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Pupils' perceived immersion, attitudes, and learning effectiveness in virtual field trips: A comparison between immersive and projective environments

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Abstract: Focusing on the implementation of virtual field trips in elementary school classroom, this study aimed to explore pupils' affective perceptions and cognitive performance in either immersive environments (using VR headsets, n=26) or projective environments (using traditional projection screen, n=26) through a quasi-experimental design. The results showed that the pupils exhibited stronger perceived immersion and positive attitudes toward virtual learning and achieved better learning effectiveness in the immersive setting than in the projective setting. We are continuing to expand this work for more understandings of immersive virtual field trips in elementary classrooms.

Keywords: Virtual reality, field trip, science learning, immersion

1. Introduction

Virtual field trips are one of the educational applications of virtual reality (VR) technology for instructors to lead learners to explore learning content in virtual environments (Çaliskan, 2011). Several studies have examined the pedagogical possibility of immersive virtual field trips in classrooms (Cheng & Tsai, 2019; Han, 2020). Notably, some studies reported that learning science by immersive VR may result in attentional dispersion and cognitive overload for learners (Makransky et al., 2019). Compared with learning science by immersive VR, students showed less affective perceptions (e.g., motivation, interest, and engagement) but performed better when using traditional medium such as slideshows (Parong & Mayer, 2018). Similar findings were also documented in Parong and Mayer's study (2021). However, these studies were conducted in the context of research lab rather than in the practical fields such as classrooms. Therefore, focusing on the implementation of virtual field trips in elementary school classroom, this work aimed to explore students' affective perceptions and cognitive performance in either immersive environments (using VR headsets) or projective environments (using traditional projection screen). Specifically, a series of comparison of pupils' perceived immersion, attitudes, and learning effectiveness in immersive and projective virtual field trips will be implemented in this study.

2. Method

2.1 Participants

There were 52 elementary school students from two classes in fifth grade (26 students for each class) invited to participate in this study. The gender distribution of the pupils was balanced, that is, there were 13 males (50%) and 13 females (50%) for each class. About half of the pupils had had experiences in the usage of VR-related applications, indicating that the

novelty effects of virtual technology the participants perceived may not interfere the results of the current study.

2.2 Experimental design and procedure

A quasi-experimental study was conducted to compare the pupils' perceived immersion, attitudes, and learning effectiveness in immersive virtual field trips with those in projective virtual field trips. While the pupils in the experimental group (n=26) were involved in the virtual learning activities by individually wearing head-mounted displays (HMDs, plastic cardboard used in this study) for freely interacting with the virtual learning elements and navigating the virtual scenes, the pupils in the control group (n=26) engaged in the virtual learning activities by passively observing the virtual learning elements and scenes through a projective screen in front of a classroom. The pupils in the two research groups received the same science learning content of solar energy from a VR application for implementing virtual field trips. Two teachers with experiences in using the VR application were invited to implement the learning activity in the experimental and control groups, respectively. They reached a consensus in exploiting the same learning content and instructional strategies. In other words, the possible extraneous variables were controlled in this study.

The learning activities involves three science lessons (approximately 40 minutes for each lesson). While the first two lessons were instructed in a traditional way, the third lesson was instructed by virtual field trips. Before the virtual learning activity began, the pupils were required to complete a pre-test for assessing their prior knowledge in terms of solar energy. When the virtual field trips finished, the pupils had to complete a post achievement test and respond to two surveys. One instrument was adapted from Jennett et al.'s *Immersive Experience Questionnaire* (IEQ) (2008) including the subscales of (1) *basic attention*, (2) *temporal dissociation*, (3) *transportation*, (4) *emotional involvement* and (5) *enjoyment*. The other one was adapted from the questionnaire including the subscales of (1) *usefulness*, (2) *visual appeal*, (3) *satisfaction*, and (4) *intention* used in Cheng et al.'s study (2019).

