

# University EAP Students' Perceptions of Using a Prototype Virtual Reality Learning Environment to Learn Writing Structure

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## ABSTRACT

This study investigates English language learner (ELL) perceptions of using a prototype virtual reality learning environment (VRLE) designed for teaching and learning writing structure. A mixed-methods approach was used, incorporating pre- and post-participation questionnaires, as well as semi-structured interviews. Participants consisted of 10 ELLs enrolled in first year English for Academic Purposes (EAP) courses at a university in Mainland, China. Results indicate that while the majority of students enjoyed using the VRLE, they maintained varying attitudes regarding the usefulness of the VRLE. Additionally, results from a correlation analysis suggest that learners' attitudes towards the material or content being learned (EAP writing) significantly correlates with learners' attitudes towards using the VRLE for learning writing structure.

## KEYWORDS

CALL, EAP, Immersive Virtual Environments, Technology-Mediated Pedagogy, Virtual Reality, Writing Structure

## INTRODUCTION

Virtual Reality (VR) as a pedagogical tool has gained increasing attention over the past two decades (Reisoğlu et al., 2017). Concurrently, the technology has evolved considerably, and is currently mass marketed to consumers for a variety of educational and entertainment purposes. The increased affordability and availability of VR devices has likely led to the growing interest in using VR technology for training and education purposes (Cheng et al., 2017; Haluck & Krummel, 2000). Further still, the use of VR in second language acquisition specifically is just beginning to be understood. Schwienhorst (2002) in one of the earliest reviews of VR in second language acquisition concluded that the research in the area at the time was insufficient, limiting much of his review to un-refereed publications and web pages. A more recent review by Lin and Lan (2015) had a much richer selection of articles to cross-analyze from top computer-assisted language learning (CALL) journals. They concluded that there are several areas of research for VR in second language acquisition that have yet to be investigated, including studies in language for specific purposes.

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Much of the recent research done with VR in second language acquisition centers on speaking and listening (e.g. Chen, 2018; Wang, Petrina and Feng, 2017), or in using non-interactive 3D videos in pre-writing activities (e.g. Dolgunsöz et al., 2018; Patera et al., 2008), but no research has emerged that uses VR to teach and learn writing structure. It may seem natural to focus on oral and aural language skills, as one of the key affordances of VR is the immersion in unique and specific contexts, allowing for a broad spectrum of situations to supply input and to elicit key output. The adaptation of 2-dimensional text into a 3-dimensional environment may seem counterintuitive, however VR has other qualities that are conducive to learning other than the creating of specific virtual worlds and their respective language portfolios. Elements of immersion and presence, as aspects of the user experience of VR, have important educational benefits (Mikropoulos & Natsis, 2011; Dalgarno & Lee, 2010 ) and warrant exploration in the language acquisition context.

Given the novelty of VR technology, especially in its more contemporary iterations, and the scarcity of research in its applications to teaching writing structure, an exploratory study into the attitudes and opinions of English language learners (ELLs) on using VR for this purpose is called for. As VR technology can bring many unique qualities which could benefit language learning and teaching, and as research into these benefits is still quite young, many avenues of research are becoming available.

## LITERATURE REVIEW

### Relevant Terms

Due to the recent and rapid development of VR technology, a short review of the key terminology and concepts as they apply in this study is necessary. Although VR is a term used liberally to describe a variety of 3-D technologies, such as massive multiplayer online games (MMOGs) like World of Warcraft™, and Augmented Reality (AR) as applied in the popular smartphone game Pokémon GO™, VR is understood in the current study wherein “the real world is completely occluded from the field of view” (Martirosov & Kopecek, 2017), delivered by such platforms as the Oculus Rift™ or HTC Vive™. The key difference in this type of VR is in *immersion*. Immersion has been defined as “a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences” (Witmer & Singer, 1998). Although this definition allows for purely psychological immersion, such as that experienced when identifying with a character in a good book, the immersion experienced in VR is delivered via visual, aural and haptic feedback. This immersion, as a measurable asset of the environment, leads to a sense of *presence*, which is the subjective sense of being in a place (Witmer & Singer, 1998). Thus, the immersive aspects of VR can be argued to come from the technological components, while presence is psychological (Dalgarno & Lee, 2010). Presence is a key attribute to VR environments used in educational contexts, as it is what allows the students a feeling of “being there”. VR environments or other 3-dimensional environments that are used for learning purposes are known as Virtual Reality Learning Environments (VRLEs).

### VR in Language Education

Typically, VR devices that are wearable and provide a fully immersive experience that totally occludes the real world are not employed in educational research, probably due to pragmatic reasons such as cost and scale. Most studies on the topic of VR employ 3D virtual worlds, which users interact with through a computer screen, and therefore are not totally occlusive. However, both VR and 3D virtual worlds can be designed and constructed for almost any context, which makes them particularly useful for language learning (see Thomas & Christel, 2018; Hsu, 2015, for examples using Second Life™). As Kluge and Riley (2008) note, VRLEs are highly adaptable to different learning strategies, are student centered, and instill a “learning by doing” model of education. A recent review of language-

classroom practices that employ VR and AR by Bonner and Reinders (2018) included creating virtual campus tours using descriptive language and direction giving; shadowing presentation skills using 360-degree video, creating VR videos for focused role-playing, and familiarizing students with a reading topic through 360-degree video. However, they do not include activities which employ VR in L2 writing, which could be an unfortunate omission, due to the learning affordances of VR.

