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Teachers' Concerns about Adopting Interactive Spherical Video-based Virtual Reality

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Abstract: Fieldtrip-based learning is regarded as one of the most important pedagogic approaches in geography education. However, some valuable fieldtrip sites are too costly or/ and dangerous for school-age students to visit. With the technology of interactive spherical video-based virtual reality (ISVVR), low-cost virtual learning environments can be created to immerse students into near real-life contexts for conducting virtual fieldtrips. This study aimed to investigate geography teachers' concerns about leveraging ISVVR in practice via an open-ended questionnaire-based survey. A natural language processing method, RAKE (Rapid Automatic Keyword Extraction), was adopted to analyze the collected data. Results have shown that the way to proper integrate ISVVR into the geography class is the peak concern. Directly acquiring proper ISVVR instruction resources can also influence teachers to adopt ISVVR. The technical support determines whether ISVVR can be successfully implemented in schools.

Keywords: Teacher Concerns, Interactive Spherical Video-based Virtual Reality (ISVVR), Geography Education

1. Introduction

The Road Map for 21st Century Geography Education: Geography Education Research proposed a research agenda over the next several decades. Within recommendations, 1) research about fieldtrip and its impact on learning geography knowledge, and 2) research about teacher preparation and the needs in geography teaching and learning were highlighted (Bednarz et al., 2013). However, some valuable fieldtrip sites are too costly or/and dangerous for school-age students to visit. The virtual reality (VR) technology, as an advanced technology, allows users to explore immersive environments from any location and enables to construct and integrate different learning contexts (Pantelidis, 2009). The common concerns of the VR technology supported pedagogical approach would benefit for learning contexts where hazard and possibility of damage are involved. Spherical videos, also known as 360-degree videos, can record a view in every direction at the same time. This video-based virtual reality technology provides a new potential pedagogical approach. With the technology of *interactive spherical video-based virtual reality (ISVVR)*, low-cost virtual learning environments can be created to immerse students into near real-life contexts for conducting virtual fieldtrips.

An innovation often requires not only gaining new skills but shifting one's attitudes and beliefs. The effective implementation of an innovation is a highly personal developmental process. The ***Stages of Concern (SoC)*** Model, first was developed by Hall and Hord (2001), is a conceptual framework that describes, explains, and predicts probable participants' behaviors through identifying their attitudes and beliefs toward an innovation. Further, Cheung and Yip (2004) refined the model with five dimensions that has been introduced in this study (See Table 1). This study was conducted in the context of teacher training programs. According to the SoC model, teachers' concerns about leveraging ISVVR in practice were investigated, with the aim of better understanding on the necessary supports for the further program implementation.

Table 1: Operational definitions of the Refined SoC Model (Jong & Tsai, 2016, pp.333-334)

Dimensions	Operational Definitions
Evaluation	The teacher is concerned about the worth and possibility of introducing the education innovation into his/her school.
Information	The teacher is uncertain about the pedagogical roles and tasks involved in the education innovation, and is concerned about the availability of corresponding support and resources.
Management	The teacher is concerned about the tasks and processes of implementing the education innovation; the issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.
Consequence	The teacher is concerned about the impacts of the education innovation on student learning and his/her own professional development.
Refocusing	The teacher is concerned about the education innovation's further development, exploring ways to improve the existing pedagogical effectiveness of the education innovation.

2. Research Design

2.1 Training of the ISVVR Technology for Geography Teachers

The subjects were from 60 secondary geography teachers who registered for the teacher development program. The training program was especially designed for leveraging ISVVR in geography classes.

