So, H. J. et al. (Eds.) (2020). Proceedings of the 28th International Conference on Computers in Education.
Asia-Pacific Society for Computers in Education

Co-Creation of Structure Visualization with Virtual Reality in On-Line Communities: An Analysis of Student Engagement

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Abstract: This study investigated student engagement in paper-based, digital 2D, and VR co-creation environments. The study utilized a quasi-experimental research design with 66 tenth-grade students in two EFL classes in northern Taiwan. The results showed insignificance of co-creation platforms for behavioral and cognitive engagement. However, VR co-creativity resulted in significance in emotional engagement, due to its novel and immersive nature. The study suggested that co-creation be a long-term project for thorough idea synthesis lest the essence and strength of co-creation be under-estimated.

Keywords: Co-Creation, Virtual Reality, Student Engagement

1. Introduction

Virtual reality (VR), with presence, interactivity, and immersion (Ryan, 2015), has proved value in conceptualizing abstract environments (Lamb, 2014), activating cognitive attributes (Lamb, 2014), and improving retention and efficacy for novel information (Freina & Ott, 2015). For social constructivists, VR creation could further turn traditional drill-driven instruction into contextualized inquiry learning where authentic contexts stimulate situativity in knowledge development.

VR co-creation, distinguished from collaboration in high equity and shared leadership for collective wisdom, has shown positive outcomes in subject-matter comprehension (Bertolini et al., 2018), increased self-awareness (Lubicz-Nawrocka, 2018), and improved collaborative skills (Blau & Shamir-Inbal, 2017). Moreover, it has sparked a reading pedagogical shift where student engagement is featured (Rapp et al., 2007).

Student engagement, referring to learners' physical or mental participation for expected academic outcomes (Sun & Rueda, 2012), is specified as behavioral, emotional, and cognitive, each encompassing diversified activity involvement, emotional responses, and psychological efforts in learning (Fredricks, Blumenfeld, & Paris, 2004).

Student engagement helps learners to be goal-oriented, which in turn increases their chance for learning success (Bakker et al., 2015). However, to date, little research has investigated student engagement in VR co-creativity. To fill in the gap, this study explored the effects of on-line real-time VR co-creation on student engagement for creative structure visualization in EFL classrooms. The research model of this study is shown in Figure 1.

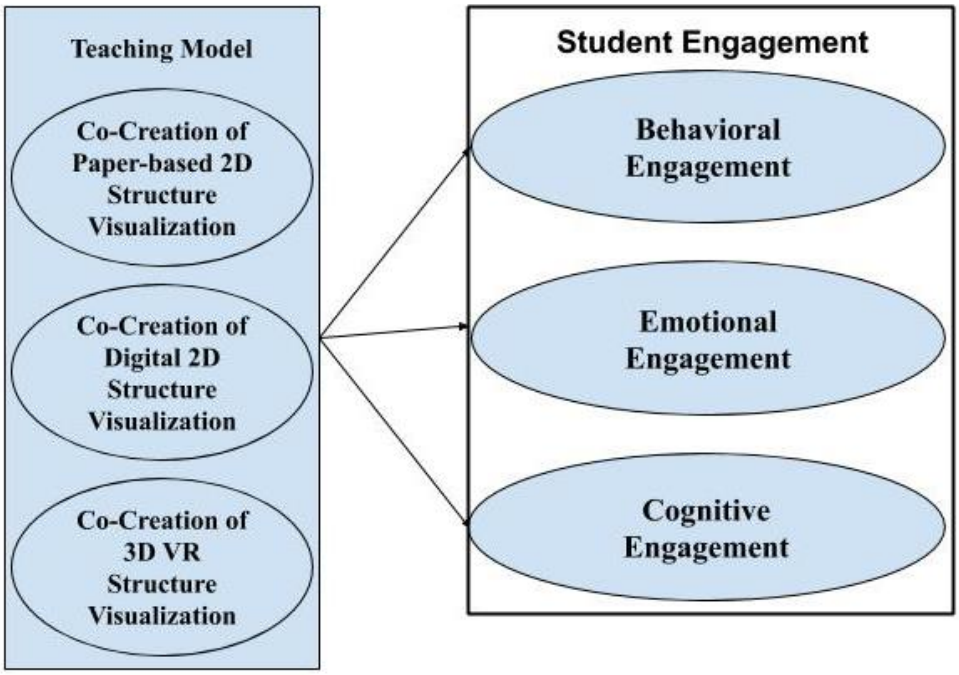


Figure 1. Research Model.