## VR and L2 Writing

Exploring how VR has been employed in the teaching and learning of writing, it is useful to start with Wang, Lan, Tseng, Lin, and Gupta's (2019) meta-analysis of studies on 3D virtual worlds in language learning. After reviewing over 800 published works on the topic, 13 were ultimately selected for the meta-analysis based on the quality of the data produced and the focus on language learning outcomes. Of those 13, three were studies that involved the skill of writing, which scored a moderate effect size (Cohen's  $d = 0.617$ ) compared to other target skills such as listening ( $d = .947$ ) reading ( $d = .931$ ) and speaking ( $d = .195$ ). This indicates that writing and speaking may require extended research to determine the nature of the disparate results in respective studies.

Examining the three selected studies, Xu et al. (2011) measured the effects of using the VRLE Second Life™ as a platform for digital storytelling, comparing the outcomes to a group who did the same project offline. They concluded that digital storytelling in a VRLE is more effective based on the results of a writing self-efficacy questionnaire and a flow state scale (a measure of optimal experience). Similarly, Warren et al. (2009) employed a VRLE to instigate writing. Users of their self-created VRLE progressed through various in-program "quests" which assigned different writing tasks, integrated via a storyline where users were journalists investigating a crime. The third selected study (Lan et al., 2019) used Second Life™ in the pre-writing stage for students of Chinese as a second language. They found that students "who explored authentic contexts in [Second Life™]" showed significantly higher quality writing compared to a control group who didn't have the immersive experience. Additionally, they found the VRLE users exhibited higher motivation.

A further search on the Education Resources Information Center (ERIC) database for "virtual reality", "writing", and "language learning", collectively, yielded three relevant studies (out of 90 overall results for Journal publications), all of which employed VR or AR in various ways for pre-writing. Dolgunsöz et al. (2018) used fully occlusive VR headsets on which students watched VR videos which provided context and information for a writing assignment. They analyzed writing scores and conducted semi-structured interviews in comparison to students who watched 2-D traditional videos for the same purpose. They discovered that the use of VR did not affect writing performance but did positively impact the long term retention of information from the videos. Chen et al. (2019) exploited a less occlusive, but more interactive, VR experience by using Google Earth VR to fuel expository writing, with results indicating an increase in writing skills. Liu and Tsai (2013) performed an AR-based study which employed student-owned smartphones which provided overlays of additional information for specific scenes. For example, using the smartphone camera display and pointing your phone at a scene, an image may include names of objects or descriptions of buildings, students then use this additional information to inform their writing. Their results showed that students used the language resources from the AR in their writing.

## Pedagogical Benefits of Completely Occlusive VR

It should be noted that each of the identified studies on VR and L2 writing used VR-based technology to support a component of the writing process; most frequently pre-writing, by providing context or motivation. Additionally, all but one of the studies employed technology that is not fully occlusive, making them more similar to interacting with 3-dimensional content on a 2-dimensional screen, as in many video games. Although these can afford an immersive experience, they fail to provide a sense of presence that can afford a wider array of pedagogical benefits. In pedagogical contexts, the sense of presence in the virtual environment is a form of student-centered attention that can encourage

students to behave like they do in the real world (Mikropoulos & Natsis, 2011), or conversely, without the anxiety or affective filters which may inhibit them in a real classroom (Lin & Lan, 2015; Vogel et al., 2006; Schwienhorst, 2002). Immersion and presence in VRLEs can also encourage a deeper connection with the material, as visual and auditory distractions are blocked out (Gadelha, 2018).

These affordances can be especially beneficial in the Chinese context, where the present study takes place. Many studies have focused on the particular difficulties of Chinese learners in the English language classroom (Malik et al., 2017; Xie, 2009; Liu & Jackson, 2008). They typically point to learner anxiety, teacher-centered classes, and Confucian cultural mores such as saving face and respect for elders as the primary causes for these difficulties. VR can address many of these issues, which makes Chinese and East Asian students' ideal participants for the present study.

### **Attitudes and Opinions of VR in Language Learning**

Of the available literature, no studies were found that involved fully occlusive VR equipment to teach and learn writing structure, and none of the studies thus far attempt to use VR to inform students about writing structure. Therefore, a key question to answer involves university learners' attitudes and opinions towards using a fully immersive VR learning environment for learning writing structure.

There have been a number of studies that have investigated L2 learners' attitudes and opinions towards using technology for learning (Lee, Yeung, & Ip, 2017; Huang & Liaw, 2007; Liaw et al., 2007), including the leveraging of VR technology (Huang et al., 2016; Huang et al., 2010). While these studies contribute to our understanding of users' willingness to accept various forms of technology for educational purposes (e.g. by measuring perceived enjoyment, usefulness, and intention to use technology), they fail to take into consideration how L2 learners' previous language learning experiences may affect their experience utilizing the particular technology and thereby color the L2 learners' attitudes and opinions towards accepting the technology in question. To put it another way, in having focused on learners' attitudes and opinions towards using the technology, previous studies have overlooked the learner's attitudes and opinions towards the material, content, or subject matter that is being learned by means of the technology. It might be that a learner's attitudes and opinions of the actual material or content being learned may affect the learner's attitudes and opinions of using a particular kind of technology leveraged to learn said material or content.

This study aims to fill this research gap by investigating whether or not L2 learners' attitudes and opinions towards the subject matter of EAP affects their attitudes and opinions towards using a VRLE for learning writing structure. In order to explore this possible relation, the current study draws its inspiration from L2 motivation studies that leverage the concept of the antecedent conditions of the learner.

