Educational Use of Spherical Video-based Virtual Reality: A Preliminary Study from the Teacher Perspective

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Abstract: Virtual reality (VR), which is regarded as one of the important educational technologies in recent years, has become more popular to be adopted in teaching and learning contexts in Hong Kong. The present study investigated the changes in teachers' pedagogical and technological knowledge, attitude and satisfaction after attending a teacher training course on the educational use of VR. Participants were 29 in-service teachers in Hong Kong taking the course. Data were collected from the pre- and post-participation in the course by using four scales: (i) *Pedagogical and Technological Knowledge*, (ii) *Technological Knowledge*, (iii) *Positive Attitude towards Harnessing VR*, and (iv) *Teacher Satisfaction*. The results showed good reliability of the scales and significant differences between the pre-test and post-test on using VR in their teaching. Participants had significant improvement in the knowledge of the VR technology and the ICT integration after the training course. They also showed a positive attitude towards harnessing VR in their teaching. Since the factor of content knowledge was not significant in the present study, we will reinforce the teacher training course based on the subject content via school-based development. Thus, the teaching training package will be more comprehensive and suitable for training teachers to adopt VR in practice.

Keywords: Virtual reality technology, EduVenture® VR, teacher training

1. Introduction

Knowledge construction is based on active experience (Jong, 2019). Piaget and Dewey indicated that educators' role was to shape a learners' experience and the learning environment to promote meaningful learning experience (Ornstein & Hunkin, 1998 cited in Huang, Rauch, & Liaw, 2010). Virtual reality (VR) can create immersive environment for students to experience what they are learning. It can improve students' interaction with the learning environment and make learning more vivid (Chang, Hsu, Chen, & Jong, 2018).

2. Literature Review

2.1 Definition of Virtual Reality

Virtual reality (VR) is broadly defined as "an interactive computer system that is so fast and intuitive that the computer disappears from the mind of the user, leaving the computer-generated environment as reality" technological (Kendrick, 1996, p.145). The characteristic of VR comprises the notion of collaboration and interaction among users in an intuitive computer-generated environment that appears real, with full integration of artificial intelligence products and information tools (Schwienhorst, 2002). In education, visuals are often used for receptive purposes, serving as scaffolds that help students to comprehend complex information (Cappello & Lafferty, 2015) because the use of images helps make ideas more concrete for students.

Nowadays, visualization technologies include anything from still images, infographics, and 3D printing, to VR tools (New Media Consortium, 2016). VR tools largely expand what a single image can convey by creating immersive, sensational and interactive experiences without the travel. For instance, spherical video-based VR uses 360° images and videos to create virtual scenes. With a mobile device and a pair of VR goggles, users can turn their heads around in a full 360° circle and observe the environment in all angles. This VR tool combines technologies from computer graphics and vision and create virtual environments from either photographs or video images to immerse users in the VR environment (Lorenzo, Lledó, Pomares, & Roig, 2016; Passig et al., 2016; Chang et al., 2018). Faced with the increasing importance of experiential education, the present study uses VR technology to build an educational VR platform, allowing learners to access richer and more lively learning materials specifically accommodated in pedagogical needs of teachers, so as to enhance the effectiveness of experiential learning.

2.2 Application of VR in Experiential Learning

Experiential learning theory defines learning as ‘‘the process whereby knowledge is created through the transformation of experience” (Kolb, 2014, p. 41). The four steps of the experiential learning cycle are concrete experience, reflective observation, abstract conceptualization, and active experimentation (Baker et al., 2002). The immersive nature of educational use of VR can be a useful tool to promote and enhance experiential learning (L.M. Pilgrim & J. Pilgrim, 2016). In the virtual tour, students can observe the people, places, and the environment intimately and repeatedly. This may create an enriched experience which students can make sense. For example, students can be immersed in a cave environment where bats live and generate much questions and consequently inquiry about the living environment and the creatures. Thus, VR could be an essential teaching tool for enhancing teaching and learning experience and effectiveness in the classroom. The immersive learning environment provides individual opportunities for experience and reflection (J.M. Pilgrim & J. Pilgrim, 2016). For example, Google Expeditions is one popular mobile application for teachers to virtually bring students to every corner of the world without setting foot outside the classroom.