Two training events were organized. Each event consisted of 30 teachers. Two evening sessions for every training event were designed: *1) In Session 1*, teachers first experienced spherical videos and discussed the importance of the fieldtrip in the Geography Curriculum. With the explanation of ISVVR relevant definitions and learning theories, a special topic of capturing 360-degree videos in a real environment was introduced. Then, participants (geography teachers) were divided into 5 groups. Under the training helpers' guidance, they learnt on capturing 360-degree video fragments in practice. In the last part of Session 1, each group discussed the group assignment about designing a geography class with the ISVVR support. *2) In Session 2*, the post-processing of ISVVR resources had been introduced first. Participants learnt the procedure of making ISVVR instruction resources. With uploading and downloading their ISVVR instruction resources (from YouTube to their mobile phones), low-cost virtual learning environments can be created by themselves. Google cardboard, as the last training part, can support future students using ISVVR instruction resources in their classes.

2.2 Survey Design

Given to the potential uncertainty when working with a smaller sample size (around 60 teachers), instead of conducting quantitative analysis, a survey with an open-ended question was designed: *"The three most concerns when adopting ISVVR in the geography class"*. The basic background information from responders was involved. Text-based data were collected.

2.3 Method for Text-based Data Analysis: Rapid Automatic Keyword Extraction (RAKE)

Natural Language Processing (NLP) is a crucial part of artificial intelligence for understanding complex languages. It involves a large variety of underlying tasks and machine learning models powering NLP applications. Keyword extraction is one of the most important NLP tasks when working with text (Shukla & Kakkar, 2016). By definition, *keywords* describe the main topics expressed in a document. *Rapid Automatic Keyword Extraction (RAKE)* is a well-known and widely used NLP technique. RAKE is an algorithm to automatically extract text-based keywords from documents. The algorithm follows strictly three steps of a typical keyword extraction algorithm, and has a good design structure (Berry & Kogan, 2010). In this study, we followed the original existing Python implementation of RAKE

algorithm as described by Rose et al., (2010). The source code is released under the MIT License. The main steps are:

Step 1. Candidate selection: RAKE is based on the observation that keywords frequently contain multiple words but rarely contain standard punctuation or stop words (such as "and, the, of", or other minimal lexical meaning). The input parameters comprise a list of stop words, a set of phrase delimiters, and a set of word delimiters. RAKE uses stop words and phrase delimiters to partition the document text into candidate keywords.

Step 2. Properties calculation: Co-occurrences of words within these candidate words are meaningful. Word associations are further measured. Enabling adaptive and fine-grained measurement of word co-occurrences is used to score candidate keywords.

Step 3. Scoring and selecting keywords: The RAKE score is a ratio (*deg(w)/ freq(w)*) of the word degree (*deg(w)*) to the word frequency (*freq(w)*). The keyword identification is depending on the RAKE score. After candidate keywords are scored, the top *T*-scoring candidates are selected as keywords. Here, *T* is computed as one-third the numbers of words (Mihalcea and Tarau, 2004).

3. Result

3.1 Primary Dealing with Text-based Data

The survey was conducted at the end of each training event. Fifty-four attending teachers replied. The collected text-based data were a mix of English and Chinese. Since the implementation of RAKE is English-oriented, the data written in Chinese were translated into English before the analysis. The translation followed the rules of maximizing the accuracy: 1) it kept original sentence structure and the meaning of phrase using. For example, if a record was a phrase, it was translated as a phrase without any sentence extension. 2) Same words were translated by the consistent terms. As a result, 87 records about teacher concerns (from 54 teachers) were put into one text document (see Figure 1).

Question: The three most concerns when adopting ISVVR in the geography class

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Responder 11:
1. After students turn on their mobile phone, they will play with their phones as they prefer;
2. Not enough technical support;
3. I am worried about those students may not listen to teacher instructions after turning on their mobile phone.

Responder 12:
1. Students' mobiles are not modern enough to use relevant VR app.
2. Very slow Wi-Fi connections that make the VR class resource difficult to be downloaded.
3. Students are doing other things when the time they should learn from VR resources;
……

Figure 1. Records of teacher concerns about "Virtual Reality in Geography Class"

3.2 Descriptive Analysis of Teachers' Background

From the descriptive analysis of teachers' background, within 54 teachers, 59% were female geography teachers and 31% were male geography teachers (9% were missing information). The age was well distributed: 11 teachers were 30 years old or below (20%); 18 teachers were with the age around 31-40 (33%); 19 teachers were around 41-50 years old (35%), and 6 teachers were 50 years old or above (11%). Furthermore, 59% of teachers did not have any experience of the VR technology; 31% of teachers had a little experience, and 9% of teachers were using the VR technology sometimes.