### **Antecedent Conditions of the Learner**

Several previous L2 motivation studies highlight the significant influence that the antecedent conditions of the learner (ACL) can have on the formulation of present attitudes and beliefs, which in return may influence future behavior (Carpenter et al., 2009; Falout et al., 2009; Gorham & Millette, 1997; Christophel & Gorham, 1995). ACL are, as Carpenter et al. (2009) describes them, "students' own affective and attitudinal baggage." At the onset of any present experience learners bring with them various psychological variables such as goal orientations, expectations of success, and attitudes towards the subject being learned, as well as attitudes and opinions towards the subject matter being learned that derive from previous experiences relating to the subject matter (Carpenter et al., 2009; Gorham & Millete, 1997).

Relating this to previous studies on L2 learner's attitudes and opinions towards using VR technology, each learner has, at the onset of the study already formulated attitudes and opinions towards the subject matter and technology being used. If the motivation studies mentioned above are any indicator, it is likely that these ACL also affect student's affective states during the study and what attitudes and opinions they formulate regarding the technology leveraged in the study. The present

study therefore examines the possible relation between ACL and learner's attitudes and opinions towards using technology, and takes the following for its research questions.

## Research Questions

1. What are university English language learners' attitudes and opinions towards using a VR learning environment for learning writing structure?
2. To what degree do the antecedent conditions of the learner (the learners' attitudes and opinions towards the subject matter of EAP) affect their attitudes and opinions towards using a VR learning environment for learning writing structure?

## METHODOLOGY

### The Virtual Reality Learning Environment

The VRLE leveraged in this study is the Virtual Reality Language Learning Lab, a prototype VRLE created by the authors which functions as a technology-mediated pedagogical tool to assist in the teaching and learning of writing structure. The VRLE utilizes the Oculus Rift + Touch VR system (see Figure 1) to provide users with an immersive VR experience where the physical world is completely replaced by a synthetic, digital environment.

The VRLE employs an activity adapted from (Pack, 2019) in which students demonstrate their knowledge of paragraph or essay structure by coloring each sentence according to its respective function. This is accomplished in the VRLE by virtually selecting a color of paint from an array of buckets and applying it to a digital canvas which contains a paragraph or essay, painting the sentences in the chosen color (see Figures 2 and 3). Each color represents a different sentence function, such as topic sentence, supporting idea, supporting detail or example, and conclusion. There is also a function to black-out a sentence (for irrelevant sentences in harder paragraphs) or reset a color if a mistake was made. After a student has finished coloring the paragraph or essay (see Figure 5 for an example) they discuss it with a supervising tutor, who can monitor the students' progress in the VRLE from a computer monitor. The VRLE also includes instruction and help menus which give information on paragraph and essay structure as well as instructions on how to complete the activity (see Figure 4).

The VRLE has a database of thirty paragraphs and nine essays that divide into three levels of difficulty: easy, medium, and hard. When a student completes a paragraph or essay, they are presented with the choice of choosing the same or different types of text (paragraph or essay) and the same or different types of difficulty. When a student completes a paragraph or essay, it is removed from the selection pool, ensuring that the student is not presented with the same text for the next task.

### Participants and Context

Participation in the study was voluntary with standard procedures undertaken to preserve the anonymity of the students and to adhere to the research ethics requirements of the institution where the study was conducted and approved.

Participants were recruited through the university's Language Centre's learning management system. The participants were selected based on the following criteria:

1. They were first year students currently in their first semester.
2. They were currently enrolled in an EAP class within the Language Centre.
3. They were 18 years or older.
4. They were physically able to complete the tasks (e.g. standing for a prolonged period of time and able to maintain balance).

Figure 1. VR equipment including laptop, Oculus Rift headset, Touch controllers and sensors



In total ten participants were involved in the study, which is a sample size not uncommon in research studies in the field of human-computer interaction (Caine, 2016). Participants were first-year students enrolled in compulsory EAP courses at a transnational English as a Medium of Instruction (EMI) university located in Mainland China. These first-year, first-semester, EAP courses are organized into three pathways: foundation, standard, and advanced. The foundation and standard pathway EAP modules are benchmarked at a Common European Framework of Reference for Languages (CEFR) B1 level, while the advanced pathway EAP module is benchmarked at a CEFR B2 level. Each student is assigned to a particular EAP pathway according to their English proficiency levels, which are determined by a placement test before the start of the semester. One of the primary learning outcomes of these EAP modules is for students to be able to write different genres of paragraphs that include a topic sentence with a main topic and controlling idea, supporting ideas that are relevant to the topic sentence, and the development of supporting ideas through details and examples. At this point in the curriculum students are not taught academic writing that is tailored to their specific academic disciplines, rather the curriculum adopts a prescriptive approach towards teaching paragraphs and essays with the hope of helping Chinese students become familiar with the direct expository style of writing found in academic English, a style many Chinese students may be unacquainted with (Snow, 2014).

As Table 1 illustrates, there were five females and five males, all between 18 (n=9) and 19 (n=1) years of age. In terms of nationality, nine students were Chinese with the remaining student being from South Korea. Eight of the ten students were enrolled in the standard EAP course, one student was enrolled in the foundation course (the level comprised of students with the lowest proficiency), and one student was attending the advanced EAP course. Five students reported their major as business, and the remaining five students listed their majors as electronic communication, electronic

Figure 2. Paint colors on table in VRLE. Each color correlates with a specific sentence function

