Investigating the Relationship Between Students' Preferred Learning Style on Their Learning Experience in Virtual Reality (VR) Learning Environment

Shiva Pedram[1(✉)], Sarah Howard[2], Ken Kencevski[3], and Pascal Perez[1]

[1] SMART Infrastructure Facility, Faculty of Engineering and Information Sciences, University of Wollongong, Wollongong, Australia
spedram@uow.edu.au
[2] School of Education, Faculty of Social Science, University of Wollongong, Wollongong, Australia
[3] Devika, University of Wollongong, Wollongong, Australia

Abstract. This study aims to investigate the effects of a virtual reality (VR)-based learning environment on learners with different preferred learning styles by measuring various dimensions of technology mediated approach. The learning outcomes were measured through academic performance, and affectively through "learning experience" and "perceived learning". "Learning experience" in VR was measured through perceived realism, immersion, interaction, presence, engagement, enjoyment, ease of use, usefulness, technology functionality, task-technology fit and attitude towards using the technology. A pretest-posttest design was employed for this study. Students were categorized based on their preferred learning style and their responses were compared. Results presented here are based on data collected from 130 students (grade 5–11) in NSW, Australia. As the result of our analysis indicates, regardless of students' preferred learning style, students similarly benefited from VR and their learning experience and learning outcome did not differ significantly.

Keywords: Virtual Reality · Experiential learning · Learning style · Education · STEM · Technology-mediated · Learning

1 Introduction

Advanced technologies such as Virtual Reality (VR) have gained renewed popularity as a teaching platform among educators and schools, allowing students to learn and experience dangerous, expensive and inaccessible events. Even though virtual reality as a training and teaching platform has proven useful over the years in different industries (flight, surgery, and driving simulators to name a few), these three-dimensional virtual environments are currently not widely utilized in the education sector [1]. However, the trend is changing and the use of computer simulations as learning environments, has progressively embraced technological innovations from chart-based interfaces to fully immersive environments [2].

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As educational technologies are pushing their ways into the schools, there have been few studies investigating the relationship between different individual's preferences for learning on how they interact with VR environment. Hwang [4] and Lee et al. [3] investigated the effects of a virtual reality (VR) based learning environment on learners with different learning styles. In both studies, they confirm that VR-based learning environment offers promise in accommodating individual differences pertaining to learning styles and there was no difference between students' "cognitive knowledge gain". To complement previous studies, in this study we are focusing on students' "learning experience" and we are going to investigate the relationship between students' preferred learning style and their "learning experience" in VR. Students' perceived "learning experience" in VR is going to be measured through: their perceived "realism", "immersion", "interaction", "ease of Use", "usefulness", "functionality", "task technology fit", "attitude towards the technology", "presence", "engagement", "enjoyment", "stress and worry", "task characteristics". Then students learning experience will be compared based on their preferred learning style.

2 Experiential Learning and VR as a Teaching Platform

Dewey [5] believed learning best occurred through direct experience with the learning environment and content. Effective learning experiences are characterized as active experiential, situated, problem-based, capable of providing immediate feedback [6] and high level of engagement [7]. Realistically, true experiential learning is difficult in many cases and/or significantly limited. VR technologies allowing direct interaction with environments and content through virtual spaces and objects, and it is predicted to enhance the possibility of delivering experiential learning [8].

The greatest capability of VR is in creating "experiences" close to real life events. Mikropoulos [8] defined VR learning environment "as a virtual environment that has one or more educational objectives, pedagogical metaphors, provides users with experiences they would otherwise not be able to experience in the physical world and leads to the attainment of specific learning outcomes" (p. 198). To capture students' learning experience in VR, the factors affecting the learning experience in VR environment are extracted from the body of knowledge.

The objective characteristics of VR is "Immersion" [9] and immersion is what makes it possible to experience and be included in. Skarbez et al. [10] stated that immersion enables presence in VR environment. Sense of "Presence" enhances the students' firsthand experience [11] and first-hand experience happens when students' can directly "Interact" with the virtual or real world. Sense of presence encourage trainees to "Engage" and transform them to be active participants of virtual world [8]. Besides to that, based on Technology Acceptance Model (TAM) and Task-Technology Fit (TTF) technology must be "Easy to use", "Useful" and "Fit the task (Task Technology Fit)" in order for users to "Enjoy" their interaction and experience to ultimately engage with the task to achieve the expected outcome. Contrary, if students feel excessively "Distress and Worry" due to finding the technology hard to use or the learning material hard that would adversely affect their learning process.

