Cyprus University of Technology
Department of Communication and Internet Studies
MEDIA, COGNITION, AND LEARNING RESEARCH GROUP
University of Central Lancashire UCLan Cyprus

Exploring higher education students' immersion in relation to cultural heritage learning in a virtual reality environment

Y. Georgiou, M. Souropetsis, E. A. Kyza, L. Nisiotis, and M. Efpraxia

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Introduction [VR & Learning]

Growing interest in the use of Virtual Reality (VR) environments to **support learning** across all levels of education

The affordances of VR, such as interactivity, sense of presence and embodiment can contribute to experiential and inquiry-based learning

(Luo et al., 2021)

However, studies report **contradictory** findings regarding the learning potential of VR environments

(Coban et al., 2022; Hamilton et al., 2021)

Introduction [Immersion]

These contradictory findings may be attributed to the concept of **immersion**

- A popular concept in HCI and games research but has received less attention in the learning sciences

While immersion is largely discussed in the context of VR environments, there is a debate on whether it reflects a **subjective psychological process** or an **objective concept** reflecting the technical affordances of a VR system

(Agrawal et al., 2020)

Taking into account this debate, we argue that:

- High levels of immersion should not always be taken for granted in VR environments
- We find more value on focusing on **"how"** rather than **"if"** immersive VR can influence learning

Theoretical framework & Hypotheses

According to the psychological conceptualization of immersion:

- **Presence and flow** are considered as **optimal "states of mind"**
- **Immersion** can be viewed as a **gradated process of cognitive and emotional involvement** that may provoke a sense of presence and/or flow

(Brown & Cairns, 2004; Georgiou & Kyza, 2017)

Adopting this conceptualization, we stated the following hypotheses:

- #H1: Students will not experience the same degree of presence and flow in an VR environment
- #H2: Students' learning gains will depend on their experienced immersion

The VR learning environment

A VR learning environment has been developed to support higher education students' cultural heritage learning

- **Inquiry-based learning scenario:** Students assume the role of historians trying to date a prominent church ceiling mosaic through data gathering
- **Learning mission:** The students visit four learning stations (areas) in the church, collect evidence and complete a quiz at each station, before "unlocking" and proceeding to the next one
- **Multimedia sources:** Each learning station features different educational materials in various formats (e.g., videos, figures), providing information
- **Semi-realistic look:** The VR environment was designed with the "Unreal Engine, resembling the interior of the church"
- **Single-user mode:** Each student can experience the VR world, through a head mounted VR display

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Case study [overview]

The VR learning environment was initially employed by **two higher education students**

- Susan (21 years-old) and Tom (23 years-old) – both names are pseudonyms
- Both students had no prior experience with VR environments

We addressed **two main RQs**

- To what extent are students immersed during a VR activity about cultural heritage learning?
- How does immersion relate to students' learning?

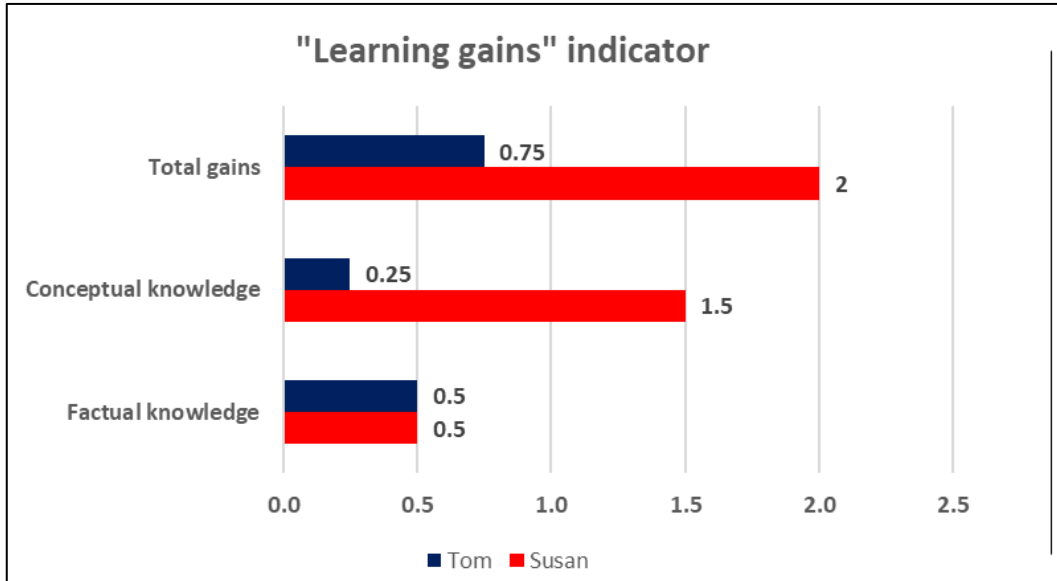
The data collection included:

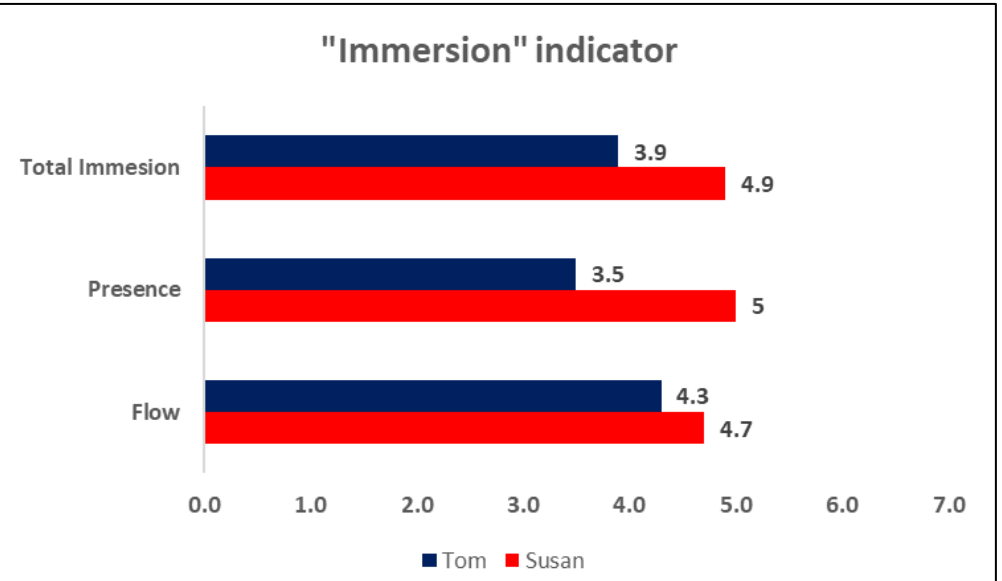
- Questionnaires for evaluating students' experienced immersion and learning
- Post-activity interviews
- Screen recordings of the activity to capture students' performance

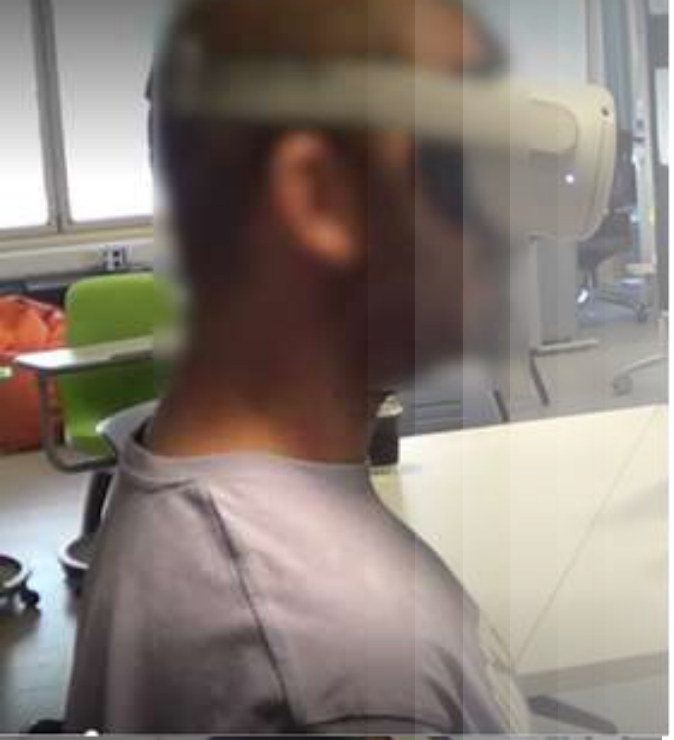
Case study [Findings]

Susan's investigation had a more extended time duration than Tom's and only Susan successfully completed the inquiry-based mission, and specified the correct era of the wall mosaic