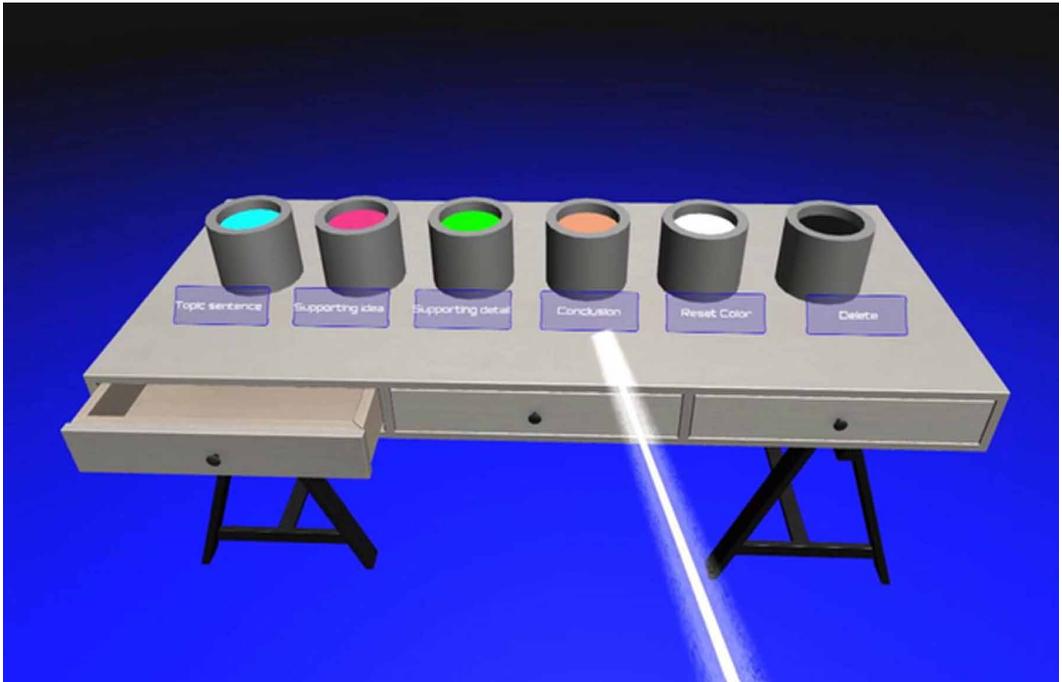


Figure 3. The paragraph/essay display board. A student paints a medium difficulty paragraph

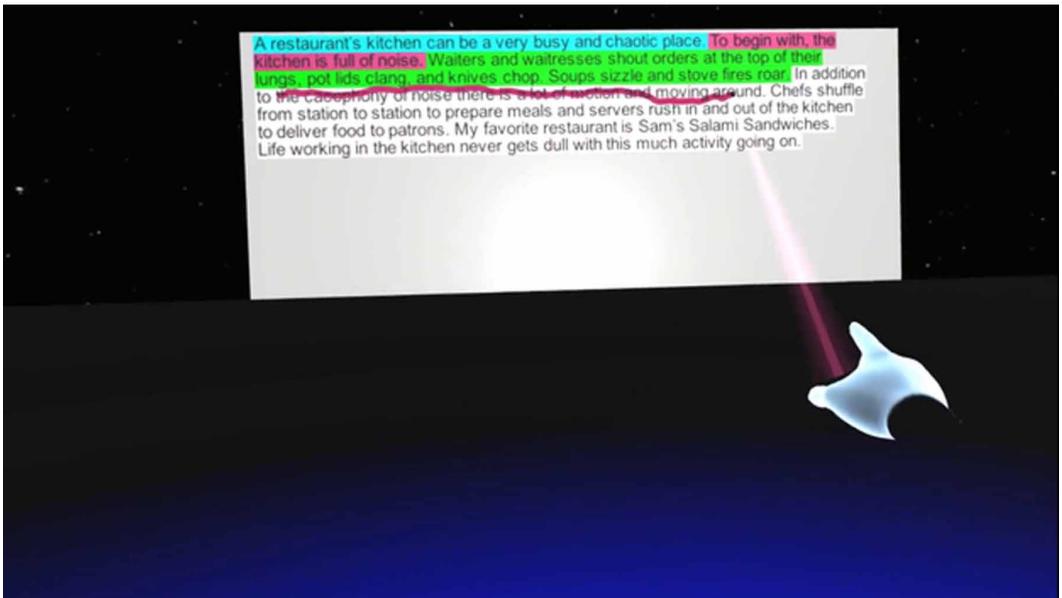


Figure 4. Paragraph information board. Students can read about different sentence functions