Having said that, Kolb [15] argues that people learn in different ways according to their preferred learning style. The 'learning-style' of every learner indicates his/her cognitive trends [12]. This is supported by constructivism where constructivists believe that learning is dependent upon the learner's ability to analyze, synthesize and evaluate information to create meaningful, personalized knowledge [13]. Since learners vary in their cognitive or learning styles, they also benefit from those teaching techniques that appeal to their individual styles [14]. Experiential Learning Theory (ELT) defined nine different learning styles as: (1) Initiating, (2) Experiencing, (3) Imagining, (4) Acting, (5) Reflecting, (6) Deciding, (7) Thinking, (8) Analyzing and (9) Balancing [15]. ELT emphasizes that learning style is not a fixed psychological trait but a dynamic state resulting from synergistic transactions between the person and the environment [15]. The stability and endurance of these states in individuals comes from consistent patterns of transaction between the individual and his or her environment. This highlights the importance of learning environment. This study aims to investigate the relationship between students' "learning preferences" and their "learning experience" in VR. Therefore, firstly students' "learning experience" and the "outcomes" of, Virtual Reality (VR) teaching session will be measured and then students' responses will be compared based on their preferred learning style.

3 Methodology

3.1 Participants

The participants of this study were 130 students from five different public and private schools in NSW, Australia. The participants were boys and girls and they were in grade 5 to 11 (Table 1). The students were randomly selected by their teachers and researcher had no control over selecting the participants.

Table 1. Sample distribution

Year	# Students	Schools participated in this study
Year 5	38	(28 students from school 1, 10 students from school 2)
Year 6	18	(18 students from school 3)
Year 8	10	(5 students from school 4 and 5 students from 5)
Year 9	15	(11 students from school 5 and 4 students from St 4)
Year 10	40	(20 students from 5 and 20 students from school 4)
Year 11	9	(9 students from school 4)

3.2 Scenario

In this study students experienced the Antarctic and learnt how to interact with penguins (Fig. 2). The content was developed by Australian Company (Devika) and delivered via the virtual reality headset HTC VIVE (Fig. 1). The scenario is extracurricular and mapped to the Australian school curriculum. The Antarctic scenario

Fig. 1. Student experiencing VR

Fig. 2. Antarctic scene in VR

begins where a scientist will introduce the topic and explain the reasoning for their presence, their significance with the ecology, and some of the activities that take place. The scenario teaches students about Antarctica by placing them in a VR experience that requires them to listen to a scientist in Antarctic. This is done by having the students complete a series of tasks such as photographing penguins with the aid of a narrator.

3.3 Procedure

A pretest-posttest design was employed for this study.

Pre-test Phase

(i) Prior to the experience content related questions were distributed: The aim is to assess students' knowledge level about penguins, Antarctic and climate change prior attending the learning session in VR. They were asked to answer six questions related to the scenario, such as: "What is the average temperature in Antarctic?" Or "What is the effect of climate change on penguins?" The total score of each content related test was 6.

(ii) Prior to the experience KLS v4 [7]. Inventory was distributed: The aim is to assess students' preferred learning style prior exposure to VR. A participant who took this test needed to complete 12 sentences that described learning. Each item had four endings and the participants were required to rank these endings according to how well he or she thought each ending described the way he or she learned. The scores were calculated to determine the dominant type of learning style for each participant.

Post-test Phase

(i) After the experience post-experience questionnaire was distributed: 5–10 min After the learning experience in VR, a post-training questionnaires was distributed (10-likert scale where 0 was highly disagree, 10 was highly agree and 5 in middle was neutral), to measure students experience in VR. The items in this questionnaire are taken from standard questionnaires.

(ii) After the experience, Content related questions were distributed again: in order to measure students' knowledge gain the content related questions were repeated within one-hour timeframe of the first test.

4 Result and Discussion

4.1 Gain Score and Preferred Learning Style

From the survey result (subjective analysis), 74% of students (95 students out of 124) reported that they have learned from VR experience and they know more about penguins, Antarctic and climate change after VR experience (perceived learning score was 7, 8, 9 or 10 out of 10). Additionally, the result of content related (pre and post test) reveals that students' performance enhanced by 37%. Moreover, one-way ANOVA was performed to see whether statistically there is a significant difference between students' gain score with respect to their preferred learning styles. As the result of analysis indicated there was no significant difference between the mean scores ($p > 0.05$) and regardless of students' preferred learning style they have opportunity to benefit from a VR experience.

4.2 Learning Experience in VR and Preferred Learning Style

Correlation between factors measured after the VR learning experience indicates that the measured factors are statistically significant and correlated with perceived learning, also there is a correlation within these factors which is going to be discussed in our next paper. In Table 2, ATU is (Attitude Toward Use), TTF is (Task Technology Fit) and TC is (Task characteristics).

Then, one-way ANOVA was performed to see whether students' who have different preferred learning styles are having different learning experience in VR. The result of analysis indicated that statistically there were no significant difference ($P > .05$) between students and it is safe to claim there is no relationship between students' preferred learning style and "learning experience" in VR.

