Exploring the Effects of Integrating SVVR Into High School History on Students' Self-Efficacy, Learning Behavior, and Learning Performance

Chia-Ling Wu, National Taiwan University of Science and Technology, Taiwan
Hui-Xin Chen, National Taiwan University of Science and Technology, Taiwan
Shuo-Jung Hsu, National Taiwan University of Science and Technology, Taiwan

The Asian Conference on Education 2024
Official Conference Proceedings

Abstract
Previous studies show that VR immersion effectively enhances students' curriculum integration, content understanding, self-efficacy, learning behaviors, and performance. In this study, the impact of creating a VR course related to historical homes tours through Uptale is expected to enhance students' self-efficacy, learning behaviors, and learning performance. The initial test was conducted by recruiting 22 graduate students. Comparison of 2D video and SVVR to test the effectiveness of the software. This experiment explored the SVVR group's self-efficacy, learning behaviors, and learning performance through the results of the Achievement Test in History, and analyzed the effects of SVVR on the learning of historical through descriptive statistics and t-tests. The statistical results show that although there is no significant difference between the two groups, it can be seen that the value of the SVVR group is still higher than that of the 2D film group. It is expected that SVVR teaching will be extended to senior high schools and used in curriculum teaching, and experiments and interviews will be conducted in the hope that effects such as enhanced learning concentration can be facilitated for use in other subjects or professional training programs.

Keywords: Virtual Reality (VR), Self-Efficacy, Learning Behaviors, Learning Performance

Introduction

Research Motivation and Background

Virtual reality (VR) is increasingly being utilized in the domains of education and learning (Zawacki-Richter & Latchem, 2018). Spherical video-based virtual reality (SVVR) serves as a notable example, as it immerses users in realistic scenarios, thereby offering an engaging experience (Elmezeny et al., 2018; Jong et al., 2018). This technology can be implemented using cost-effective or more accessible VR solutions. The application of SVVR spans a wide range of areas, including science education (Yang et al., 2024), library guide (Lin et al., 2019), English language acquisition (Huang et al., 2023), engineering education (Lingli, 2023), teacher training (Pitura et al., 2024), and nursing education training, among others (Chang et al., 2022). Research suggests that SVVR promotes a learning style that enhances student interest, motivation, and academic performance (Geng et al., 2018). Additionally, it has the potential to complement traditional pedagogical approaches, introduce novel concepts, and deepen students' comprehension of content while simultaneously increasing their motivation to learn (Huang, et al., 2020; Lin et al., 2019). However, practical opportunities for students to engage in field trips are often constrained by factors such as time, distance, cost, safety, and the complexities of real-world environments (Geng et al., 2021; Çaliskan, 2011), which may adversely affect their learning interests and opportunities for experiential practice. Furthermore, there is a paucity of research focusing on tours of historical homes within the context of social studies. Consequently, we propose a further investigation to explore the integration of SVVR into senior secondary history education, specifically examining its effects on students' self-efficacy, learning behaviors, and academic performance.

Research Purposes

The main purpose of this study is to allow users to experience a learning experience that is different from traditional learning during the game, and to experience historical situations without being limited by time and space, thereby enhancing students' interest in learning. This study aims to enhance students' interest in learning. Since most senior high school history lessons are typically delivered in a conventional textbook format, students often struggle to develop a profound understanding of the temporal and spatial contexts of historical periods. The purpose of this study is to explore the impact of SVVR learning on students' self-efficacy, learning behavior and academic performance. By enhancing students' sense of self-efficacy, we hope that they will be more confident in handling learning challenges, thereby cultivating positive learning behaviors. In addition, we expect that immersive learning will promote a deeper understanding of history and culture while enhancing interactive learning experiences, resulting in improved academic performance. Researchers believe that this teaching method can present the best interactive and immersive learning, make students better understand history and culture, and provide them with a more interesting and effective learning experience.

Research Questions:

1. What is the effect of self-efficacy on students using SVVR versus 2D Video learning?
2. What is the effect of learning behaviors on students using SVVR versus 2D Video learning?
3. What is the effect of learning performance on students using SVVR 2D Video learning?

Literature Review

Virtual Reality (VR)

Virtual reality (VR) is a new media technology that brings a sense of real presence through computer simulation of a 3D virtual world. It is regarded as an innovative teaching method in learning (Gadelha, 2018). With its 360-degree panoramic immersion, VR allows users to feel as though they are in a genuine environment (Elmezeny et al., 2018; Jong et al., 2018). Chen (2016) pointed out that through appropriate learning design, VR can help students develop more complex and higher-level thinking skills, while improving students' learning motivation, problem-solving ability, opinion expression skills, and strengthening critical thinking Sexual thinking and self-efficacy (Meyer et al., 2019).

The Influence Between Self-Efficacy and Learning Behaviors of SVVR

With the rapid development of technology, VR has been widely used in online courses. This study chose to use spherical video-based virtual reality (SVVR) in course learning. SVVR is VR that uses 360-degree panoramic photos or videos. SVVR has been used in teaching a variety of subjects and has been proven to be effective in influencing students' learning behavior. Research indicates that this kind of course can stimulate students' interest in learning, improve students' learning motivation and learning performance (Geng et al., 2018), and improve academic performance. Research has proven that compared with the learning satisfaction of students who use traditional teaching and students who use SVVR to learn, students who use SVVR to learn achieve better learning satisfaction.