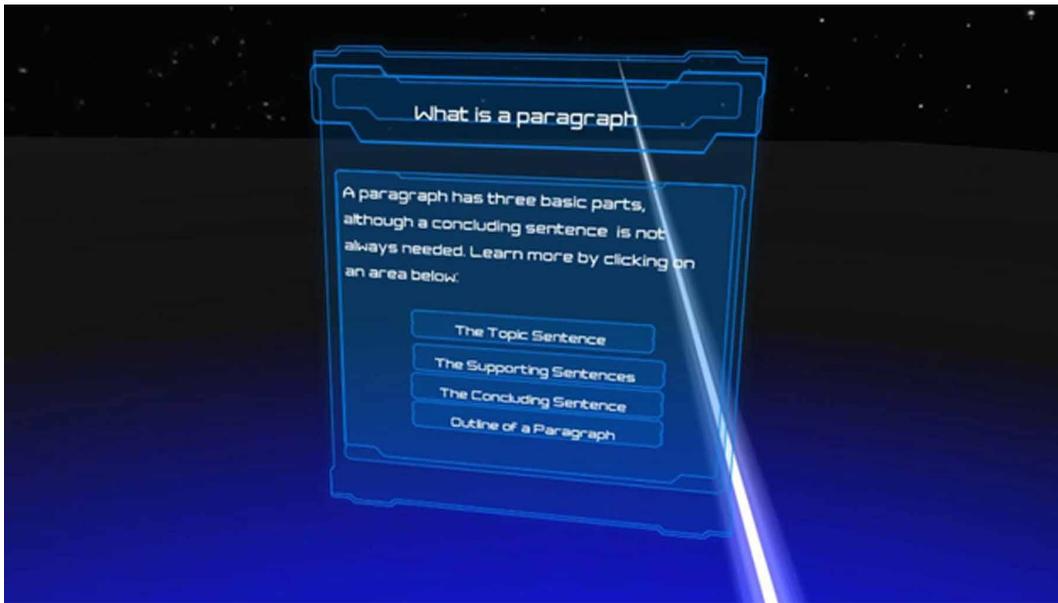


Figure 5. Example hard-difficulty paragraph

The first year of an infant's life can be divided into three major developmental periods. First, an infant's body needs to learn to live in the world outside their mother. During these first three months babies may smile, track objects with their eyes, grip objects in their hands, and even raise their head and chest when laying face-down. Next, usually during the age of four to six months, babies learn to manipulate the world around them. Expect to see an infant begin to roll over, make sounds, laugh, and sit up. The final stage of an infant's first year of development is from seven to twelve months. During this period of time babies usually learn to crawl, sit without support, respond to their name, begin feeding themselves, point at objects, and even take their first steps. After one year of age infants often begin to learn words more quickly. It is impressive all the things that infants learn to do in such a short period of time!

engineering, industrial technology, science, and undecided. In terms of familiarity with VR, four students had never used VR previously, six students had used VR a few times before. No students answered that they frequently use VR. The students, on average, had studied English for nine and a half years, with a range from six to twelve years.

### Data Collection Procedures

This study utilized a mixed methodology including pre and post-participation questionnaires and a post-participation semi-structured interview. These research instruments, as well as the process of guiding students during their utilization of the VRLLL, were piloted with four second-year EAP students. Subsequently, the wording of several items from the questionnaires and interview questions were changed in minor ways to make the items more readable and clear to the participants. Additionally,

Table 1. Profile of participants

Participants	Gender	Nationality	Age	Year of study	Major	EAP course	Length of English study	Familiarity with VR
P1	M	South Korean	19	1	Business	Advanced	6	Used VR a few times
P2	M	Chinese	18	1	Industrial technology	Standard	12	Never used VR before
P3	F	Chinese	18	1	Science	Standard	12	Used VR a few times
P4	M	Chinese	18	1	Business	Standard	10	Never used VR before
P5	M	Chinese	18	1	Electronic engineering	Standard	6	Used VR a few times
P6	M	Chinese	18	1	Undecided	Standard	10	Used VR a few times
P7	F	Chinese	18	1	Electronic comms.	Standard	10	Used VR a few times
P8	F	Chinese	18	1	Business	Standard	10	Used VR a few times
P9	F	Chinese	18	1	Business	Standard	10	Never used VR before
P10	F	Chinese	18	1	Business	Foundation	9	Never used VR before

an item asking students if they experienced motion sickness was added to the post-participation questionnaire. The final pre and post-participation questionnaires, as well as the post-participation semi-structured interview questions, are given in the appendices.

Participants were recruited during the third, fourth and fifth week of the first semester of their first year. Participants were informed that they would be using a VR program to learn writing structure for paragraphs. Data collection occurred in the fourth and fifth week, which is shortly after the timing of the teaching of paragraph structure in the foundational and standard pathways. This means that all students had at least a basic familiarity of the different functions of sentences within a paragraph.

Before using the VRLLE, participants completed a pre-participation questionnaire to collect the demographic information of the students, as well as their attitudes and opinions towards EAP (i.e. ACL).

Following the completion of the pre-participation questionnaire, the EAP tutor prepared the students for the coloring task that they would be asked to complete in the VRLE. The tutor showed the VR equipment, explained the function of relevant buttons on the Touch controllers, and described the VRLE and task before the students donned the Oculus Rift headset and touch controllers. This mini-training session helped prevent students from feeling overwhelmed and confused when navigating within the VRLE, allowing them to focus on the task at hand.

As the students' actions in the VRLE were displayed in real time on a large television screen, the tutor was able to guide students in the VRLE during the entire process. A tutor was physically present during the study to ensure students were able to navigate the program, to assist students should they experience motion sickness, and to provide feedback based on students' task performance. Students were first asked to demonstrate their knowledge of academic writing structure by painting an easy-difficulty paragraph. Students were given time to read and color a paragraph at their own pace. After the student painted the entire paragraph, if the student completed the task with some difficulty, the tutor then asked if the student wanted to color another easy-difficulty paragraph. If the student completed the task with ease, the tutor asked if the student wanted to color a medium-difficulty paragraph.

At the completion of each paragraph the tutor would ask if the student wanted to continue or stop painting paragraphs. Students were only permitted to choose easy and medium paragraphs, as hard paragraphs and essays of all difficulties had not been fully programmed yet.

After using the VRLE students then completed the post-participation questionnaire. Both pre- and post-participation questionnaires were administered via Qualtrics, an online survey platform. Participants' experience and opinions towards using the VRLE for learning writing structure were then further probed by means of a semi-structured interview.

## Instruments

The pre-participation questionnaire, which was written in English, was adapted from questionnaires utilized by Carpenter et al. (2009) and Fallout et al. (2009) in their research to measure learners' ACL. The pre-participation questionnaire was comprised of items aimed at collecting basic information regarding the participants (age, gender, year of study, major, familiarity of VR, EAP class, and years having studied English, as well as five items measuring one construct (ACL). Each of these items were statements to which participants were asked to indicate the extent to which they agreed or disagreed, by means of a five-point Likert scale (strongly disagree to strongly agree).