2.3 Significance of VR in Teacher Education

VR in education is becoming a prominent feature at schools in recent years. However, very few studies examined how teachers develop their competencies in designing VR for classroom use teachers can provide opportunities for students to engage in the environment with VR tools only if they are able to understand the affordances of VR, what are students’ gaps in learning a topic, and how VR can help to bridge understanding gaps. In other words, teacher need VR-based pedagogical content knowledge. This is a form of Technological Pedagogical Content Knowledge (TPACK) framework which is about how teacher integrate information and communication technology (ICT) in their teaching (Chai, Koh, Tsai, & Tan, 2011). The TPACK framework provides new directions for teacher educators in solving the problems associated with integrating ICT into classroom teaching and learning (Hewitt, 2008). In the present study, we emphasis how to teach effectively through educational VR combined with pedagogical approaches to address language learning problems, i.e., we attempt to build the teachers’ VR-PCK. Thus, the technological knowledge such as techniques of making education VR resources, design of VR-based lesson plan is essential in the teacher training course. From the teachers’ perspective of educational VR, it is significant to enhance the participating teachers’ satisfaction and have a positive attitude towards harnessing VR.

2.4 EduVenture® VR

EduVenture® VR (EVVR) is an educational VR platform developed by the technical team of Centre for Learning Sciences and Technologies of The Chinese University of Hong Kong (Geng, Jong, Luk, & Jiang, 2018; Jong, Luk, Leung, & Poon, 2018). It can design SVVR learning resources by combining 360° images and videos of real scenes and learning content. In contrast with most of the VR entertainment platforms in the industry, EVVR provides an easy-to-use authoring environment for teachers to tailor-make interactive VR field trips that suit their subject content and students’ learning needs. The interactive possibilities on EVVR include voice answering, object searching, etc. which are unique to other VR platforms and greatly accommodate the pedagogical needs of teachers. Students can then experience the VR scenes by using their mobile phone and low-cost VR equipment (e.g. Google Cardboard, iQiyi, etc.).

The assessment module of EVVR (Retriever) lets teachers view and compare the feedback of students and keep tracking the learning progress of the whole class. The database module contains databases of VR learning materials, learning portfolios, student information, and quiz results. With mobile devices and VR goggles, students can experience outdoor learning in VR, which makes teaching and learning more interesting and flexible.

2.5 Teacher Training of Using VR in Teaching

The training course in the present study focuses on how teachers may enhance learning and teaching effectiveness by adopting VR technology and relevant strategies in the classroom. First, the course provides the definition and global trend of VR technology in education. It provides techniques and essential skills of using VR equipment, designing VR learning resources (i.e. including 360 photo and movie capture in the University campus and 360 movie clip transfer, editing and publishing on different VR platforms) and implementing learning and teaching strategies in the classroom. Composing VR Learning and Teaching in EVVR and school management in EVVR were also introduced at the end of the course. Three research questions framed the present study:

Q1: Will teachers' pedagogical and technological knowledge be enhanced significantly after participating in a teaching training course?
Q2: Will teachers' attitudes towards harnessing VR in education improve significantly after participating in a teaching training course?
Q3: Will teachers' satisfaction be enhanced significantly after participating in a teaching training course?

3. Method

3.1 Participants

The participants were 29 in-service primary and secondary school teachers who attended a 3-hour teacher training course on VR for enhancing students' Chinese language literacy held by CLST of CUHK. Of the total number, 27.6% were male, 69% were female. Their mean of age range was 31-35 (27%). Fifty-nine per cent were teachers and 28% were senior teachers, 4% were teaching assistants, 9% were unknown. Half of them have been used e-learning platform such as Kahoot, Nearpot and VR 1-3 years, 31% of them have been used 4-10 years and a few of them have been used for over 10 years.

3.2 Data Collection Procedure and Measures

Self-administered questionnaires were collected at the beginning and the end of the teacher training course. The instruments used in this study was adapted from Schmidt et al. (2009), Koh et al. (2010) and Chai et al. (2013). The initial instrument consists of 30 items. Four factors were included in this questionnaire, namely (i) Pedagogical and Technological Knowledge, (ii) Technological Knowledge, (iii) Positive Attitude towards Harnessing VR, and (iv) Teacher Satisfaction. Teachers responded using 1 = strongly disagree to 7 = strongly agree. A total of 28 valid responses were matched (i.e. pre-test and post-test) and adopted as sample for subsequent analyses. The preliminary analyses were conducted, including descriptive statistics, reliability of instruments, paired sample t-test and effect size of the variables, using SPSS 25.

4. Results

4.1 Descriptive Statistics

Table 1 displays a summary of the reliability coefficients, mean (*M*) and standard deviations (*SD*), and effect size (*d*) of the variables. The reliability of the four scales was satisfactory, i.e. the range of the scales was from (M = 6.05, SD = 0.42, Cronbach's α = 0.95) (Factor name: Pedagogical and technological knowledge – content knowledge) to (M = 5.09, SD = 1.10, Cronbach's α = 0.97) (Factor name: Technological knowledge).