The Impact Between Learning Behaviors and Learning Performance of SVVR

SVVR provides multi-sensory stimulation and allows learners to experience a high degree of interactivity (Chang et al., 2019). Its convenience, interactivity, and contextualized experiences hold great potential for the educational field (Ye et al., 2019). Traditional classroom instruction often struggles to effectively capture learners' attention, which frequently leads to deficiencies in problem-solving and critical thinking skills (Durham, 2015). SVVR can arouse students' interest and motivation to learn through the interaction in the scene. Gilliam et al (2017) pointed out that learning in an authentic learning environment is of certain importance and helps improve students' academic performance in the subject. Chang et al. (2017) introduced SVVR teaching into the natural science geology course in primary schools and used a two-tier testing strategy to improve students' learning performance. Research results show that this teaching method not only improves students' learning performance and motivation but also enables them to learn how to solve problems more proactively.

Self-Efficacy

Self-efficacy refers to an individual's subjective beliefs and feelings regarding their ability to organize and achieve specific competencies (Bandura, 1997). In this study, self-efficacy is operationally defined by the scores of participants on the General Self-Efficacy Scale (GSES), developed by Zhang and Schwarzer (1995). The GSES consists of 10 questions designed to measure an individual's confidence in facing setbacks and solving problems. A higher score on the scale indicates greater self-efficacy, while a lower score reflects diminished self-efficacy.

Post-experiential Immersion Experience Scale

In the study of Jennett et al. (2008), they explored the personal emotional aspect and observed the changes of users during the immersion process through three different experimental situations and proposed the "Immersion Experience Scale after Experience Activities" to make the immersion experience visible. Quantitative testing, this scale contains six aspects and is divided into: 1. Attention: refers to the degree to which the subject is devoted to the interactive navigation system; 2. Temporal dissociation: refers to the subject's degree of concentration Ignore the surrounding things or forget about the passage of time, and only focus on the interactive navigation system; 3. Transportation: refers to the degree to which the subject feels after experiencing the interactive navigation system; 4. Challenge): refers to the subject's level of challenge to the interactive navigation system; 5. Emotional involvement: refers to the degree to which the subject invests his/her emotions in the interactive navigation system; 6. Enjoyment (enjoyment): refers to the subject's level of challenge Experience the level of enjoyment that comes with an interactive tour system.

Methodology

Research Structure

This study employs a quasi-experimental design utilizing the Uptale system to examine the effects of integrating Spherical Video-based Virtual Reality (SVVR) into history instruction for senior secondary school students. The experimental group will engage with SVVR for their learning, while the control group will receive traditional teaching methods. The study's content will feature a guided tour of a historical home relevant to high school curriculum. By interacting with the system in a virtual reality environment, students can develop a deeper understanding of historical figures and their contexts. An overview of the entire study is presented in Figure 1 below.

While the course design of this study was intended for senior secondary school students, postgraduate students were selected as the subjects for this experiment. The goal was to help the courseware designers understand the optimization needs of the SVVR courseware design, allowing them to better grasp the key considerations and precautions necessary for the design of such courseware when it is implemented in other training programs in the future.

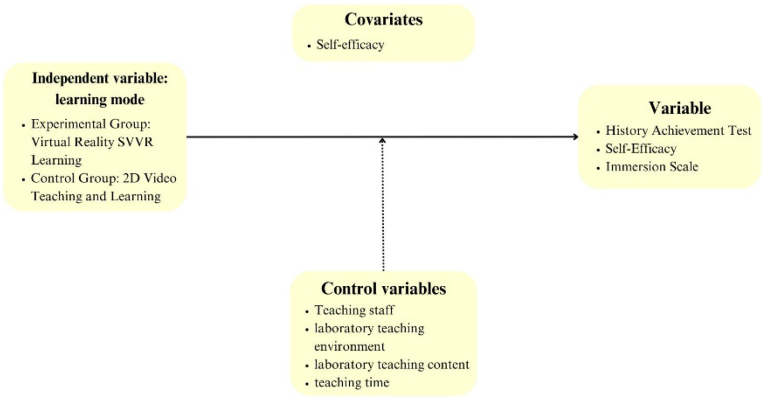

Figure 1: Research in Disguise

System Architecture and Process

This research uses the Uptale system as a development tool. Learners conduct guided tours of historical residences through the SVVR game. They enter the game screen at the beginning, learn historical knowledge through interactive objects (such as videos, slides, voice recognition, tests, etc.) and complete stars (task rewards). collect. Teachers can use the system to check whether students' learning effectiveness and learning behaviors have improved, so as to adjust the teaching material design. Teachers can use the system to evaluate students' learning effectiveness and monitor improvements in their learning behaviors, allowing them to adjust the design of teaching materials accordingly. As shown in Figure 2 below.