The post-participation questionnaire, which was written in English was comprised of items that assess what parts of the program participants used, the duration in which the participants used the program, whether or not motion sickness was experienced, and six items measuring students' attitudes towards using the VRLE for learning writing structure. These items each included a statement in which participants were asked to indicate the extent to which they agreed or disagreed, by means of a five-point Likert scale.

Guided by six questions, the semi-structured interviews were conducted in English by the first author and were aimed at further exploring students' attitudes and opinions towards using the VRLE as a tool for learning writing structure.

## Data Analysis Procedures

Quantitative data obtained by the pre- and post-participation questionnaires were analyzed with SPSS version 22. First, the internal consistency reliability of the Likert scale questionnaire items was measured by calculating the Cronbach Alpha coefficient. Next, the descriptive statistics for the Likert scale items in both pre- and post-participation questionnaires were calculated (see Table 2 and Table 3 respectively). Participants' responses to ACL Likert scale items were averaged, providing an ACL score for each participant. Likewise, participants' responses to the Likert scale items in the post-participation questionnaire regarding their attitudes toward using the VRLE were averaged, thereby providing an attitude towards VRLE score (hereafter post-participation attitude score). The authors then divided students into three ACL groups by their ACL scores, similar to Carpenter et al. (2009). These three groups are: negative (with an average ACL Score  $<3$ ,  $n=3$ ), low positive (average  $\geq 3$  but  $< 4$ ,  $n=2$ ), and high positive (average  $\geq 4$ ,  $n=5$ ). These groups, as well as their associated ACL scores and post-participation attitude scores are presented in Table 4. A two-tailed non-parametric correlation analysis was conducted to compute Spearman's rho correlation coefficient in order to see if there was any relationship between participants ACL scores and their post-participation attitude scores. An independent-sample *t*-test was then carried out to explore possible differences in ACL and post-participation attitude scores between male and female participants.

Post-participation semi-structured interviews were recorded, transcribed, and coded by Nvivo 12 for further analysis. The coding process was cyclical in nature, involving what Saldaña (2009) refers to as first cycle descriptive coding and second cycle pattern coding. This first cycle involved the reducing of data to various descriptive categories (represented as nodes in NVivo 12). These lower-order descriptive nodes were then categorized into higher-order nodes, or patterns. For example, lower-order descriptive nodes such as 'excited', 'happy', and 'dizzy' were assigned the higher-order node of 'feelings'. As the purpose of the semi-structured interview was to probe participants'

experiences and attitudes towards using the VRLE, another round of values coding (Saldaña, 2009) was completed, thereby organizing students comments into positive and negative categories (e.g. 'program is fun' would be coded under 'positive'). The number of positive and negative comments belonging to various subcategories were then tallied. Findings from the data analysis will be described and discussed in the next section.

## RESULTS

### Reliability of Pre- and Post-Participation Questionnaires

The overall reliability for the pre-participation questionnaire Likert scale items, as measured by the Cronbach Alpha coefficient, was .897. This is well above the .70 threshold that is often considered as an acceptable reliability coefficient (Dörnyei & Taguchi, 2010; Santos, 1999). Therefore, the internal consistency reliability of the pre-participation questionnaire has acceptable reliability.

As for the post-participation questionnaire, the Cronbach Alpha coefficient of the six Likert scale items was .932, thus the internal consistency reliability of the Likert scale items of the post-participation questionnaire can be considered reliable.

### Time Spent Using the VRLE and Motion Sickness

Participants chose to use the VR program for a variety of lengths of time. This ranged from 10 to 28 minutes, with a mean of 20 minutes. Eight students reported experiencing no motion sickness. Two students reported feeling a little motion sickness.

### Correlation Analysis of ACL and Post-Participation Attitude Score

A two-tailed non-parametric correlation analysis revealed a significant positive relationship between the participants' ACL average score and the average of their post-participation attitude score, Spearman's  $r_s = .815$ ,  $p = .004$  (correlation is significant at the .01 level). This is reflected in Table 6, where those students with lower ACL scores had lower post-participation attitude/experiences scores, and those students with higher ACL scores generally had higher post-participation attitude/experience scores.

### Independent t-test

An independent *t*-test of male and female participants revealed that on average, male participants had higher ACL scores ( $M = 3.76$ ,  $SE = .57$ ) than female participants ( $M = 3.04$ ,  $SE = .62$ ). This difference was not significant ( $t(8) = .851$ ,  $p > .05$ ; the effect size was  $r = .29$ , thereby showing a small to medium effect (Cohen, 1992; Cohen, 1988).

Male participants, on average, also had slightly higher attitude/experience scores ( $M = 3.87$ ,  $SE = .52$ ) than female participants ( $M = 3.40$ ,  $SE = .51$ ). This difference was not significant ( $t(8) = .642$ ,  $p > .05$ , with a small-sized effect  $r = .22$ ).

