IPE Project

Members of Southern Cross University, Practera, Northern NSW Local Health District (NNSW LHD) and the Mid North Coast Local Health District (MNC LHD) have formed this collaborative project. The Microsoft HoloLens 2 mixed reality headset with the integration of GigXR HoloPatient software was chosen for its capabilities of displaying holographic patients while providing a view of the real environment in front of the user. Benefits of using MR holographic projections include the ability for users to visually identify one another to discuss their approach to caring for the deteriorating patient with their hands free, enabling them to carry out procedures during the sessions notionally. A variety of healthcare professions is critical to establishing an interprofessional dynamic within the healthcare team. The training sessions were conducted at the Tweed Hospital, NSW, Australia. The participants were provided with online accounts to access a structured IPE curriculum delivered through a website that was built by project partner Practera. The participants were required to complete an initial module of study and orientation session to become familiar with the technology before attending the deteriorating patient training session. Patient vitals were provided across the session and manipulated by the lead training facilitator to simulate patient deterioration. The session concluded as the patient recovered through correct diagnosis and treatment. In Post MR session, participants were asked to reflect on their personal experiences. Training facilitators kept field notes of each session, recording spontaneous comments, specific events during the training and all participant comments made during the session reflection. Training facilitators then conducted a short meeting without the participants to discuss insights from the training sessions and potential improvements for future iterations.

3 Theoretical Framework

This study appropriates a hybrid model framework (Figure 1), combining Task Technology Fit (TTF) with an Expectation Confirmation Model (ECM). An early study of users' intention to continue using online learning services with analysis using this hybrid model was conducted by Ouyang Y, et al., 2017. The intent of this study is to analyse factors that influence users' acceptance and intentions to continue using technology through this proven model of constructs (Ouyang et al., 2017).

The ECM + TTF hybrid model contains appropriate variables facilitating the psychological impacts with a focus on post-adoption of the technology utilisation. The MR technology is much like any other product, if the user's initial expectations of that technology are confirmed, their satisfaction will increase accordingly, and their long-term intention of using the technology can be positive (Bhattacherjee, 2001). This model has a well-balanced number of constructs for analysing both technology and human aspects. The outcome will provide insights into how the user perceives their experience alongside how the technology was performing for the user's expected requirements. The application of this model in context to the use of MR for IPE training makes this study unique.

The expectation Confirmation Model (ECM) was introduced by Oliver R, L., 1977, 1980. Originally referred to as Expectation Disconfirmation Theory, the theory was further adapted for study on the continuance usage of information systems (Bhattacherjee, 2001). ECM is theoretically abundant in the context of post-acceptance in consumer behaviour literature. The application of ECM in information systems is vital (Ouyang et al., 2017). The variables in the ECM model are more appropriate for specifically focusing on Perceived Usefulness (PU), whether a user believes a piece of technology is useful, and Confirmation of Expectation (CE), relating to the user's original expected performance of the technology. These variables directly influence user Satisfaction and Continuance Intention of Usage (CIU), refereeing to the future behaviour of users to use a service or product again. CE has been proven to influence CIU through Satisfaction (Kim, D. J. 2012).

The Task-Technology Fit (TTF) was introduced by Goodhue, D. L., & Thompson, R. L. 1995. The TTF model clarifies technology utilisation by examining the technology's functionality alongside the users' task requirements. Two independent variables influence the dependent TTF variable. Technology Function Characteristics (TFC) analyse how the technology operates for the user, and Task Requirement

Characteristics (TRC) target the user's perceived task needs. The more suitable the fit throughout these variables, the more positive the performance impacts for the user. The outcome of a positive task-technology fit denotes utilisation and positively impacts perceived performance (Goodhue et al., 1995). The correlation between TTF and Performance Expectancy is supported by prior studies confirming that TTF affects Perceived Usefulness and Perceived Fit (Dishaw & Strong, 1999; Zhou, Lu & Wang, 2010). Applying TTF to the hybrid model will provide data for potential improvements to future mixed reality technology used by observing changes in user experience regarding ease of use and the system's reliability. TTF is best applied to other technology-based models. (Goodhue et al., 1995).