Figure 3 below is the research flow chart of this experiment. The entire experiment was conducted according to the following flow.

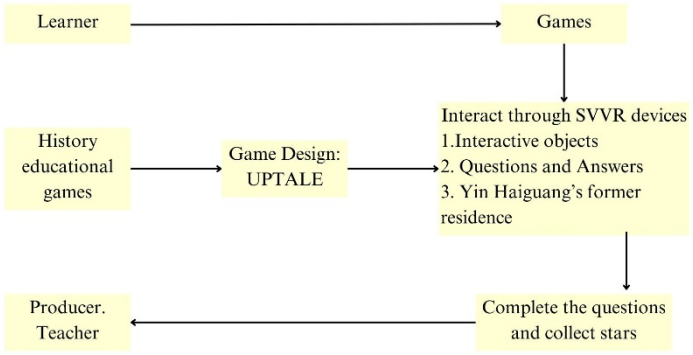

Figure 2: Teaching Material Design Structure

Experimental Flow Chart

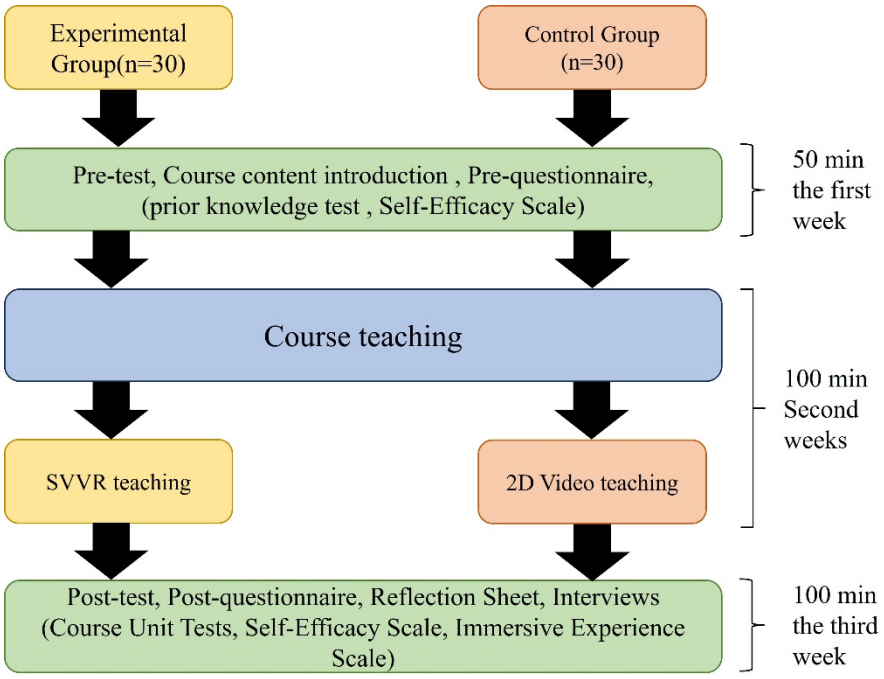

Figure 3: Experimental Flow Chart

Research Object

A total of 22 graduate students from a national university of science and technology in Taiwan participated in a three-week experiment. The subjects did not require prior knowledge and were divided into an experimental group and a control group. The experimental group utilized SVVR for learning, while the control group received instruction through 2D video teaching.

Experimental Design

The following six pictures are the game screens of the SVVR teaching materials, namely Figure 4, Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9. Figure 4 is the first scene when learners enter the screen. Learners can get a preliminary understanding of Yin, Hai Guang's introduction in this scene. Figure 5 further presents Yin, Hai Guang's relevant information through pictures and text, and there are similar introductions in subsequent scenes.

Figure 6 is in Scene 3, which shows important scenes leading to various parts of the former residence, and includes photos and newspaper introductions related to Yin, Hai Guang. The video in Figure 9, also located in this scene, mainly introduces Yin, Hai Guang's life story and the reasons why he lives here.

Figure 7 is a question-and-answer area set up during the learning process, giving users the opportunity to learn more about Yin, Hai Guang's deeds. When the questions are answered correctly, the user can collect the stars needed to complete the level. Figure 8 introduces Yin, Hai Guang's political philosophy through voice. After the introduction, you can give a voice answer. Those who answer correctly can unlock the opportunity to go to other scenes.

Gameplay

Figure 4: SVVR Scene 1

Figure 5: Introduction of Yin, Hai Guang's Former Residence

Figure 6: Scene 3 and photo

Figure 7: Question

Figure 8: Photo and Voice Tour

Figure 9: Video

Research Results

Independent Two-Sample t-Test

This study adopted a quasi-experimental design. Two sets of independent sample t-tests were used for quantitative analysis in order to explain the differences in learners' prior knowledge and experience during the self-efficacy pre-test. This method can effectively ensure that researchers can exactly value the differences between the experimental group and the control group when conducting post-test analysis results.