2 Materials and Methods

2.1 Participants

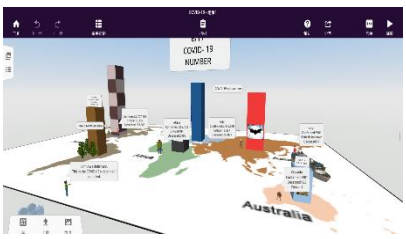
This quasi-experimental research was conducted in 2020 and involved one teacher and 66 tenth-grade students in two English classes from a public senior high school in northern Taiwan. To assess the effects of the paper-based, digital 2D, and VR platforms, the classes were divided into Control Group, Experimental Group A, and Experimental Group B, with a valid sample of N= 22 for each.

2.2 Methods and Instructional Design

The experimental process is shown in Figure 3. Session 1 involved the pre-test on student engagement and reading strategy training. Session 2 involved genre reading instruction: text-based and numerical reports. To visualize the global reading structure, Control Group performed paper-based co-creation, while Experimental Group A and B respectively used Google Jamboard and CoSpaces for digital 2D and VR co-creation (See Figure 2). The experiment ended in Session 3 with the post-test on student engagement.

Control Group

Experimental Group A



Experimental Group B

Figure 2. Co-Creation Interfaces of the Various Groups.

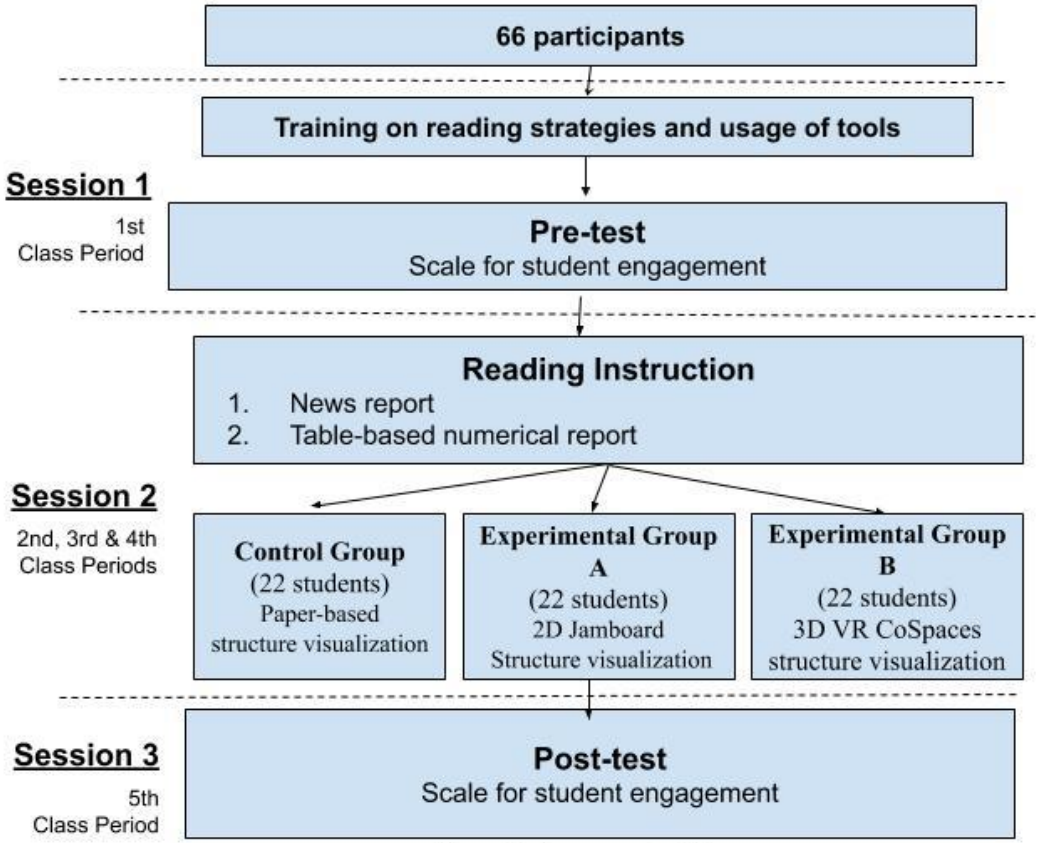


Figure 3. The Experimental Flow.