According to the quantitative indicators, Susan achieved higher levels of immersion, in terms of presence and flow as well as higher learning gains than Tom, in terms of conceptual knowledge







Case study [Findings]

For Tom, while the environment initially captured his interest and attention, there were three main barriers which negatively affected his sense of presence:

- Usability issues related to his navigation in space
- The multimedia learning resources which were perceived as “distractors”
- The limited sense of embodiment due to the lack of full-body interaction

For Susan, the VR environment not only captured but also maintained her interest and attention throughout the experience, resulting in a high sense of presence due to three factors:

- The overcoming of usability issues
- The multimedia learning resources which served as “focal” points
- The sense of embodiment due to the realism/authenticity of the environment

Case study [conclusions & implications]

Our findings provide empirical documentation to the argument that **immersion is a subjective psychological process**…

(Brown & Cairns, 2004; Georgiou & Kyza, 2017)

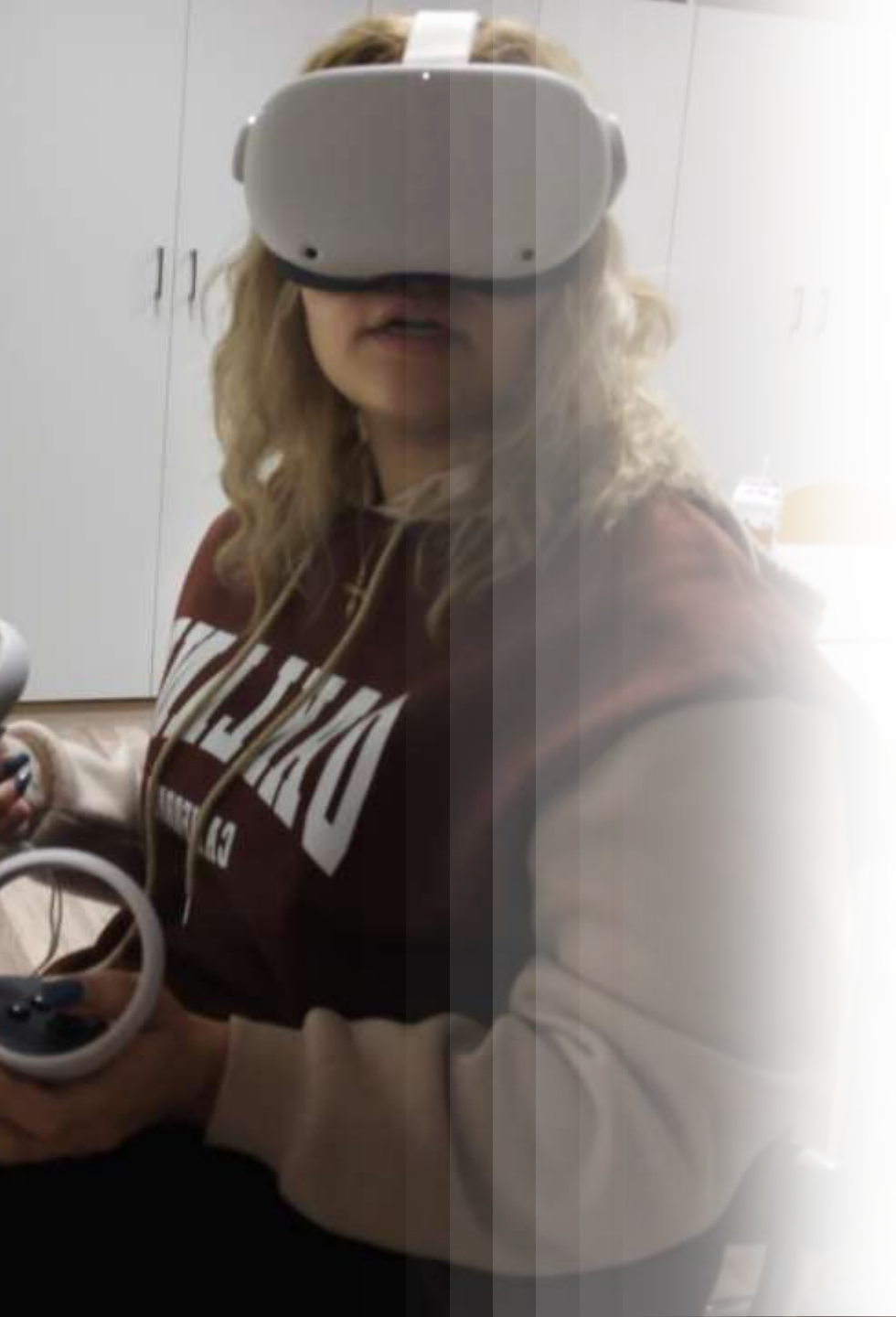
…rather than simply a technical concept reflecting the "objective" and "measurable" properties of a virtual environment