3.3 Keywords Extraction of Text-based Teacher Concerns

All extracted candidate keywords fulfilling with the *T*-scoring measurement were analyzed. Thirty-nine candidate keywords were generated by first running of RAKE. For refining the number of keywords, the second time running RAKE on these 39 candidates was conducted. The top-ranking keywords from two times running results were the same. Hence, all 21 keywords from the second time running results were selected. Since RAKE cannot recognize synonyms, 11 keywords were identified after manually combined with synonyms. In addition, through reading the original data again, keywords, *'transfer the knowledge', 'students' motivation', and 'learning effectiveness'*, cannot be recognized by RAKE, because they were only mentioned once and the phrase length was less than the average. Plus these 3 manually assigned keywords, as a result, 14 keywords were finally determined. The extracted keywords were grouped following the definitions of SoC model categorical concerns. *Freq. (IR)* recorded the number of the records that can be retrieved from original data with indexing keywords (see Table 2).

Table 2: Keywords extraction of text-based teachers' concerns by RAKE

SoC Model	Freq. (IR)	Keywords (Extracted by RAKE)	RAKE Scoring	Keywords (Manually assigned and combined with synonyms)
Evaluation	15	'VR class resource difficult'	14.14	-- (false positives)
		'relevant VR app'	8.94	'relevant VR app'
		'software availability'	8.5	
		'modern mobile phones'	8.5	'modern mobile phones'
		'smart phone availability'	8.5	
		'school budget support'	7.5	'school support'
		'VR device'	5.44	'VR device'
Information	5	'preparing VR instruction resources'	13.94	'preparing VR instruction resources'
		'VR instruction resources'	9.94	
		'proper VR resources availability'	13.69	'proper VR resources availability'
		'teaching materials availability'	8.0	
		'VR resources'	6.19	--
Management	10	'proper integrate VR instruction resources'	18.44	'proper integrate VR instruction resources'
		'integrate VR resources'	10.19	
		'longer class hour needed'	14.7	'longer class hour needed'
		'class order management'	9.2	'class order management'
		'classroom order management'	9.0	
		'VR class preparation'	9.14	'VR class preparation'
		'longer time preparation'	9.0	
		'class preparation'	5.7	--
Consequence	4	'listening teacher instructions'	8.5	'listening teacher instructions'
		--	--	'transfer the knowledge'
		--	--	'students' motivation'
		--	--	'learning effectiveness'
Refocusing	0	--	--	--

3.4 Validation of the Text-based Data Analysis

In the field of Machine Learning, NLP, and Information Retrieval (IR), the evaluation is a necessary procedure. To evaluate the performance of RAKE, the developers (Rose et al., 2010) tested RAKE against with experiments reported in Hulth (2003) and Mihalcea and Tarau (2004) by the same collection of technical abstracts. This benchmark evaluation clearly revealed that RAKE effectively extracted keywords in terms of precision, efficiency, and simplicity. Apart from the test for individual

documents, Rose et al. (2010) tested RAKE for a corpus of documents. Finally, the developers concluded that RAKE can be used in many applications where keywords can be leveraged.

In this study, *precision, recall, and F-measure* were applied as well. Out of 21 extracted keywords, 18 are true positives. There are 3 false positives (although they were extracted by RAKE, these keywords cannot be recognized as meaningful keywords.) in the set of extracted keywords, resulting in a *precision* of 85.71%. The 11 RAKE extracted keywords to the total of 14 identified keywords results in *a recall* of 78.57%. Equally weighting precision and recall generates an *F-measure* of 81.98%.