Table 2. Correlation table between learning and factors affecting learning experience

	Realism	Immersion	Interaction	Ease of use	Usefulness	Functionality
Learning	.536	.575	.663	.563	.771	.815
p value	.000	.000	.000	.000	.000	.000

	ATU	TTF	Presence	Engagement	Enjoyment	Stress	TC
Learning	.653	.789	.646	.672	.717	-.545	.724
p value	.000	.000	.000	.000	.000	.000	.000

5 Discussion and Conclusion

Game play provides learners the opportunity to learn by doing and though role-play, enhancing students' learning outcome (e.g. [16]), our findings also suggest this view. In this study, students played the role of scientists in VR, and as our subjective (perceived learning) and objective (results of content related questions) analysis revealed, students' knowledge level enhanced. Our knowledge test was short and there was not enough time lag between two tests, but hat being said, the result of our analysis indicated that there was no relationship between students' preferred learning style and students' knowledge gain. Lee et al. [3] also, reported the same findings that, there was no significant difference in the cognitive and affective learning outcomes for students with different learning styles in the VR-based learning environment.

Moreover, the result of correlation indicated that there is a relationship between students' knowledge gain in VR and students' "learning experience" through perceived sense of presence, immersion, realism, interaction and affective factors including perceived sense of enjoyment, engagement, usefulness and attitudes towards using technology. However, our findings indicates that there is no relationship between students' "preferred learning style" and their "learning experience" in VR. Therefore, based on our findings and the trend we observed in students' performance after VR session and their positive perception of "learning experience" in VR, educators and decision makers are encouraged for future investigation in VR integration into classrooms.

References

1. Dholakiya, N.D., Ferjencik, M., Schofield, D., Kubík, J.: Virtual learning for safety, why not a smartphone? Process Saf. Prog. **38**(2) (2019)
2. Bell, P.C., Taseen, A.A., Kirkpatrick, P.F.: Visual interactive simulation modeling in a decision support role. Comput. Oper. Res. **17**, 447–456 (1990)
3. Lee, E.A.L., Wong, K.W.: Learning with desktop virtual reality: low spatial ability learners are more positively affected. Comput. Educ. **79**, 49–58 (2014)
4. Hwang, G.J., Wu, P.H., Chen, C.C.: An online game approach for improving students' learning performance in web-based problem-solving activities. Comput. Educ. **59**(4), 1246–1256 (2012)
5. Dewey, J.: Democracy and Education. Macmillan Company, New York (1916)
6. Ketelhut, D.J., Schifter, C.C.: Teachers and game-based learning: improving understanding of how to increase efficacy of adoption. Comput. Educ. **56**(2), 539 (2011)
7. Park, B., Plass, J.L., Brünken, R.: Cognitive and affective processes in multimedia (2014)
8. Mikropoulos, T.A., Natsis, A.: Educational virtual environments: a ten-year review of empirical research (1999–2009). Comput. Educ. **56**(3), 769–780 (2011)
9. Slater, M.: Measuring presence: a response to the witmer and singer presence questionnaire. Presence: Teleoper. Virtual Environ. **8**(5), 560–565 (1999)
10. Skarbez, R., Brooks Jr., F.P., Whitton, M.C.: A survey of presence and related concepts. ACM Comput. Surv. (CSUR) **50**(6), 96 (2018)
11. Winn, W., Jackson, R.: Fourteen propositions about educational uses of virtual reality. Educ. Technol. **39**, 5–14 (1999)

12. Nawaz, A., Kundi, G.M.: From objectivism to social constructivism: the impacts of information and communication technologies (ICTs) on higher education. Int. J. Sci. Technol. Educ. Res. **1**(2), 30–36 (2010)
13. Phillips, P., Wells, J., Ice, P., Curtis, R., Kennedy, R.: A case study of the relationship between socio-epistemological teaching orientations and instructor perceptions of pedagogy in online environments. Elect. J. Integ. Technol. Educ. **6**, 3–27 (2008). http://ejite.isu.edu/. 6 (1). Accessed 10 Apr 2007
14. Cagiltay, N.E., Yildirim, S., Aksu, M.: Students' preferences on web-based instruction: linear or non-linear. J. Edu. Technol. Soc., **9**(3): 122–136 (2006). http://www.ask4research.info/. Accessed 10 Apr 2007
15. Kolb, D.A.: The kolb learning style inventory 4.0: guide to theory, psychometrics, research and applications (2013)
16. Annetta, L.A., Minogue, J., Holmes, S.Y., Cheng, M.T.: Investigating the impact of video games on high school students' engagement and learning about genetics. Comput. Educ. **53** (1), 74–85 (2009)