How interactivity and presence affect learning in virtual reality: a mixed methods study design

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1 Problem

An increasing amount of research is focused on identifying the key VR features that promote learning. There has been a shift toward hardware and software that increases immersion, which can be exploited to enhance VR educational apps.

The rapid change in technology over the last five years has led to a confusing range of meanings for some of the concepts we use to think about VR, so it can be difficult to compare research studies.

These concepts are:

- **Immersion** - the ability to forget the real world and foreground the virtual world
- **Presence** - the sensation of being inside the virtual world
- **Interactivity** - the ability to perform actions in the virtual world
- **Agency** - The ability to make decisions and control what you do in the virtual world

Some recent studies have tried to adapt existing pedagogies of multimedia learning and cognitive load for educational VR development (Makransky & Petersen 2021 and Petersen, Petkakis & Makransky 2022). Their aim has been to model how VR's capabilities interact with learning processes to affect learning outcomes, but there are problems with these studies linked to concept definitions, particularly interactivity (see box).

2 What else is missing?

The experience of VR is **highly subjective**, with individual emotional and physical factors impacting on how a participant will feel, act and respond to the virtual world.

Very **few studies in this area** consider probing the personal experience of VR through qualitative methods (Radianti et al. 2020), instead relying on quantitative proxies for the perceptions and feelings of participants.

What is 'highly interactive', anyway?

The level of interactivity used in studies is inconsistent, poorly defined, and doesn't reflect the capabilities of modern VR systems.

For example, (Petersen, Petkakis & Makransky 2022) used a 'highly interactive' condition that allowed users to walk around a virtual museum and look at (but not touch or manipulate) 3D models, and play pre-recorded presentations. In a recent review, (Pavic et al. 2022) found that the word 'interactive' has been used to mean anything from 'able to navigate' to 'able to complete a task.'

True interactivity comprises several factors, including congruity and responsiveness (Domagk, Schwartz & Plass 2010; Johnson-Glenberg et al. 2018). For this study, they have been conceptualised as shown in Figure 1.

3 Study design

This study will build upon the current state-of-the-art in this field. It will study the impact of high-level interactivity on presence and learning outcomes, using a custom VR learning programme based on chemistry materials.

In an effort to capture a full picture of participants' experiences, and to mitigate the statistical weakness of a small-scale study, a mixed methods approach has been chosen (Figure 2).

Research questions:

1. Do increased levels of interactivity result in greater feelings of presence in an immersive VR learning environment compared to a lower interactivity intervention?

2. Do feelings of presence correlate positively with learning outcomes?

3. How do interactivity and presence impact the learner's experience?

4 Hypotheses

This study will focus on interactivity as the independent variable, and assess its impact on presence, cognitive load and knowledge.

H1: Highly interactive content will have a positive effect on presence

H2: Highly interactive content will have a negative effect on extraneous environmental cognitive load

H3: Self-reported feelings of presence will have a positive effect on learning outcomes

5 Next steps

I am now developing the chemistry-based VR learning material that this experiment will use for the high and low interactivity cases, with a view to running the study during Easter Term 2024. See Figure 3 for the experimental protocol.

I am open to collaboration and information sharing/ support with any colleagues who have an interest in this area.

Figure 1: Conceptualising interactivity & presence

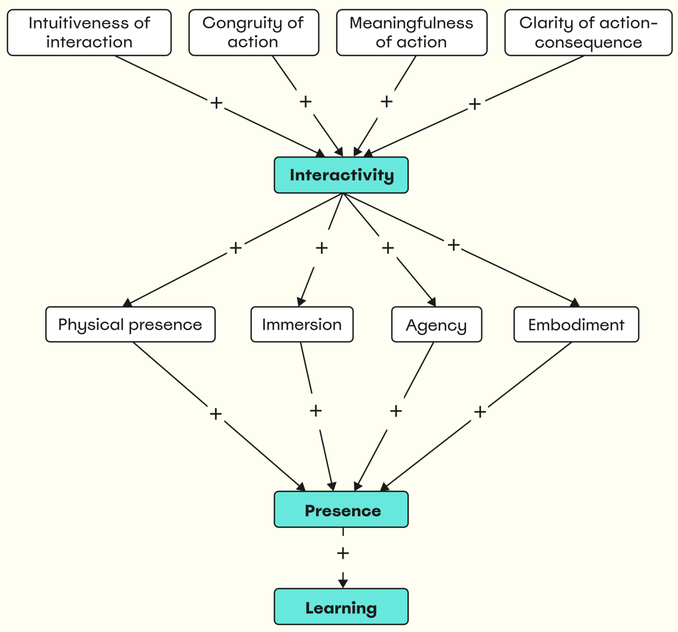


Figure 2: Research design diagram

Adapted from Morse (2010)