Differences in Self-Efficacy Between Learning Styles

An independent samples t-test was conducted using the learning method as the independent variable and self-efficacy as the dependent variable. The results are presented in Table 1. The t-test analysis of the average self-efficacy pretest scores for different learning methods revealed that t(20)=0.97, p=.17 (p>.05). This indicates no significant difference in self-efficacy between the SVVR group (M=3.12, SD=0.37) and the 2D Video group (M=2.91, SD=0.62). Therefore, the pretest results show that the self-efficacy of participants learning history courses through SVVR and 2D Video is not significantly different.

Table 1: The t-Test Analysis of Pre-test Averages for Self-Efficacy Across Different Learning Methods

	n	*M*	*SD*	*t*
SVVR	11	3.12	0.37	0.97
2D Video	11	2.91	0.62	

*p< .05; **p<.01

Independent samples t-test analyses were conducted with learning methods as the independent variable and self-efficacy as the dependent variable. The results of the study are presented in Table 2. The t-test analysis of the mean self-efficacy post-test scores for the different learning styles yielded t(20)=1.76, p=.07, which is greater than .05. This indicates that the self-efficacy scores for the SVVR group (M=3.38, SD=0.34) and the 2D Video group (M=2.95, SD=0.75) were not significantly different. Post-test analyses revealed no significant difference in self-efficacy between the SVVR and 2D Video groups as two distinct learning methods for the history course.

Likewise, statistical analysis of the posttest produced non-significant results, identical to those of the pretest. It is assumed that the lack of significant differences in the posttest can also be attributed to the small sample size and issues related to the scale design. Therefore,

the results regarding research question 1 indicate that the differences in self-efficacy between different learning methods are not significant.

Table 2: The t-Test Analysis of Post-test Averages for Self-Efficacy Across Different Learning Methods

	n	*M*	*SD*	*t*
SVVR	11	3.38	0.34	1.76
2D Video	11	2.95	0.75	

*p< .05; **p<.01

Differences in Learning Behaviors Across Learning Styles

Using learning method as the independent variable and learning behavior as the dependent variable, an independent sample t-test analysis was conducted. The research results are shown in Table 3. The t-test analysis of the average learning behaviors of different learning methods shows that t(20)=0, p=.14>.05, and it can be found that SVVR (M=3.39, SD=0.56) and 2D Video (M=3.39, SD=0.90) The two groups were not significant in the learning behavior section. According to the post-test analysis results, it was found that there was no significant difference in the learning behavior of the subjects regarding the two different learning methods of SVVR and 2D Video used in history courses.

The insignificant results from the above analysis may stem from the limitations of the equipment used in designing the SVVR teaching materials, which hindered the full presentation of details. As a result, students may not have had the opportunity to thoroughly understand the introduction of certain monuments and artifacts, thereby diminishing their sense of immersion. Additionally, the timely provision of guidance is crucial in the effective implementation of SVVR teaching materials. Due to the experimenter's inexperience in administering the guidance portion of the experiment, some students were uncertain about the content of the teaching materials, leading to incomplete levels of understanding.

Table 3: The t-Test Analysis of Average Learning Behaviors Across Different Learning Methods

	n	*M*	*SD*	*t*
SVVR	11	3.39	0.56	0.00
2D Video	11	3.39	0.90	

*p< .05; **p<.01

Differences in Learning Performance Between Learning Styles

Independent samples t-test analyses were conducted using learning methods as independent variables and learning performance as dependent variables. The results of the study are presented in Table 4. The t-test analysis of the mean learning styles across the different groups indicated that $t(20)=0.89$, $p=.87$, which is greater than .05. This finding suggests that there was no significant difference in the learning styles between the SVVR (M=71.82, SD=11.46) and 2D Video (M=67.27, SD=12.52) groups. Furthermore, the post-test analyses revealed no significant difference in the performance of participants using the two different learning methods, SVVR and 2D Video, in the history course.

Kolarik et al. (2024) utilized immersive virtual reality (IVR) in logistics process training and compared its effectiveness to a traditional paper-based test. The findings indicated that there

was no significant difference in the learning test results between the two groups involved in the experiment. Consequently, this statistic suggests that different learning methods do not necessarily impact students' test scores in the subject.

In the future, the design of teaching materials should focus on the connection between the topic and the curriculum. This approach will more effectively demonstrate whether the SVVR teaching materials are appropriate for this type of curriculum.

Table 4: The t-Test Analysis of Average Learning Performance Across Different Learning Methods

	n	*M*	*SD*	*t*
SVVR	11	71.82	11.46	0.89
2D Video	11	67.27	12.52	

*p< .05; **p<.01

Discussion and Conclusion

Discussion

In the first question, we compared the effects of self-efficacy between students who learned through SVVR and those who engaged in conventional learning. The lack of a significant difference may be attributed to the small number of participants and the inadequacy of the scale questions, which were not sufficiently tailored to the content of the subjects taught. Additionally, the number of response options in the scale design may significantly influence the results of subsequent statistical analyses. Utilizing a 4-point scale for the self-efficacy measure may yield insignificant results due to either the limited number of participants or the reduced choices available to respondents when completing the scale. Similarly, the post-test of self-efficacy produced non-significant results, mirroring those of the pre-test in the statistical analyses. It is presumed that the lack of significant difference in the post-test is also a consequence of the small sample size and issues related to the scale design.