### Semi-Structured Interview Data

#### *Discomfort Resulting from VR Headset and Glasses*

The majority of negative comments made by participants in interviews relate to discomfort associated with wearing the VR Oculus Rift headset. Students who wore glasses found fitting the headset on to be particularly problematic. If the headset was not properly situated, students found it somewhat difficult to see words in the VRLE clearly. The strain of trying to read the words sometimes caused students to feel tired, as demonstrated by the students' comments below:

**Table 2. Descriptive statistics for pre-participation ACL Likert scale questions (n = 10)**

		SD	D	N	A	SA	Mean	SD
1	Generally, I think that I enjoy learning EAP in class.	1	3	1	4	1	3.10	1.287
2	Generally, I think that I enjoy learning EAP out of class.	0	5	0	4	1	3.10	1.197
3	I am confident in learning EAP now.	1	2	2	2	3	3.40	1.430
4	I think that EAP is useful.	3	0	0	2	5	3.60	1.838
5	I think academic writing is important for my present and/or future.	3	0	0	0	7	3.80	1.932

SD: Strongly disagree; D: Slightly disagree; N: Neither agree nor disagree; A: Slightly agree; SA: strongly agree.

**Table 3. Descriptive statistics for post-participation attitude Likert scale items (n = 10)**

		S D	D	N	A	S A	Mean	SD
1	I enjoyed using the VR program.	0	3	0	4	3	3.70	1.252
2	The VR program is helpful in learning academic writing structure.	0	2	3	2	3	3.60	1.174
3	I would use the VR program again if given the opportunity.	1	1	1	1	6	4.00	1.491
4	I would recommend the VR program to students who want to learn about academic writing structure.	0	4	1	0	5	3.60	1.506
5	Students will improve their academic writing if they use this program.	0	3	2	4	1	3.30	1.059
6	The Language Centre should use the VR program in one on one tutoring sessions to help students learn academic writing structure.	0	2	3	2	3	3.60	1.174

SD: Strongly disagree; D: Slightly disagree; N: Neither agree nor disagree; A: Slightly agree; SA: strongly agree.

SD: Strongly disagree; D: Slightly disagree; N: Neither agree nor disagree; A: Slightly agree; SA: strongly agree.

*I think virtual reality is not really good for the man who has glasses. I think I can't see really clearly use my glasses. (P3)*

*People having glasses on like me have a problem, like you can't see really well you have to adjust your glasses a bit so... if I do it for a long time I think it will be like... naw I'm not going to do this anymore. (P1)*

*I feel tired because I cannot see clearly in the center of the glass... and I think the letters are too small... and I cannot move near it. (P8)*

### Preference for Non-VR Approaches

Some students expressed a preference for using non-VR approaches like pen and paper because of the difficulty of getting used to VR, the discomfort caused by wearing the headset, or the inability to take notes while in the VRLE.

Table 4. ACL groups, average scores, and post-participation attitude/experience average scores

Participant	ACL group	ACL average score	Post-participation attitude average score
8	Negative	1.2	2.167
2	Negative	1.6	2
10	Negative	2	2.333
7	Slightly positive	3.4	4
1	Slightly positive	3.8	3.5
5	Highly positive	4	4.667
9	Highly positive	4.2	4.833
3	Highly positive	4.4	3.667
6	Highly positive	4.6	4.333
4	Highly positive	4.8	4.833

Note.  $r_s = .815$ ,  $p = .004$ , correlation is significant at the .01 level (2-tailed).

*I personally prefer to learn in the classroom. Well cause like some people are not used to have like this kind of stuff, maybe have negative feelings about it. I don't know, because I haven't used VR for a long time and I think if I use VR for a long time then my eyes will be hurt. (P1)*

*The negative things I think... such as if there is a word I don't know, I want to learn it and write it in my notebook, but in VR I couldn't do that. Paper pen, I get used to it. (P10)*

### VRLEs for Learning Writing May Lead to an Increase in Motivation

Positive comments tended to center on how the experience was interesting, fun, fresh, or new. Some students suggested that utilizing VR for learning writing, because of its novelty, caused them to feel motivated and/or more interested in learning than they normally would be by using traditional methods in the classroom.

Table 5. Most frequent positive and negative comments

Positive Comments	Number of students who mentioned	Total number of references	Negative Comments	Number of students who mentioned	Total number of references
Interesting/exciting	8	15	Wearing glasses is problematic	7	8
New way of learning, fresh, new opportunity	5	12	Can't see well, some words not clear	5	8
Helps students to focus on learning, motivates students to learn, raises interest in studying	5	9	VR headset is uncomfortable	4	4
Fun experience	4	5	Not used to VR	3	3
Feel present in a new world, realistic environment	4	5	Don't want to use VR for a long time	2	3

*I think that was interesting. It could let students who don't really like study to study hard... I think it could be used to let some students who don't really want to learn this subject to translate into wanting to learn this subject. (P3)*

*I think it will help because VR is a new way to help us to learn about it so maybe we will get interested in that. Yes, raise interest. I think it's more interesting. I just use pens for too many years I want to try something new. (P6)*

*I think it's interesting. If I use the VR to study I will pay more attention on my study. And I think... if we just use paper or computer it's not as easy to use as VR. I am a student who is not like study but I think if some student like me, if we use VR we will be more happy to study... I can have the feeling that I participated in the study all by myself. Not the teacher teach me but I participated all by myself... powered by my motivation. I'm a student who don't like to study, so it's helpful to me. I think use VR can strengthen my... can push me into study... not by some others ask me to do it... but all by myself. (P7)*

### **VRLE for EAP May Help Students to Focus**

Another pattern found in the participants' comments is that many students feel that utilizing VR for learning writing may help them to better focus.

