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Reality check: Insights on critical thinking in health education through mobile mixed reality

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Mobile mixed reality (mMR) is increasingly being integrated into health education, however, the affordances and design principles for the facilitation of critical thinking are yet to be explored. The objective of this study is to explore the perceptions of mobile mixed reality and critical thinking in health education. Thematic analysis was undertaken of data collected from focus groups including students, academics, and mobile mixed developers (n=8). The focus groups revealed two main themes: (1) "purposeful critical thinking" including the benefits of freedom of failure in the virtual environment, and (2) "making it meaningful" by incorporating co-design of virtual learning environments while extending or focusing the learning experience to something that could not be achieved any other way. We conclude that the potential for mMR in health education is considerable. Purposeful inclusion of critical thinking could be achieved by students co-designing scenarios that integrate choose-your-own-adventure healthcare pathways in safe, virtual environments.

Keywords: mixed reality, mobile learning, critical thinking, authentic learning, co-design, health

Background

The worldwide shortage of healthcare workers has impacted the availability of staff to supervise students in clinical placements (Song & Kim, 2023). The subsequent limited exposure to clinical learning has detrimental effects on students' readiness for practice, and the development of critical thinking (El Hussein et al., 2023). This has led to the need to investigate alternative approaches to supplement student exposure to clinical environments.

Mobile mixed reality

Mixed reality presents the virtual world and real-world environments together (Milgram & Kishino, 1994). The recent increase in the ubiquity of mobile devices has enabled students to access mixed reality on personal devices (i.e., mobile mixed reality- mMR), enhancing the flexibility of learning at a self-determined time, place, and pace around other life commitments (Universities UK, 2022).

Critical thinking

There is increasing concern about the limited development of critical thinking in health students (El Hussein et al., 2023). Critical thinking refers to "purposeful, self-regulatory judgement which results in interpretation, analysis, evaluation, and inference as well as explanation" (Facione, 1990, p. 3). Critical thinking is essential in health education and practice as it enables the analysis of a situation and drawing on evidence to make informed, safe, and effective clinical judgements (Carbogim et al., 2018).

Description of work undertaken

This concise paper presents the findings of focus groups that contribute to an educational design research project that aims to inform design principles for developing critical thinking using mobile mixed reality. The focus group discussions explored "How does mobile mixed reality facilitate critical thinking in health education?" Sub-questions included the exploration of affordances, perceptions, and design principles that may inform subsequent phases of this project and future studies in health education.

Methods

The exploration phase included two focus groups consisting of students (2), academic staff (3), a learning software developer, an educational technologist, and an immersive media coordinator (n=8 participants total).

Facilitation of the focus groups was guided by an interview protocol approved by the University of Melbourne Ethics Committee (2022-23676-30979-3) which concentrated on mobile mixed reality, critical thinking, and student learning experience. The 45-minute discussions were audio recorded and uploaded to Otter.ai for transcription The transcripts were verified by one researcher (TS) before being uploaded to NVivo for reflexive thematic analysis (Braun & Clarke, 2022).

Results and Discussion

Two main themes emerged from the focus group discussions- (1) "purposeful critical thinking" and (2) "making it meaningful". The following briefly presents supporting literature, a summary of overall findings for each sub-theme, and excerpts from the focus group transcripts.

Purposeful critical thinking

What: Ill-defined
The term "critical thinking" in health has been synonymously aligned with clinical judgement, clinical reasoning and decision-making (Griffits et al., 2023). Victor-Chmil (2013) suggests that 'critical thinking' is a cognitive process that analyses knowledge, 'clinical reasoning' extends this to the context of a clinical situation, while 'clinical judgement' is the cognitive, psychomotor, and affective processes demonstrated in both action and behaviour. However, some have suggested that critical thinking is only one process employed when making decisions (Jans et al., 2023)- leaving a clear definition for 'critical thinking' ambiguous.

Student participants also aligned critical thinking to the integration of interrelated patterns, while the majority of focus group members identified the difficulty in defining critical thinking, and therefore integrating it into content or contextual learning:

> #1009 (Student) '…in that particular subject, which was anatomy and physiology, they put the emphasis mainly on, like**, integrating different concepts** and like, you know, how does the heart, you know, interactive with the lungs as a kind of relatively basic example, as opposed to displaying them as kind of modular things.'

> #1002 (Lecturer) 'I've literally been trying to teach critical thinking to these first-year students recently. And to begin with, **we couldn't even define what critical thinking was to them**, because it's just such, a sort of, intangible thing.'

What: "Freedom of failure"
Purposeful "freedom of failure" helps students to accept errors as a normal experience in the learning process (Palominos et al., 2022), and has been utilised to facilitate clinical decision-making (Morningstar-Kywi & Kim, 2021; Palominos et al., 2022). Being intentional about including "freedom of failure" has reportedly enabled students to compare their knowledge and practical performance with a standard of practice, thereby enhancing clinical decision-making while safely learning from identified mistakes (Morningstar-Kywi & Kim, 2021; Palominos et al., 2022).

The focus groups aligned reflection in learning to critical thinking. Learning from mistakes was viewed positively, especially in the controlled, non-life-threatening mixed reality environment:

> #1005 (Learning Software Developer) 'But you know, in the clinical sciences, **having the freedom of, of, of failure really enhances, you know, that sort of that critical thinking**… …allowing them to fail design and design something that they're going to lose. Kobayashi Maru.'