4. Discussion

According to the study of Cheung and Yip (2004) and Jong (2016), if teachers intensively concern of Evaluation, Information, and/or Management perspectives, no matter the innovation is widely recognized as a future tendency, teachers tend to reject to adopt the education innovation. If teachers concern more about Consequence and Refocusing perspectives, teachers are positively reflecting on the impacts of the innovation on students' learning and on their own professional development. Once the peak categorical concern is identified, improvement on targeting their real needs of adopting the innovation should be formulated (Jong & Tsai, 2016).

4.1 Peak Teachers' Concerns about "Virtual Reality in Geography Class"

Top 5 RAKE scoring keywords were selected to express the main content of a document (Medelyan, 2015). According to their belonging categories of the SoC model, both ***Information*** and ***Management*** are the peak categorical concerns from participating teachers (see Table 3).

Management is the top categorical concern of the SoC model. From the information retrieval, teachers are caring the most about the new geography class design with the ISVVR technology integration. The categorical concern of *Information* is the second major concern. From the information retrieval, the time to prepare ISVVR instruction resources is one of the major concerns. Meanwhile, directly acquiring proper VR instruction resources also influences teachers to adopt the ISVVR technology.

Table 3: Information retrieval by indexing keywords from the peak categorical concerns

Categorical Concerns	Information Retrieval by Indexing Keyword
Management ***Freq. (IR):*** *3*	**Keyword:** 'proper integrate VR instruction resources' & 'integrate VR resources' Responder 41: "when conducting the class design, we should proper integrate VR instruction resources. It is somehow difficult." Responder 56: "How to integrate VR resources into the class?"
	Keyword: 'longer class hour needed' Responder 16: "longer class hour needed".
Information ***Freq. (IR):*** *5*	**Keyword:** 'preparing VR instruction resources' & 'VR instruction resources' Responder 41: "There is no IT technician to support the VR instruction resources. For doing it by myself, there is no time". Responder 43: "Preparing VR instruction resources"; Responder 46: "Currently, there are not enough VR instruction resources. We need time to prepare."
	Keyword: 'proper VR resources availability' & 'teaching materials availability' Responder 48: "Proper VR resources availability"; Responder 12: "Teaching materials availability".

4.2 The Most Frequently Mentioned Categorical Concern: Evaluation

Fifteen out of 34 retrieved records by indexing extracted keywords are from the Evaluation category (see Table 4). “Whether the school is technically ready” is the most concern. From the perspective of school implementation, the technical support determines the successful implementation of ISVVR in schools, such as Wi-Fi, VR devices, relevant software, smartphone support, and budget support.

Table 4: Information retrieval by indexing keywords from the categorical concern of Evaluation

Categorical Concerns	Information Retrieval by Indexing Keyword
Evaluation ***Freq. (IR):*** *15*	**Keyword:** 'relevant VR app' & 'software availability'; ***Freq. (IR): 7*** Responder 40: “students' mobiles are not modern enough to use relevant VR app”; Responder 1, 2, 10, 14, 18 & 21: “VR hardware and software availability”.
	Keyword: 'modern mobile phones' & 'smartphone availability'; ***Freq. (IR): 3*** Responder 10: “Students' smartphone availability”; Responder 13: “WIFI, SMART PHONE availability”; Responder 56: “Not all students have modern mobile phones to use”.
	Keyword: 'VR device'; ***Freq. (IR): 2*** Responder 38: “VR device cost”; Responder 45: “VR device”.
	Keyword: 'school support'; ***Freq. (IR): 3*** Responder 1 &2: “school support”; Responder 56: “School budget support”.

4.3 SoC Model-based Categorical Concern: Consequence

In the categorical concern of Consequence, only the index keyword *'listening teacher instructions'* was extracted by RAKE, the most concern is the students’ self-management (e.g. “students are not listening teacher instructions but playing their mobile phones”). Other three keywords, *'transfer the knowledge', 'students’ motivation', and 'learning effectiveness'*, were manually assigned through reading the original data again. These keywords although rarely occur, they are important to highlight some teachers concerned about the learning effectiveness by leveraging ISVVR in practice.