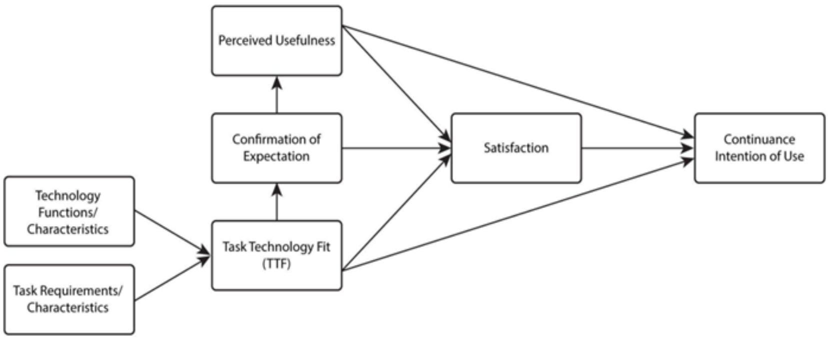

Figure 1. Expectation Confirmation Model (ECM) + Task Technology Fit (TTF) Acceptance Hybrid Model.

4 Methodology

4.1 Sampling and Data Collection

This research will follow a quantitative approach by seeking answers to questions through a reliable and unbiased application of scientific procedures, specifically gathering data on user acceptance and ongoing intention to use the MR technology for IPE. Data was collected through validated surveys using a voluntary non-probability sampling strategy targeting 124 Australian healthcare workers. Participants answered the survey questions as part of the learning modules on the Practice website. Post-survey data is being collected and processed at this stage of the research. Participant demographic data has been collected and recorded anonymously using participant ID numbers. This study has ethical approval from the (removed for refereeing) and (removed for refereeing) as part of the collaborative project.

4.2 Measures and Instrument Development

Instruments for latent constructs within the proposed model were developed from previous studies. There are three participant surveys. The first survey is initiated before MR training and assesses the demographic data and previous experience using MR technology of each participant. The second and third post surveys are initiated after two MR training sessions are completed at the fourth and tenth week of the study. The six-week gap between the two post surveys provides a longitudinal comparison by asking the same questions. The two post surveys contain four quantitative questions for each of the seven variables of the model (Figure 1). Each question was quantifiably structured with a reliable and unbiased measured scale of 1 to 7 for answers. To ensure the validity of all measures, the measurement items for latent constructs within the proposed model (see Figure 1) were developed from prior studies (Bhattacherjee, 2001: Faqih et al., 2021; Lu & Yang, 2021; Ouyang et al., 2017; Zhang et al., 2017).

4.3 Analysis of Data

The partial least squares (PLS) structural equation modelling (SEM) method will be used to test the hypothesised ECN + TTF acceptance hybrid model applied to this study. Confirmatory Factor Analysis will be conducted in PLS. Descriptive stats, Mean, Variance and Standard deviation will be calculated in SPSS. Tools for data analysis include IBM SPSS and Smart PLS software.

5 Preliminary Results

At this stage of our research, we are investigating the data collected from participant surveys with an initial focus on the demographic data about previous MR use and experience, as well as a reasonable representation of the current Australian healthcare industry. Future participant survey results will reveal how the MR characteristics and the training task requirements influence the task technology fit (TTF). These insights will deliver an understanding of how the users adopt the training by predicting the satisfaction and overall intention to continue using the MR technology for healthcare IPE.

5.1 Demographic Data

124 participants completed the pre-survey during the project and provided the following demographic data. The cohort demonstrates a broad range of ages, work experience and disciplines represented in the study. 101 females and 23 males between 18 to 64 made up the demographic of the group. 56% of participants were aged 34 years and younger. The distribution of participants' ages was 20% 18 to 24 years, 36% 25 to 35 years, 20% 35 to 44, and the remaining 24% aged 45 years and older. 70 registered nurses took part in the study, along with 9 Enrolled Nurses, 5 Clinical Nurse Specialists, 2 Clinical Nurse Educators, and 4 Nursing Unit Managers; medical professionals included 3 Resident Medical Officers, 8 Junior Medical Officers, 2 Medical Interns; allied health professionals including 4 Physiotherapists, 7 Pharmacists, 1 Social Worker, 2 Speech Pathologists, 5 Occupational Therapists, and 2 Dietitians. Years of workplace discipline experience ranged between <1 year to >21 years, with 56 participants with 1 to 4 years of experience. 87.9% of participants had no experience using MR technology, 10.5% considered themselves novices using MR and 2.4% considered themselves experienced MR users.