As mentioned in Question 2, the lack of a significant effect on learning behaviors between the two groups of students utilizing different learning methods may be attributed to some participants in the SVVR group experiencing moderate dizziness during the experiment. Consequently, the experiment was conducted using a website operation method instead. These factors may have contributed to the absence of a significant difference in the learning behaviors of the two groups.

Previous studies have indicated that motion sickness is linked to individual visual-vestibular perception and conflicts in visual cognition, which can result in symptoms of motion sickness (Drummond, 2005; Golding, 2006).

In the research question three, which compares the impact of learning performance between two groups of students using different learning methods and those employing traditional learning, the results of the historical test indicated that there was no significant difference in the learning outcomes between the two groups. This lack of difference may be attributed to the design of the SVVR teaching materials, which did not align well with the test questions. Additionally, the students exhibited a low level of engagement with the film materials, leading to increased cognitive load and negatively impacting their learning performance.

Conclusion

Although there was no significant difference between the two groups in terms of self-efficacy pre-test and post-test, the mean values indicated that the self-efficacy of the SVVR group was higher than that of the 2D Video group. This suggests that the SVVR group experienced greater self-efficacy with this type of teaching method. When designing the SVVR teaching materials, it was necessary to adjust the number of scenes. During the experiment, participants became disoriented due to the excessive number of scenes and experienced moderate dizziness, which adversely affected their learning behaviors. In the future, by refining the teaching materials and utilizing improved devices, the incidence of dizziness can be minimized. Additionally, due to the small sample size and the discrepancies between the questions of the performance test questions and the teaching materials, the performance component of the performance test was not significant. Therefore, adjustments must be made to prevent similar issues in future when conducting the follow-up studies.

Acknowledgements

I would like to thank the graduate students who participated in the experiments, the professors and seniors who helped me with my questions, and the lab that provided me with the Uptale software and allowed me to create teaching materials. As a first-time postgraduate student, this seminar provided me with a valuable experience in learning how to conduct research and where to make improvements.

References

Alhalabi, W. (2016). Virtual reality systems enhance students' achievements in engineering education. *Behaviour & Information Technology*, *35*(11), 919-925. https://doi.org/10.1080/0144929X.2016.1212931

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Çaliskan, O. (2011). Virtual field trips in education of earth and environmental sciences. *Procedia-Social and Behavioral Sciences*, *15*, 3239-3243. https://doi.org/10.1016/j.sbspro.2011.04.278

Chang, C. Y., Sung, H. Y., Guo, J. L., Chang, B. Y., & Kuo, F. R. (2022). Effects of spherical video-based virtual reality on nursing students' learning performance in childbirth education training. *Interactive Learning Environments*, *30*(3), 400-416. https://doi.org/10.1080/10494820.2019.1661854

Chang, S. C., Hsu, T. C., Chen, Y. N., & Jong, M. S. Y. (2020). The effects of spherical video-based virtual reality implementation on students' natural science learning effectiveness. *Interactive Learning Environments*, *28*(7), 915-929. https://doi.org/10.1080/10494820.2018.1548490

Chang, S. C., Hsu, T. C., Kuo, W. C., & Jong, M. S. Y. (2020). Effects of applying a VR-based two-tier test strategy to promote elementary students' learning performance in a geology class. *British Journal of Educational Technology, 51*(1), 148–165. https://doi.org/10.1111/bjet.12790

Chen, Y. T., Li, M., Huang, C. Q., Han, Z. M., Hwang, G. J., & Yang, G. (2022). Promoting deep writing with immersive technologies: An SVVR-supported Chinese composition writing approach for primary schools. *British Journal of Educational Technology*, *53*(6), 2071-2091. https://doi.org/10.1111/bjet.13247

Chien, S. Y., Hwang, G. J., & Jong, M. S. Y. (2020). Effects of peer assessment within the context of spherical video-based virtual reality on EFL students' English-Speaking performance and learning perceptions. *Computers & Education*, *146*, 103751. https://doi.org/10.1016/j.compedu.2019.103751

Dahan, N. A., Al-Razgan, M., Al-Laith, A., Alsoufi, M. A., Al-Asaly, M. S., & Alfakih, T. (2022). Metaverse framework: A case study on E-learning environment (ELEM). *Electronics*, *11*(10), 1616. https://doi.org/10.3390/electronics11101616

Drummond, P. D. (2005). Triggers of motion sickness in migraine sufferers. *Headache: The Journal of Head and Face Pain*, *45*(6), 653-656. https://doi.org/10.1111/j.1526-4610.2005.05132.x

Durham, B. (2015). The nurse's role in medication safety. *Nursing2022*, *45*(4), 1-4. https://10.1097/01.NURSE.0000461850.24153.8b

Elmezeny, A., Edenhofer, N., & Wimmer, J. (2018). Immersive storytelling in 360-degree videos: An analysis of interplay between narrative and technical immersion. *Journal For Virtual Worlds Research*, *11*(1). https://doi.org/10.4101/jvwr.v11i1.7298