(Nash et al., 2000; Slater & Wilbur, 1997)

The differences between students' learning could be attributed to students' experienced immersion

(Cheng & Tsai, 2013)

Main implication: Focus on understanding how we can **support learners' immersion** in VR settings and through the **design of more immersive VR environments**



Quasi-empirical study
[Gamification]

Gamification may contribute to students' immersion by making learning more engaging

(Caponetto, 2014)

Even though gamification has a long history in the field of education, various **constraints** have limited its use in VR environments

(Khaitova, 2021)

While some studies have demonstrated **positive impact** on motivation, engagement, and learning outcomes, other studies reported **limited or short-term effects**

(Hamari et al., 2014; Osatuyi et al, 2018)

RQ: What is the impact of gamification on students' immersion and learning in a VR setting?

Quasi-empirical study
[Methodology]

Experimental design

Two groups of university students - Each student was randomly assigned to one of two conditions

- Condition 1: Gamified VR environment
  (Scoring system, Badges, Time limit-Countdown)
- Condition 2: Non-gamified VR environment

Participants

46 higher education students

- recruited using convenience sampling
- randomly assigned to the gamification or non-gamification condition
- none of the students had any prior experience in using VR

Quasi-empirical study [Methodology]

Data collection

Virtual Reality Immersion (VRI): 3 main scales (comprising of 21 Likert-scale items)

- The *Engagement* scale, consisting of two subscales (*Interest* and *Usability)*
- The *Engrossment* scale, consisting of two subscales (*Focus of attention* and *Emotional attachment)*
- The *Total Immersion* scale, consisting of two subscales *(Presence* and *Flow)*
- Cronbach's alpha for all scales and subscales ranged from 0.77-0.87.

Conceptual understanding Pretest & Posttest questionnaires

- eight multiple-choice items (evaluating factual knowledge)
- four open-ended items (evaluating conceptual understanding & reasoning)

Semi-structured in-depth interviews (*n*=46)

Quasi-empirical study [Results]

Analyses showed statistically significant differences in students' ***learning performance*** between the two conditions.

- No statistically significant differences were found between the pre-test learning scores of the students in the gamified and non-gamified condition.
- However, the overall post-test learning scores of students in Condition 1 (Gamification) (M=5.93 SD=1.00) exceeded the overall post-test learning scores of students in Condition 2 (Non-Gamification) (M=5.10 SD=1.33) [t=2.40, p<0.05] and this difference was statistically significant.

Analyses showed statistically significant differences in ***immersion*** between the two conditions.

- The *focus of attention* in the gamified condition (M=5.96, SD=.83) exceeded the *focus of attention* in the non-gamified condition (M=5.32, SD=.85), and this difference was statistically significant [t=2.57, p<.05].
- Students' *sense of flow* in the gamified condition was higher (M=5.72. SD=1.26) in comparison to the non-gamified condition (M=4.82, SD=1.03) and this difference was statistically significant [t=2.64, p<.05].

Quasi-empirical study
[Conclusions]

Overall, the findings of this study demonstrate that the integration of the gamification elements in the VR learning environment contributed to students' higher **immersion** and increased **learning gains**

These findings provide empirical substantiation for the value of gamification in the design of VR learning environments, if appropriately designed

This quasi-experimental research went beyond a mere "media comparison"

Rather than focusing on "whether immersive VR can influence learning" or not, we have reframed this question, as per Kozma's suggestion (1994), into the "how" can immersive VR influence learning

Limitations, and next steps

The sample of this study was relatively small and drawn from a population of convenience

Our findings are most relevant to the VR environment employed in this study

We discussed the impact of the gamification elements used in this study holistically rather than discussing the potential impact of each of the three gamification elements separately

The qualitative analysis of the interviews is ongoing to help us understand how each one of the gamification elements may have influenced the learning process and the participants' experienced immersion

Thank you!

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Pictures

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