Table 1 Mean, standard deviation and reliability of the Teachers on VR training (post-test) (N = 29)

Variables	*N*	*No. of item*	*M*	*SD*	*α*	*Sample Item*
Pedagogical and technological knowledge						
Content knowledge	29	4	6.05	0.42	0.95	I have enough professional knowledge in Chinese language.
Knowledge about using technology to teach	29	4	5.39	0.87	0.89	I am able to guide the students to use technology (VR) to examine the hidden details in VR.
ICT integration knowledge	29	6	5.58	0.51	0.88	I am able to design student-centred courses, and appropriately integrate teaching content, teaching techniques and teaching methods.
Technological knowledge	29	3	5.09	1.10	0.97	I am able to independently use (operate) VR technology in the Chinese writing class.
Positive attitude towards harnessing VR	29	4	5.38	1.02	0.996	Using VR in teaching Chinese writing class can help my students learn efficiently.
Teacher satisfaction	29	5	5.30	0.88	0.98	I like teaching this Chinese writing class

Note: 1= strongly disagree to 7= strongly agree

4.2 Signicance Test

Table 2 displays the results of the paired sample t-test and effect size of the four scales. Five out of six pairs of t-test showed significant differences between pre-test and post-test. For example, there was a significant difference in the scores of Technological Knowledge (pre-test: M = 3.54, SD = 1.31) and (post-test: M = 5.13, SD = 1.10), $t(27)$ = -6.43, p = .000). In addition, the range of the effect size was from (d = 0.06 to d = 1.31) of the scales.

Table 2 Paired sample t-test of the teachers on VR training (N = 29)

Variables name	***M***	***N***	***SD***	***t***	***df***	***P-vale***	***Cohen's d***
Pedagogical and technological knowledge							
Pre-content knowledge	6.02	28	.50				
Post-Content knowledge	6.05	28	.43	-.89	27	.381	0.06
Pre- Knowledge about using technology to teach	4.29	28	1.32				
Post- Knowledge about using technology to teach	5.40	28	.88	- 4.98	27	.000	0.99
Pre-ICT integration knowledge	4.83	28	.83				
Post-ICT integration knowledge	5.63	28	.42	-5.03	27	.000	1.22
Pre- Technological knowledge	3.54	28	1.31				
Post- Technological knowledge	5.13	28	1.10	-6.43	27	.000	1.31
Pre- Positive attitude towards harnessing VR	4.69	28	1.18				
Post- Positive attitude towards harnessing VR	5.43	28	1.00	-3.86	27	.001	0.68
Pre-Teacher satisfaction	4.63	28	.71				
Post-Teacher satisfaction	5.34	28	.86	-4.21	27	.000	0.90

Note: 1= strongly disagree to 7= strongly agree

5. Discussion and Conclusion

The results showed a good reliability of the scales and significant differences between the pre-test and post-test on using VR in the teacher training course. Participants showed significant improvement in the knowledge of the VR technology and the ICT integration after the teacher training course. They also showed positive attitude towards harnessing VR in their class. Since the factor of content knowledge was not significant in the present study, we will strengthen the teacher training course based on the subject content via school-based development.

Regarding the teacher training program, it is significant to facilitate teacher development for better integration of ICT. The technological pedagogical content knowledge (TPCK or TPACK) framework (Mishra & Koehler, 2006) has reflected a paradigm shift in the recent studies (e.g., Jong et al., 2018). Therefore, teacher professional development requires cycles of iterative lesson design, implementation, and reflective refinement to resolve. This is especially for emerging technologies where information about how they could be employed in the classroom.

Teacher satisfaction is another focus in the present study. Teachers showed significant improvement after the intervention. Teachers feel satisfied after completing this teacher training course because it can improve students' learning achievement with the implement of VR in a pedagogical design. Teachers' level of satisfaction on the instruction programs will be related to what they perceive regarding various aspects of the teacher training programs (e.g., school-based or non-school-based, whether teachers' actual needs and concerns are being addressed, etc.) (Jong & Tsai, 2016).

Huang, Chen, & Chou (2016) indicated that experiential learning differs from teacher-centered instructive learning which focus on self-regulating judgment, free-thinking, and personal experience. Through interactive learning processes, students gain personal experience from which they derive an understanding of the core aspects of learning tasks and explore the correlation between activity concepts and implications. Learners integrate their learning experience into their lives, that transforms their attitudes and prompts further reflection on their behaviors (Jong, 2017). Experiential learning theory emphasizes the relationship between concrete experience and learning and teaching. In the present study, it showed how the VR technology enriched the teacher development for better integration of ICT, and how they gained more technological knowledge. The participants also have more positive attitude towards harnessing VR in the classroom after the intervention.

It is planned to collect more data to further examine the scale validation. Also, more advanced statistics will be conducted in the future, such as factor analysis and multiple regression analysis. Since the factor of content knowledge was not significant in the present study, we will reinforce the teacher training course based on the subject content via school-based development. Thus, the teaching training package will be more comprehensive and suitable for training teachers to adopt VR in practice.

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