3. Results

3.1 Comparison of the pupils' perceived immersion

To understand the pupils' perceptions of immersion in the virtual learning activities, a series of independent t-test was conducted to examine whether they perceived immersion in the immersive and projective virtual field trips in different degrees. According to Table 1, the pupils' perceived basic attention (t=3.43, p<0.01), transportation (t=2.04, p<0.05), emotional involvement (t=2.57, p<0.05), and enjoyment (t=3.37, p<0.01) in the immersive setting were stronger than the pupils' perceptions in the projective setting with large effect sizes.

Table 1. *Comparison of students' perceived immersion between the two groups*

	Immersive VR Mean (SD)	Projective VR Mean (SD)	t-value	Effect size
Basic attention	4.53 (0.60)	3.74 (1.01)	**3.43****	0.95
Temporal dissociation	3.26 (1.00)	3.09 (1.15)	0.57	0.16
Transportation	3.86 (0.95)	3.27 (1.13)	**2.04***	0.57
Emotional involvement	4.05 (0.76)	3.45 (0.91)	**2.57***	0.72
Enjoyment	4.31 (0.69)	3.54 (0.93)	**3.37****	0.94

*p < .05, **p < .01

3.2 Comparison of the pupils' attitudes

This study conducted a series of independent t-test to examine the differences of the pupils' attitudes towards the virtual field trips when engaging in immersive and projective environments. The results in Table 2 show that, with large effect sizes, the pupils in the

immersive learning environments exhibited more positive attitudes towards virtual field trips than the pupils in the projective learning environments did to a significant level. Specifically, the pupils considered that the immersive virtual field trips were usefulness for their science learning (t=3.18, p<0.01) and could appeal their visual attention (t=3.19, p<0.01). Also, they were satisfied with the virtual learning experiences (t=2.91, p<0.01) and were inclined to learn science by immersive virtual technology (t=2.92, p<0.01). In other words, compared with the projective setting in the classroom, the immersive virtual field trips may benefit the pupils' attitudes more.

Table 2. *Comparison of pupils' attitudes between the two groups*

	Immersive VR Mean (SD)	Projective VR Mean (SD)	t-value	Effect size
Usefulness	4.53 (0.73)	3.84 (0.84)	**3.18****	0.88
Visual appeal	4.46 (0.75)	3.65 (1.05)	**3.19****	0.89
Satisfaction	4.50 (0.74)	3.80 (0.98)	**2.91****	0.81
Intention	4.56 (0.63)	3.92 (0.93)	**2.92****	0.81

*p < .05, **p < .01

3.3 Comparison of the pupils' learning effectiveness

To examine whether the pupils in the two experimental groups academically performed in a different level, this study conducted an analysis of covariance (ANCOVA) with the pre-test score as the covariance. The significant difference in the pupils' learning effectiveness between the immersive and projective VR settings was found (F=5.40, p<0.05). Specifically, the pupils engaging in the immersive virtual field trips performed (adjusted mean=26.00, standard error=0.89) better than those learned science by observing virtual learning elements through a projection screen (adjusted mean=22.89, standard error=0.89).

4. Conclusion

Similar to the findings of past studies regarding learners' affective perceptions in immersive VR environments (Makransky et al., 2019; Parong & Mayer, 2018), this study did verify that the pupils exhibited stronger perceived immersion and positive attitudes toward virtual learning in the immersive setting than in the projective setting. However, in contrast to those studies (Makransky et al., 2019; Parong & Mayer, 2018), the pupils in this study were cognitively benefited more by actively exploring in the immersive learning environments than by passively observing the virtual learning content (e.g., panoramic scenes) through traditional projection screen. To understand what factors may influence the pupils' cognitive performance during immersive virtual field trips, we are continuing to collect more research data in elementary classrooms for the examination of structural relationships among the affective (e.g., curiosity or motivation) and cognitive (e.g., conceptual knowledge or transfer of learning) variables. Qualitative data such as teachers' perceptions of immersive virtual field trips in classrooms was also our attempt of virtual learning research in the future.

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