Making it meaningful

Why: Extend-ing reality
The affordances of mMR to extend learning experiences include enhancing accessibility, authentic learning, collaborative professional practice, confidence and self-efficacy in clinical skills, cost-effectiveness (low fidelity), student feedback, motivation and engagement, repetitive practice for skill improvement, and clinical safety (Birt & Cowling, 2017; Cochrane et al., 2020; Cochrane et al., 2018; Collins & Ditzel, 2021; Hanson et al., 2020; Smith & Friel, 2021; Stretton et al., 2018; Yu et al., 2021).

Participants were clear that the use of mobile mixed reality was not a replacement for conventional learning

practices. Rather, it extended the learning experiences that would otherwise be too difficult or unsafe to deliver any other way:

> #1007 (Lecturer) '…it's actually a **richer conceptual, conceptualisation of the topic**, a body part of something. So certainly, I think you can, you know, as opposed to a 2D image on a screen or textbook, you can certainly really understand that full anatomy **and grasp the concept a little bit better.**'

> #1003 (Immersive Media Coordinator) 'So, it was that **experience that would be difficult to do any other way** and having something that was memorable for them. It wasn't putting the students into a VR headset and getting them to log into the LMS and check email, for example.'

How: Co-design learning experience
The term 'co-design' has gained attention in educational practice as it enhances active collaborative engagement, and creativity and minimises the failure rates associated with technology-enhanced learning (Bovill, 2020; Treasure-Jones & Joynes, 2018). By starting with co-design, learners begin with curiosity as they discern the required knowledge with knowledgeable others in a community of practice (Nicolini et al., 2016; Thomas et al., 2014).

Focus group members suggested that the objective needs to extend beyond rote learning, have a personal connection with the learner, and be engaging to create meaningful learning experiences. While participants spoke of the curriculum being informed 'by' students, this did not expand to designing 'with' students. Students would initially be guided before self-determining the learning required while working within a community of practice:

> #1002 (Lecturer) 'I think a valuable learning experience is **one in which the students are interested in**. So, I think if there's some reason that they care about learning this thing, they're much more likely to actually learn it.'

> #1009 (Student) '…just having an attempt to like connect to things outside. Like, From the teachers' perspective, **looking into the students' lives** and like, **how will they be able to relate to this?** Outside? Kind of amplifies the engagingness of it.'

> #1002 (Lecturer) 'You can't just, they can't create the learn, the knowledge or the skills **without having someone there to actually support them** through that journey.'

How: Contextual interaction
The use of 'choose-your-own-adventure' in health education is relatively novel, though is akin to differential diagnosis and draws on clinical reasoning. Developing alternate clinical pathways has been reported to improve student clinical knowledge, engagement, satisfaction, confidence in practice, flexibility in learning, and practical decision-making (Jogerst et al., 2022; Litten & Stewart, 2023; Thomas et al., 2022).

Student participants described that interactive content made the learning more meaningful and aided critical thinking- an "if this, then that" (IFTTT) approach:

> #1008 (Student) 'Because one the **best ways to learn is to 'do'.** And by doing it, you will... It's so much more real to you. It's so much easier to embed it in your brain. So, **when you are then faced with that situation, again, you can draw on those skills.**'

> #1008 (Student) '…the idea of what happens if I do 'X'. What happens if I have a heart and I poke a hole in it here? That is such a great way to learn how something works. **And to learn, what to do when something goes wrong**… … **And it's just like, yeah, if this happens, if this does go wrong, and how do I fix it? And why is it going wrong?** And all the other things attached to it and what will that cause for something else down the road. I think that's such an exciting thing. It's such a great way to embed learning.'

How: Sensational Learning
Previous studies have utilised eye gaze tracking software, heart rate and galvanic skin resistance to measure stress within virtual health scenarios (Cochrane et al., 2020). The evolution of head-mounted displays (i.e. [HP Reverb G2 Omnicept,](#) [Meta Quest Pro](#) and [Apple Vision Pro](#)) have integrated stress monitors, eye and hand tracking and cognitive load algorithms. These may be beneficial in quantifying virtual environments' impact to

facilitate critical thinking in the future. Design features to minimise undue cognitive load in simulation include the addition of repetitive practice, as well as instruction before, during, and feedback after simulation (Lapierre et al., 2022).

The integration of a variety of senses was suggested by the participants to add a more meaningful learning experience. While auditory and visual inputs in mobile mixed reality were beneficial, focus group members identified other senses that could be incorporated to both inform and authenticate the learning:

> #1005 (Learning Software Developer) '…because basically, the way that the [head mounted display] is set up is that you can play sounds through the haptics, as in **you can feel the sound**. So, when the heart that when they beated, you could feel it in your hand.'

Conclusion

This concise paper presents some of the key themes from focus group discussions centred on the development of mobile mixed reality to facilitate critical thinking in health education. Participants first highlighted the need for purposeful critical thinking including opportunities for freedom of failure. Secondly, the need to intentionally make learning meaningful by capturing concepts that students can personally relate to, reserving mixed reality learning experiences to those where the content could not be delivered any other way. Meaningful learning can be developed by co-designing scenarios with students that include a "choose-your-own-adventure" approach to enhance student's critical thinking. These themes can aid future studies in developing design principles for the integration of mobile mixed reality for critical thinking in health education.

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