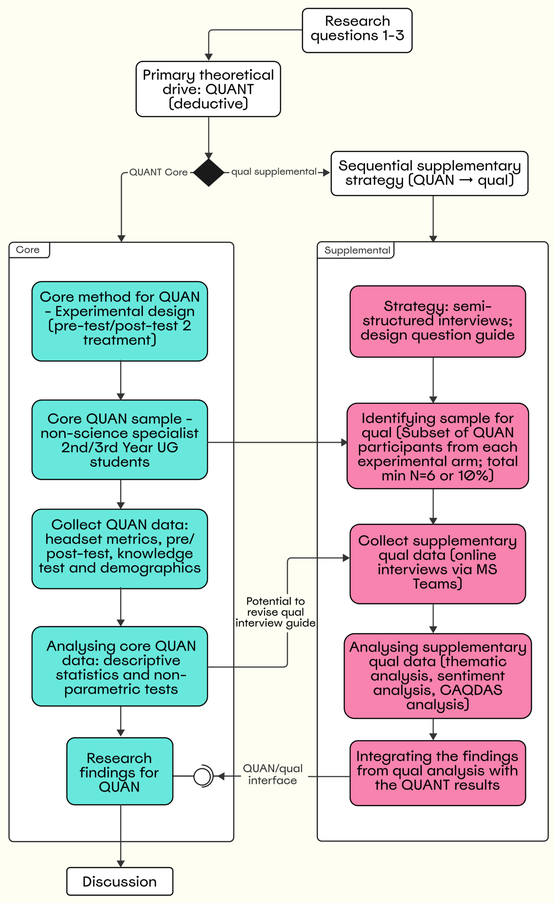
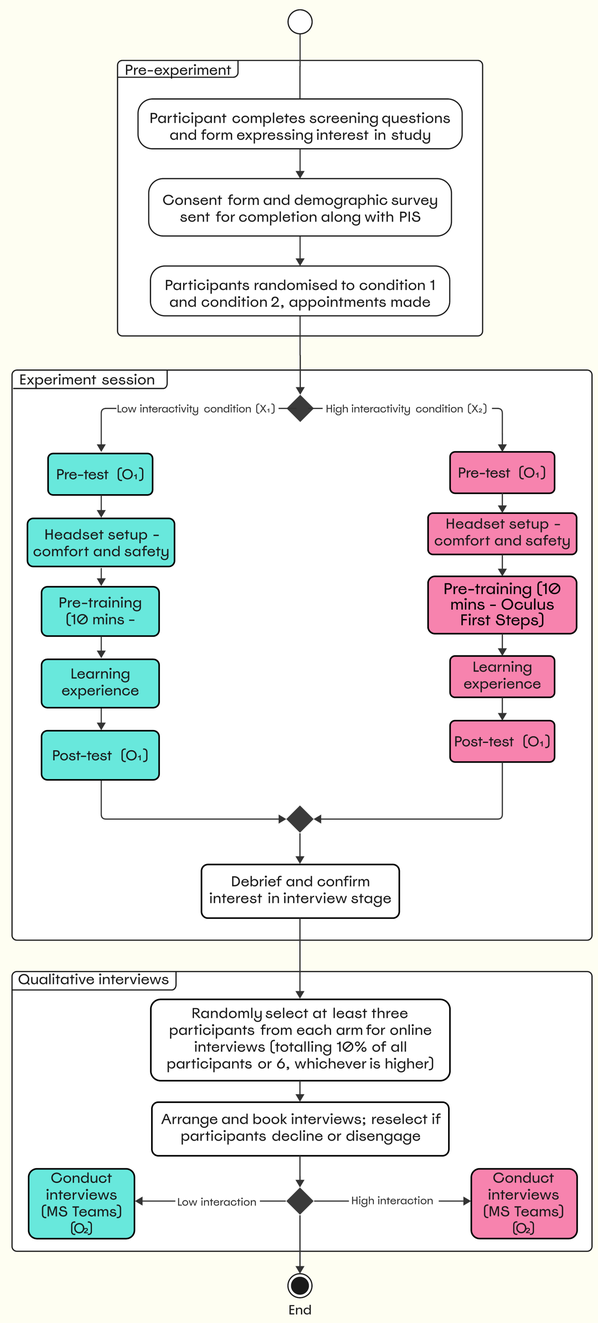


Figure 3: Experimental protocol



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