5. Implications

5.1 Needs for the Proper Curriculum Design with the Advanced Technologies Integration

Advanced technologies and internet of things are changing the way we live and work, as well as the way of teaching and learning. In the early of 1998, Youngblut has mentioned that the Virtual reality (VR) technology would potentially become a major technological innovation and can offer significant support for education. Although the unique advantages of the VR technology in education are allowing students to perceive the near real-life learning contexts, the proper curriculum design with the advanced technology integration is still in challenging. Teachers still worried about the class preparation time and the availability of VR instruction resources once they would like to adopt this advanced technology. Even the instruction resources are ready, the proper integration of the advanced technology into the classroom has still influenced the teacher to adopt this education innovation.

Here, especially for the ISVVR in geography classes, a new teaching package with the proper ISVVR integration would be recommended. Geography teachers would be guided with an integral curriculum design. Pre-preparation of ISVVR instruction resources for some classic geography classes would be helpful. Teachers may first use the common ISVVR resources. After they adapt this pedagogical approach, they would like to explore the way to create their own ISVVR instruction resources.

5.2 A Conflict Between the Current IT Deployments in Schools and the Rapid Development of Advanced Technologies

The technical support determines the successful implementation of ISVVR in schools. The results revealed that there still has been a conflict between the current IT deployments in schools and the rapid development of advanced technologies. The technical support is the major constraint for the implementation of modern education innovations. The availability of the hardware and software, and the school budget support were the major concerns.

From this perspective, the increased education budget will be considered as one solution for promoting the pedagogical uses of future advanced technologies. Further, another tendency is able to foresee that with more and more free software and affordable hardware occupying the market, the instruments (both the hardware and the software) themselves should not be a serious challenge. Instead, the user experience and the UI design of the instruments, especially focusing on the pedagogical uses, will become a challenge for the technology R&D institutions once they want to expand their users in the education field. On the other hand, in near future, how to make a connection with the technology R&D institutions and the education institutions will determine the successful implementation of an education innovation.

5.3 Performance of the NLP Technique for the Text-based Data Mining

Back to the data analysis part, normally, a number of discrete information would be collected among the class observations, interviews, or some questionnaires. Text-based data is a common type of the data collected. The NLP technique enables to conduct the “big” and “discrete” text-based data mining. Instead of manually assigning or reading a huge number of the text-based data, the NLP technique would be helpful at the primary stage to generally picture these data.

In this study, it is also an attempt to use a NLP technique supporting the traditional qualitative analysis. RAKE as a typical NLP technique helped the keywords extraction from the text-based data. This study used a smaller sample size as a pilot test that the manually assigned keywords was possible to be conducted for the validation as well. With the keywords extracted from both RAKE and the manual method, the validation measurements have been conducted: a precision of 85.71%, a recall of 78.57%, and an F-measure of 81.98%, have shown a relatively good performance when dealing with the text-based data. One limitation of RAKE leads to the missing information from some rarely appeared but also important records. In addition, lacking synonym recognition causes additional manually assigned works required. Comparing with the time for manually organizing the text-based data, RAKE may help to deal with a big text-based data within a short time. For the perspectives of the primary checking and organizing the collected data, we are satisfied with the performance. The obtained results under the in-depth education theoretical framework, somehow, answered our research questions. As mentioned above, more NLP techniques will be explored to deal with the text-based data in near future. The NLP technique is possible to be a supplementation for the further qualitative analysis, especially under the conditions of the continuously generating of a big text-based data.

6. Conclusion

This study investigated geography teachers’ concerns about leveraging ISVVR in practice via direct observations in the training class and a survey with an open-ended question. Through the RAKE implementation and manually correction, 14 keywords were determined and grouped into the SoC categories. The results have shown that both **Information** and **Management** are peak categorical concerns. This means that teachers are still considering the feasibility of adopting ISVVR in practice. The way to proper integrate ISVVR into the geography class is the peak concern. Directly acquiring ISVVR teaching resources can strongly influence teachers to adopt ISVVR. The technical support determines the successful implementation of ISVVR in schools.

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