6 Discussion

This study utilised MR technology to deliver training in interprofessional practice. This study looks at the current data of participant demographics concerning the MR experience of participants. It justifies the validity of the demographic data by comparing it to the existing Australian healthcare workforce while exploring relevant literature. Participant acceptance has varied toward the technology during this research, with a minority few participants having reluctance to use the technology due to previously experiencing photophobia, nausea, and motion sickness. At baseline, only 13% of all participants had previous experience using MR technology; of these participants who stated they had used MR before, 69% work in nursing roles, and 75% have five years or less of workplace discipline experience. 87% of all participants had no experience using MR technology. These results, in conjunction with data reported by Nisbet (2011) demonstrates, the absence of MR technology in Australian healthcare education. As the group demographic had significantly low experience, it was essential to offer a familiarisation session to prepare participants for learning opportunities within the main training scenarios. The familiarisation session gave participants an understanding of what to expect while using the MR technology after completing a series of basic interactive tasks prompted by visual and auditory directions from the MR headset. It is probable that this activity influenced the user's initial expectations of the MR technology that we know from other studies will affect user CE, Satisfaction and CIU. The session also provided supervisors with indications of any early issues between the user and the technology.

On average, Australia's health workforce is predominantly female. The Australian Institute of Health and Welfare (AIHW) reported that a total of 476,500 (74%) females and 166,000 (26%) males were registered and employed in the Australian health workforce (Aihw, 2022). The demographic of this study closely represented the percentiles of the workforce, with 81% females and 19% males participating in this study. Some studies have identified gender as a contributing factor to user acceptance of MR-related technology. Munafo (2017) suggested that MR-related technology is sexist and causes negative effects, such as motion sickness, on users depending on their gender, specifically for females. However, the results of this study indicate that gender does not appear to be a significant factor regarding the discomfort of MR technology. Out of all 124 participants, predominately female, only 12 did not use MR technology. Factors contributing to participants not being able to use the MR technology were attributed to personal health-related circumstances and technical issues. The discomfort was illuminated for most users after the MR technology was made to comfortably fit the user by adjusting headset straps and appropriately aligning the visor to the users' eyes (Stanny et al., 2020).

This study reasonably represents the age distribution of the Australian healthcare workforce. The majority of Australian healthcare workers are aged 20–34, with an increase in young health professionals joining the workforce between 2015 and 2020. Morris (2000) stated that older workers are less able to process complex information processing tasks than younger workers, and age is expected to have a negative influence on the person's attitude toward using the technology. Participants of this study are aged between 18 to 64 and work with a variety of technology in their daily duties. 56% of participants are aged 18 to 34, representing the majority in the study, with fewer participants represented in the older age groups. Future data will provide a better understanding of whether age is a significant factor for healthcare workers to accept MR technology for IPE. AIHW reported 54% of nurses, 26% of allied health, and 16% of medical professionals, including doctors working in the Australian healthcare workforce. This study had a slightly larger 73% of participants working in nursing roles, along with 17% of participants working in allied health and 10% working as medical professionals. Although nurses are slightly overrepresented in this study's demographic compared to the other disciplines, we can be confident that the demographic of participants in this study reasonably represents the Australian healthcare workforce.

Our program was set up to train IPE as a work team and generated some excellent outcomes in seeing how the teams worked together. The MR provided adequate visual and audio indications of patient symptoms. The participants diagnosed symptoms effectively from what they saw and heard. However, the visible details were compromised if participants did not adjust the visor to the proper position and some fogging occurred on the visor from participant masks. The MR provided all participants with a view of the patient in the room, simulating a real patient scenario without the danger of causing harm to the patient. This provided a safe space to make mistakes and practice skills and procedures to improve workplace operational performance through unique interprofessional experiences.

7 Conclusions

Understanding the acceptance and continuance usage intention of mixed reality for Australian healthcare interprofessional education is significant to advancing how we train medical professionals in Australia. Providing all Australian healthcare workers with better and more accessible technology to help improve their performance is imperative for increasing the safety and well-being of patients.

Mixed reality applications are constantly being developed; therefore, it is necessary to conduct further studies on mixed reality applications in healthcare education (Lange et al., 2020). Future data from this research will reveal how the participants accept the MR technology for long-term use in IPE training. The data analyses will, of course, follow an empirical approach through the proposed model. We will know more about participant insights after the longitudinal data is processed. The statistical analysis results will assist future studies relating to the prediction of how this current standard of MR technology is received and accepted by the healthcare sector.

To the best of the author's knowledge, this study is the first of its kind in Australian health professional IPE, delivering IPE training scenarios within work teams. The significance of this study impacts how we will develop the future characteristics of MR technology for IPE and other healthcare training. The outcome of this research will assist in determining the validity and accuracy of the ECM + TTF hybrid model in the context of MR healthcare training. This research will further explore participants' statistical data (pre, post, and follow-up) during the project to understand why Australian healthcare workers would continue using the MR technology for future training.

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