Gadelha, R. (2018). Revolutionizing education: The promise of virtual reality. *Childhood Education, 94*(1), 40–43. https://doi.org/10.1080/00094056.2018.1420362

Geng, J., Chai, C. S., Jong, M. S. Y., & Luk, E. T. H. (2021). Understanding the pedagogical potential of Interactive Spherical Video-based Virtual Reality from the teachers' perspective through the ACE framework. *Interactive Learning Environments*, *29*(4), 618-633. https://doi.org/10.1080/10494820.2019.1593200

Geng, J., Jong, M. S. Y., Luk, E., & Jiang, Y. (2018, July). Comparative study on the pedagogical use of interactive spherical video-based virtual reality: The EduVenture-VR experience. In *2018 international symposium on educational technology (ISET)* (pp. 261-263). IEEE. https://doi.org/10.1109/ISET.2018.00064

Gilliam, M., Jagoda, P., Fabiyi, C., Lyman, P., Wilson, C., Hill, B., & Bouris, A. (2017). Alternate reality games as an informal learning tool for generating STEM engagement among underrepresented youth: A qualitative evaluation of the source. *Journal of Science Education and Technology, 26*, 295–308. https://doi.org/10.1007/s10956-016-9679-4

Golding, J. F. (2006). *Motion sickness susceptibility. Autonomic Neuroscience, 129*(1–2), 67–76. https://doi.org/10.1016/j.autneu.2006.07.019

Gunn, T., Jones, L., Bridge, P., Rowntree, P., & Nissen, L. (2018). The use of virtual reality simulation to improve technical skill in the undergraduate medical imaging student. *Interactive Learning Environments*, *26*(5), 613-620. https://doi.org/10.1080/10494820.2017.1374981

Hollett, T., Luo, S., Turcotte, N., Ramsay, C., Stubbs, C., & Zidik, Z. (2020). Moments of friction in virtual reality: How feeling histories impact experience. *E-Learning and Digital Media*, *17*(1), 56-77. https://doi.org/10.1177/2042753019876043

Huang, H., Hwang, G. J., & Chang, S. C. (2023). Facilitating decision making in authentic contexts: an SVVR-based experiential flipped learning approach for professional training. *Interactive Learning Environments*, *31*(8), 5219-5235. https://doi.org/10.1080/10494820.2021.2000435

Huang, H. L., Hwang, G. J., & Chang, C. Y. (2020). Learning to be a writer: A spherical video-based virtual reality approach to supporting descriptive article writing in high school Chinese courses. British Journal of Educational Technology, 51(4), 1386–1405. https://doi.org/10.1111/bjet.12893

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International journal of human-computer studies*, *66*(9), 641-661. https://doi.org/10.1016/j.ijhcs.2008.04.004

Jong, M. S. Y., Luk, E. T. H., Leung, J. K. P., & Poon, S. S. K. (2018, October 7). EduVenture VR [Computer platform]. Centre for Learning Sciences and Technologies, The Chinese University of Hong Kong. http://vr.ev-cuhk.net/

Kolarik, S., Schlüter, C., & Ziolkowski, K. (2024). Impact of VR on learning experience compared to a paper based approach. *ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal, 12*. https://doi.org/10.14201/adcaij.31134

Kumar, A., Shankar, A., Shaik, A. S., Jain, G., & Malibari, A. (2023). Risking it all in the metaverse ecosystem: forecasting resistance towards the enterprise metaverse. *Information Technology & People*. https://doi/10.1108/itp-04-2023-0374

Lin, H. C. S., Yu, S. J., Sun, J. C. Y., & Jong, M. S. Y. (2021). Engaging university students in a library guide through wearable spherical video-based virtual reality: Effects on situational interest and cognitive load. *Interactive Learning Environments*, *29*(8), 1272-1287. https://doi.org/10.1080/10494820.2019.1624579

Lingli, W. A. N. G., Lehua, Q. I., Jianjun, J. I. A. N. G., Jun, L. U. O., & Bing, L. Y. U. (2023). VR Technology Applied in Engineering Practice Training Courses: A Case of Northwestern Polytechnical University's" VR Assembly Composite Practice Training Course". *Frontiers of Education in China*, *18*(4). https://doi.org/10.3868/s110-008-023-0032-2

Mayer, R. E. (2019). Computer games in education. *Annual Review of Psychology, 70*, 531–549. https://doi.org/10.1146/annurev-psych-010418-102744

Parong, J., & Mayer, R. E. (2021). Learning about history in immersive virtual reality: does immersion facilitate learning?. *Educational Technology Research and Development*, *69*(3), 1433-1451. https://doi.org/10.1007/s11423-021-09999-y

Pitura, J., Kaplan-Rakowski, R., & Asotska-Wierzba, Y. (2024). The VR-AI–Assisted Simulation for Content Knowledge Application in Pre-Service EFL Teacher Training. *TechTrends*, 1-11. https://doi.org/10.1007/s11528-024-01022-4

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, *147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Remolar, I., Rebollo, C., & Fernández-Moyano, J. A. (2021). Learning history using virtual and augmented reality. *Computers*, *10*(11), 146. https://doi.org/10.3390/computers10110146

Schwarzer, R., & Jerusalem, M. (1993). Measurement of Perceived Self-Efficacy: Psychometric Scales for Cross-Cultural Research. Berlin: Freie University.