2.3 Instruments

The student engagement scale, based on Fredricks, Blumenfeld, Friedel, and Paris (2005), with reference to that of Sun (2014), was a 6-point Likert scale with five questions for behavioral, six for emotional, and eight for cognitive engagement. In terms of reliability of the post-test scores, the Cronbach's alpha value for the scale was .91, while the reliability of the constructs had scores of .55–.93, indicating an acceptable to excellent overall internal consistency (George & Mallery, 2003).

2.4 Digital Co-Creation Platforms: Google Jamboard and CoSpaces

In this study, Google Jamboard presented digital 2D structure visualization, whereas CoSpaces enabled learners to co-create immersive scenarios that could be explored virtually using cardboard headsets. Both allow real-time co-creation. Coding within CoSpaces stimulates creativity for turning abstract to concrete by programming objects to follow instructions.

3 Results and Discussion

Analysis of covariance (ANCOVA) in SPSS 20 was performed on the post-test for student engagement to identify between-group differences, with the pre-test as the covariant, the post-test as the dependent variable, and the co-creation mode as the fixed factor. For student engagement, the effect of interaction between the covariates and variables was not significant (F=2.57, p= .086), nor was the homogeneity hypothesis test result for intra-group variance.

Table 1. *Summary of Covariance Analysis for Student Engagement*

Source of variance	SS	*df*	MS	*F*	*p*	Partial η^2
Covariates	.899	1	.899	2.74	.10	4.5%
Inter-group	1.54	2	.77	2.35	.11	7.5%
Intra-group	19.01	58	.33			
Overall	21.60	61				

As shown in Table 1, the overall student engagement revealed no significant differences among the co-creation platforms. Specifically, the covariate failed to significantly predict the dependent variable (F=2.74, p= .10), suggesting the post-test on student engagement was not influenced by the pre-test. Moreover, with the pre-test effect removed, the effect of the co-creation mode was not significant (F=2.35, p= .11), connoting the insignificance of the co-creation platforms on the post-test.

Further ANCOVA results on the three constructs were reported in Table 2. The effect of the co-creation mode was insignificant in behavioral engagement (F=1.01, p= .32) and in cognitive engagement (F= .29, p= .75); the post-tests on the two constructs were not influenced by the co-creation platforms. However, emotional engagement was greatly affected by the co-creation mode (F=6.25, p= .003). Specifically, VR CoSpaces was the most influential, followed by the Jamboard and paper-based co-creation environments respectively.

Table 2. *Summary of Covariance Analysis for the Constructs of Student Engagement*

Constructs	*F*	*p*	Post-hoc
Behavioral engagement	1.01	.32	
Emotional engagement	6.25	.003	(3) > (2) (2) > (1)
Cognitive engagement	.29	.75	

Note. (1) = Control Group; (2) = Experimental Group A; (3) = Experimental Group B

Insufficient co-creation time might account for insignificance in the behavioral and cognitive constructs. As Jensen (2008) proposed in brain-based learning, the development of cognitive attributes and preferred learning modality takes considerable time. Contrarily, emotional responses would be more easily aroused especially in VR owing to its novel, immersive, and experiential nature.

4 Conclusion and Implications

The study investigated student engagement in online real-time VR co-creativity in EFL classrooms. Based on the ANCOVA results, the effect of the co-creation platforms was not significant on behavioral and cognitive engagement. However, emotional engagement was significantly influenced by the co-creation spaces, among which VR CoSpaces was most emotionally engaging.

The study suggested that VR co-creation for collective intelligence be a semester-long project, instead of a short-term activity for transient effects, lest co-creators fail to reach consensus and the strength of co-creation tools be under-estimated.

In conclusion, co-creation evaluation shall include both quantitative and qualitative data. Open-ended interviews and interaction logs are recommended to complement empirical analysis for comprehensive insights towards co-creation essence.

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