

Introduction

Students felt their performance while learning was negatively influenced by teaching going online during the covid-19 pandemic (Stevens, 2020). The students felt that their performance was suffering from the distance lectures and felt a lack of interaction.

Previous research found that that a higher level of online interaction occurs with a higher level of social Presence and that there is strong correlation between social presence and perceived performance of students.

When using a fully immersive VR environment, the cognitive load can increase significantly (Grant Frederiksen et al., 2020). It is however important to decrease the amount of cognitive load for students since (Sweller, 1988) found that an increased cognitive load, decreases the effectiveness in problem solving.

Research Questions

1. 'How can holograms be used in distance learning to enhance teachers' presence, when students are in the same classroom, but the teacher is distant?'
2. 'How can holograms be used in distance learning to decrease the cognitive load of a lecture, when students are in the same classroom, but the teacher is distant?'

Methodology

A between subjects experiment with 4 different groups is used together with the following variables:

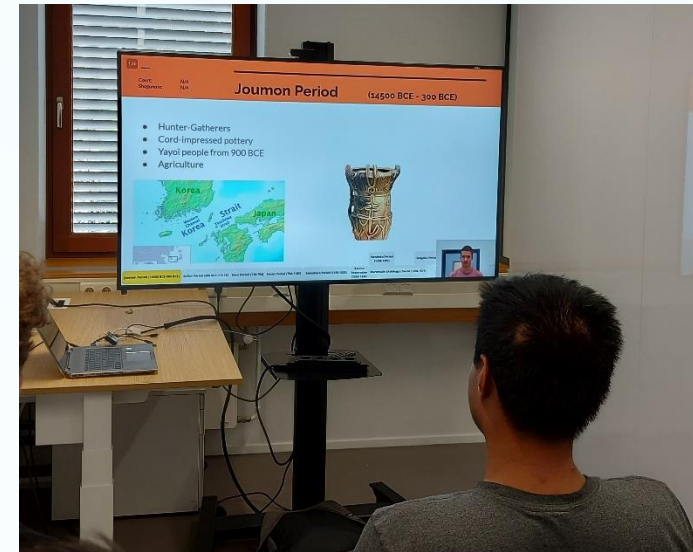
- Independent variable
 - Learning environment
- Dependent variables
 - Cognitive Load
 - Social Presence
 - Zoom Exhaustion & Fatigue
 - Engagement
 - Learning Outcomes
 - Eyestrain
 - Flow Experience
- Confounding variables
 - The lecture given by the teacher
 - Knowledge of the students about the subject (None)

Participants:

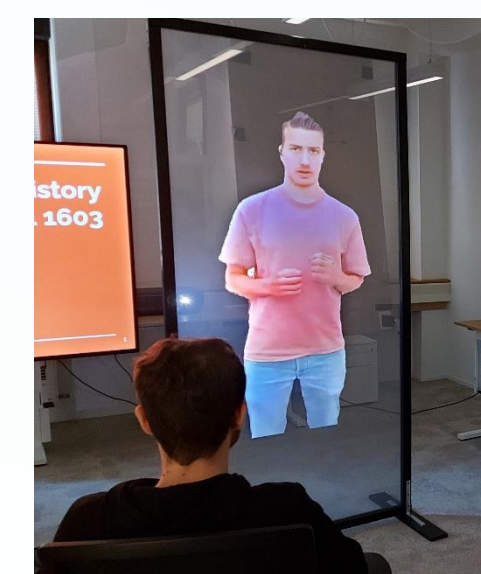
22 participants, mostly TU Delft students

Apparatus:

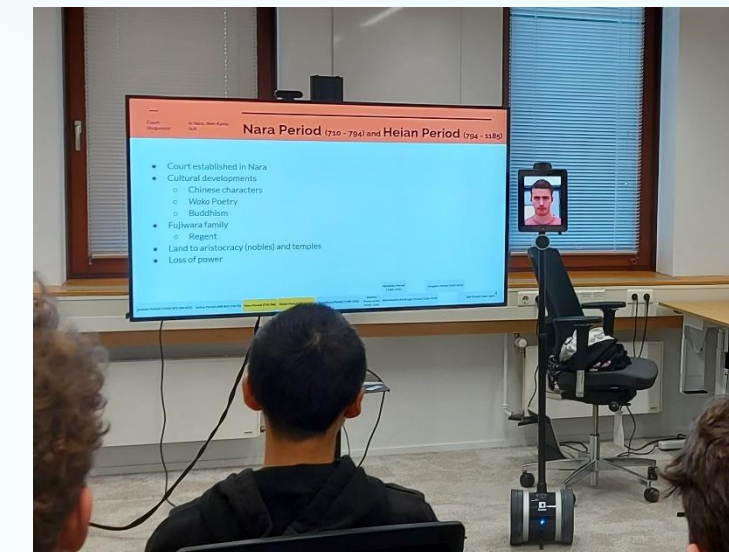
Zoom lecture:



HoloDisplay:



Telepresence robot:



VR:



Materials and measures:

- Social Presence:
 - A questionnaire with 9 sub-questions from (Weidlich, Kreijns, Rajagopal & Bastiaens, 2018) was used. It was original made for a group of students instead of single teacher, therefore it has been altered on every question.
 - One question has for example been altered from "It feels as if all my fellow students are 'real' physical persons" to "It feels as if the teacher is a 'real' physical person".
- Cognitive Load
 - A questionnaire created by (Paas, Ayres & Pachman, 2008) was used to measure the cognitive load. It contains only one question:
 - "In studying the Japanese history until 1603 I invested"
 - 9 possible answers ranging from "very, very low mental effort" to "very, very high mental effort"

Procedure:

Participants were randomly divided by an id they received. When all participants were present, they received a pre-exam about the content of the lecture. When finished with the exams, they watched one of the lecture in one of the 4 lecture types. Afterwards they had to make a post-exam and fill in questionnaires about the dependent variables.

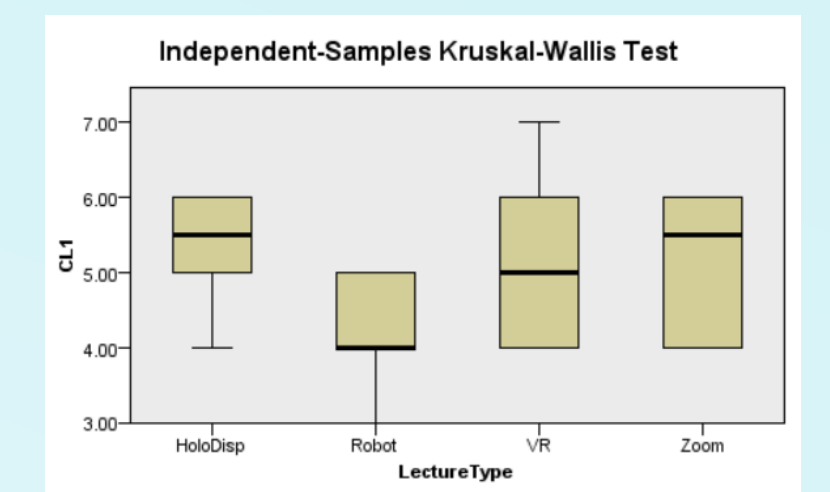
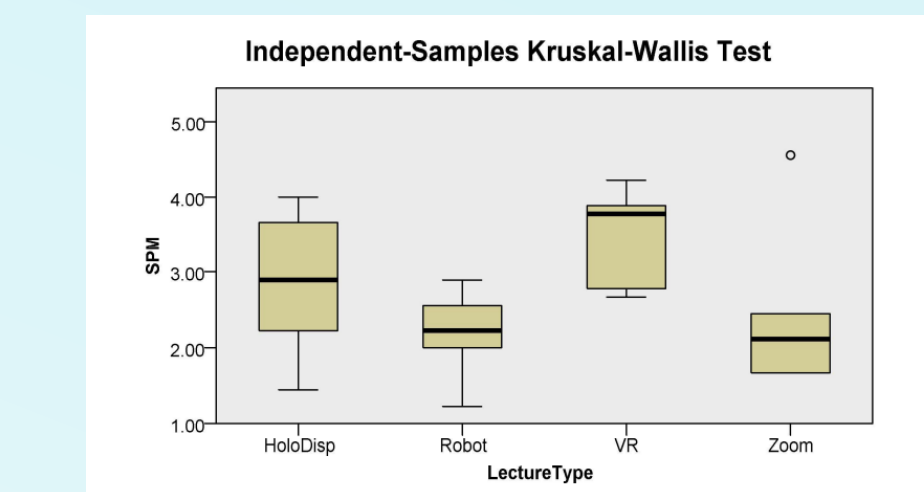
Results

No significant differences were found between the social presence means (SPM) and the cognitive load of the different lecture types:

$$H(3) = 5.916, p = 0.116$$

$$H(3) = 3.850, p = 0.278$$

The boxplots do show some differences:



The lowest SPM score of the VR environment is still higher than 75% of the scores for the zoom lecture.

The median score of the cognitive load for the zoom lecture is the highest together with that of the HoloDisplay

A significant difference has been found for sub-question 7: "In this learning environment the lecturer feels so 'real' that I almost believe we are not virtual at all" $H(3) = 8.730, p = 0.033$

Conclusion

The sample size per lecture type was too small to find any significant differences but the boxplots show that there are differences between the lecture types.

Since the set up is still available it is recommended to add more data to the already existing data to be able to find significant differences.