Wang, H., He, M., Zeng, C., Qian, L., Wang, J., & Pan, W. (2023). Analysis of learning behavior in immersive virtual reality. *Journal of Intelligent & Fuzzy Systems*, (Preprint), 1-12. https://doi.org/10.3233/JIFS-231383

Wu, W. L., Hsu, Y., Yang, Q. F., Chen, J. J., & Jong, M. S. Y. (2023). Effects of the self-regulated strategy within the context of spherical video-based virtual reality on students' learning performances in an art history class. *Interactive Learning Environments*, *31*(4), 2244-2267. https://doi.org/10.1080/10494820.2021.1878231

Yang, Q. F., Lin, H., Hwang, G. J., Su, P. Y., & Zhao, J. H. (2024). An exploration-based SVVR approach to promote students' chemistry learning effectiveness. *Interactive Learning Environments*, *32*(5), 2003-2027. https://doi.org/10.1080/10494820.2022.2135106

Ye, X., Liu, P. F., Lee, X. Z., Zhang, Y. Q., & Chiu, C. K. (2021). Classroom misbehavior management: An SVVR-based training system for preservice teachers. *Interactive Learning Environments*, *29*(1), 112-129. https://doi.org/10.1080/10494820.2019.1579235

Zawacki-Richter, O., & Latchem, C. (2018). Exploring four decades of research in Computers & Education. *Computers & Education*, *122*, 136-152. https://doi.org/10.1016/j.compedu.2018.04.001

Zhang, J. X., & Schwarzer, R. (1995). Measuring optimistic self-beliefs: a Chinese adaptation of the general self-efficacy scale. *Psychologia: An International Journal of Psychology in the Orient*.

Contact email: leeteuk6521@gmail.com

Appendices

Appendix A: Post-test-Learning Performance (History Achievement Test)

The post-test consists of 10 multiple-choice questions (40%), 10 multiple-response questions (40%) and 5 essay questions (20%) for 100 points. Compiled by two teachers with 10 years of experience in teaching history.

1. Which philosopher primarily influenced Yin, Hai-Guang's liberal ideas?			
A. John Locke	B. Immanuel Kant	C. Plato	D. Aristotle
2. Yin, Hai-Guang's ideas are associated with which of the following movements?			
A. The Civil Rights Movement	B. The May Fourth Movement	C. The Xinhai Revolution	D. The Taiping Rebellion
3. In Yin, Hai-Guang's liberalism, what is the primary responsibility of intellectuals?			
A. To change social systems	B. To promote technological progress	C. To support government policies	D. To be the eyes of the time
4. What is Yin, Hai-Guang's core definition of freedom?			
A. Unlimited autonomy	B. Collective will	C. Protection of rights	D. Obedience to law
5. According to Yin, Hai-Guang, what is the foundation of democracy?			
A. Economic development	B. Universal education	C. Citizens' awareness of freedom	D. Military strength
6. What is Yin, Hai-Guang's view of democracy?			
A. Democracy is a compromise	B. Democracy is merely a tool	C. Democracy is a political ideal	D. Democracy is useless
7. Yin, Hai-Guang's liberalism primarily influenced which area in later generations?			
A. Political system reform	B. Transformation of educational philosophy	C. Intellectual enlightenment	D. Economic structural adjustments
8. What does Yin, Hai-Guang consider the main role of science to be?			
A. Solving all problems	B. Establishing social order	C. Supporting political authority	D. Providing correct methods of thought
9. How does Yin, Hai-Guang believe freedom should be critiqued?			
A. Through outright denial	B. Through rational discussion	C. By prioritizing practice	D. By integrating tradition
10. How does Yin, Hai-Guang interpret the "May Fourth" movement?			
A. A political movement	B. A literary revolution	C. A social reform movement	D. An intellectual enlightenment movement
11. What is Yin, Hai-Guang's view on tradition and modernity?			
A. Tradition should be fully preserved	B. Modernization should replace all traditions	C. Tradition should integrate with modernity	D. Tradition is a symbol of backwardness
12. In Yin, Hai-Guang's perspective, freedom is inseparable from which concept?			

A. Equality	B. Independence	C. Democracy	D. Authority
13. How does Yin, Hai-Guang suggest intellectuals should engage with society?			
A. Maintain neutrality	B. Stand on the side of truth	C. Follow the masses	D. Support the status quo
14. What is the philosophical foundation of Yin, Hai-Guang's liberalism?			
A. Rationalism	B. Empiricism	C. Skepticism	D. Metaphysics
15. In Yin, Hai-Guang's reflections on civil society, what does he emphasize most?			
A. Religious freedom	B. Social justice	C. Rule of law	D. Individual responsibiliy
16. In the practice of liberalism, which field is Yin, Hai-Guang most concerned with?			
A. Political reform	B. Economic freedom	C. Individual liberty	D. Cultural heritage
17. Why does Yin, Hai-Guang advocate liberalism?			
A. To oppose authoritarian	B. To preserve traditional culture	C. To support religious beliefs	D. Toemphasize national self-determination
18. What characterizes Yin, Hai Guang's academic style?			
A. Moderate and conservative	B. Radical and critical	C. Rational and rigorous	D. Emotional and romantic
19. What is Yin, Hai Guang's greatest contribution to modern society?			
A. Promoting science and technology	B. Establishing a philosophical system	C. Advocating intellectual freedom	D. Creating literary works
20. What is the relationship between liberalism and democracy in Yin Haiguang's advocacy?			
A. Freedom and democracy are unrelated	B. Freedom and democracy are opposed	C. Freedom must conform to democracy	D. Freedom is the foundation of democracy

Appendix B
Questionnaire

- Adoption of Schwarzer, R. (1993). Using a 4-point scale.
- General Self-Efficacy Scale (GSES)
- 10 questions
- Cronbach's αlpha reliability coefficient with values between .82 and .93

General Self-Efficacy Scale
General Self-Efficacy Scale (GSES), the term Self-efficacy was coined by Bandura, and many scholars have developed a variety of self-efficacy scales based on different domains. The GSES was developed by Schwarzer and Jerusalem (1993), with an initial version of 20 questions, which was later revised to 10 in 1997. The GSES has been translated into 25 languages in several countries and has been widely used.

Self-Efficacy Scale Questions
The Self-Efficacy Scale is a 4-point scale with feeling, thinking, and acting as the indicators. The criteria are "1" for completely incorrect; "2" for somewhat correct; "3" for mostly correct; and "4" for completely correct.

1. I can always manage to solve difficult problems if I try hard enough.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
2. If someone opposes me, I can find the means and ways to get what I want.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
3. It is easy for me to stick to my aims and accomplish my goals.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
4. I am confident that I could deal efficiently with unexpected events.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
5. Thanks to my resourcefulness, I know how to handle unforeseen situations.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
6. I can solve most problems if I invest the necessary effort.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
7. I can remain calm when facing difficulties because I can rely on my coping abilities.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
8. When I am confronted with a problem, I can usually find several solutions.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
9. If I am in trouble, I can usually think of a solution.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.
10. I can usually handle whatever comes my way.			
1) Not at all true.	2) Hardly true.	3) Moderately true.	4) Exactly true.

Appendix C

Posttest-Immersion Experience Scale (Learning Behaviors)

- Refer to Jennett et al. (2008) "Immersion Experience Scale after Experiential Activities".
- Likert 5-point scale
- 12 questions
- Cronbach's αlpha reliability coefficient, with values ranging from 0.877 to 0.921.

Immersion Experience Scale after Experiential Activity

Jennett et al. (2008) explored the impact of personal emotion in their research and observed changes in users' immersion through three different experimental situations. They proposed the "Immersion Experience Scale after Experience Activities" to quantify and measure immersion experience. The scale covers six aspects: 1. Attention: refers to the degree to which the subject is absorbed in using the interactive navigation system; 2. Temporal dissociation: refers to the subject's ignorance of the surrounding environment or The passage of time and the degree of complete concentration on the interactive tour system; 3. Transportation: refers to the intensity of the subject's inner feelings after experiencing the

interactive tour system; 4. Challenge: refers to the subject's face The degree of challenge experienced by the interactive tour system; 5. Emotional involvement: refers to the degree to which the subject invests his or her emotions in the interactive tour system; 6. Enjoyment: refers to the subject's experience in the interaction The degree of pleasure experienced during the navigation system.

Likert 5-point Scale

Likert scales (named after their creator, American sociologist Rensis Likert) are very widely used because they are one of the most reliable ways to measure opinions, perceptions, and behaviors. Likert scale questions are widely used in many types of surveys because they provide quantifiable response options, making the data collected easier to analyze. It also provides multiple options covering a whole range of topics, allowing respondents to choose answers that are more closely related to their own feelings.

Historical Textbook Immersion Experience Scale

Attention

In the course materials, do you feel focused on the activity you are doing? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree
Does the content in the textbook hold your attention? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree

Temporal Dissociation

Do you feel the passage of time as you engage with the history textbook? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree
Do the experiences in the textbook make you forget about time in real life? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree

Transportation

Do you feel drawn into the plot of your history textbook? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree
Do the scenes and stories in the textbook make you feel like you are there? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree

Challenge

Did the tasks or challenges in the textbook excite and engage you? (1-5 points)				
1. Strongly	2. Disagree	3. Neither	4. Agree	5. Strongly

Disagree		Agree nor Disagree		Agree
Do you feel challenged by the level of difficulty in the history textbook? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree

Emotional Involvement

Did you have a strong emotional experience with your history textbook? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree
Do the characters and situations in the textbook resonate with your emotions? (1-5 marks)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree

Enjoyment

Overall, were you satisfied with your experience participating in this history textbook? (on a scale of 1-5)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree
Did the fun in the textbook meet your expectations? (1-5 points)				
1. Strongly Disagree	2. Disagree	3. Neither Agree nor Disagree	4. Agree	5. Strongly Agree