*I think students always feel more focused on class if we use VR. Because it's interesting, it's different from our class we had in the past. (P5)*

*Maybe with using pen and paper I cannot focus on what I'm reading. But use VR, because the whole world is changed and there is nothing but the paragraph, so I can focus on what I'm reading and maybe it makes it more efficient. I will read it faster. (P8)*

*It's very exciting! And I think it's very interesting. And my classmates, maybe students find learning very dry and dull, maybe they feel their studies aren't effective and that nothing sticks. But studying it in this way will make it easier for them to concentrate on their studies, and so in this way it's easy for them to learn. (P9)*

### **Feelings of Presence and Immersion**

A few students made comments relating to feelings of presence and immersion afforded by the VRLE:

*I just love it. I think because it's new technology and also because the panel is cool. I mean it give you a feeling. The kind of feeling as if you are in a Star Wars or a scientific... uh... movie. (P2)*

*T: What was your favorite part about using the VR program?*

*S: I can stand in a different world and control the different control... the whole thing... I don't know how to describe it. They are not real, but you can use the controller and choose different colors and the set, the sound, they are all not real and maybe it makes it interesting.*

*T: So it's interesting being in a different world and being able to control things in that world?*

*S: Yes. (P8)*

## **DISCUSSION**

The goals of this study were twofold: first, to investigate university ELLs' attitudes and opinions towards using a VRLE for learning writing structure; and second, to explore how the ACL (i.e. the learner's attitudes and opinions towards EAP) may affect learner's attitudes and opinions towards using a VRLE for learning writing structure.

In regard to the former research question, the data suggest students enjoyed using the VRLE. Seven out of ten students agreed that they enjoyed the VR program and nine said they would want

to use the VR program again if given the opportunity. The total number of positive comments made by participants in the interviews (74) outnumbered the total number of negative comments (26). The most frequent positive and negative comments are listed in Table 5. The qualitative data suggests that students likely enjoyed the VRLE because of the novelty of the experience of learning by means of VR technology. Students described the experience as being interesting, new, and fun. Comments falling into these three categories make up nearly fifty percent of the total positive comments. One reason some of the participants described their experience as interesting was likely due to the feelings of presence and immersion they experienced while within the virtual world (Mikropoulos & Natsis, 2011; Dalgarno & Lee, 2010).

While the descriptive statistics of the post-participation attitude questionnaire and quantitative data from interviews make it clear that the majority of students enjoyed learning by means of the VRLE, students' perceptions towards the usefulness of using the VRLE for learning writing structure are more diverse. The item *Students will improve their academic writing if they use this program* had a mean of only 3.3 (on a 5-point scale). Only half of the participants agreed that using the program will help improve their writing, and only half of the participants said they would recommend the VR program to other students for learning writing. Furthermore, only half the participants agreed that the Language Centre should use the VRLE in one-on-one tutoring sessions to help students learn writing structure.

One reason that might account for why some students felt the VRLE was not useful may be related to discomfort resulting from wearing the VR headset, the difficulty of seeing text clearly, experiencing motion sickness and possibly the VRLE itself. Out of the total 26 negative comments made, 20 related to the discomfort from wearing the VR headset, glasses, and the difficulty of seeing text clearly. While only two students reported feeling a little motion sickness, the participant who used the program the shortest amount of time mentioned in their interview that they felt dizzy after using VR for a brief period and that he didn't want to continue to use it; motion or simulator sickness is not uncommon when using head mounted VR devices (Moss & Muth, 2011; Lo & So, 2001). This finding echoes Dede, Salzman, Loftin and Ash's (1997) discovery which suggest that motion sickness may be a limitation for some students in utilizing VRLEs for educational purposes. While little can be done about the difficulty some users face when trying to wear a VR headset over glasses, the developers of the current VRLE can improve the design in future iterations by enlarging the size of the text, and/or reducing the distance between the user and the screen that students read from, in addition to fixing the user location in the virtual world to limit motion sickness.

The authors found that a major challenge of designing a VRLE for learning writing structure is how to comfortably render a large amount of text for the user. If the text is too close to the user, it fills their field of vision, requiring users to frequently move their head and neck. With the weight of a VR headset this can cause unwanted discomfort and physical strain on the user's neck. If the text is too far away, the user is likely to have difficulty seeing the text if the headset is not properly fitted, causing unwanted discomfort and physical strain on the user's eyes. Furthermore, users may not want to use the VRLE for a long time as they may easily get frustrated with straining to read and understand text while at the same time having to frequently adjust a VR headset that may become hot and may apply pressure to the participants' glasses or face.

Despite these challenges and limitations of using the VRLE for learning writing structure, the VRLE appeared to afford some students an increase in motivation or willingness to study, as well as an increase in students' ability to focus on the task at hand. As the VR goggles completely encapsulate the user's vision, the user only sees the content of the virtual space and is not distracted by what is around them in the physical space. As pointed out by one of the participants, the students who may benefit most from using the VRLEs may be students who are bored and/or unmotivated in their studies. As it seems that the novelty of the experience of learning through VR may motivate students enough to sign up and study with a tutor when they normally wouldn't desire to or be willing to, which is supported by Dalgarno & Lee (2010) who specified VRLEs can lead to "increased intrinsic motivation

and engagement” (p. 20). Using VRLEs for learning writing structure in this way may best be suited for providing additional support outside of the classroom, thereby enabling bored, unmotivated, or underperforming students to receive the additional help that they may need.

The second purpose of this study was to investigate the possible relation between ACL and users’ attitudes towards using a VRLE for learning writing structure. The results of the correlation analysis between ACL and post participation attitude scores indicated a strong positive correlation between the two. This result suggests that students’ attitudes and opinions towards using VRLEs for educational purposes may be influenced to a large degree by ACL, including the attitudes and opinions of the learners towards the subject matter and its importance in their own personal lives. This is an important finding as previous studies on educational technology, including VRLEs, generally do not measure ACL, opting instead to focus on attitudes towards the technology used rather than the actual content being learned (Lee et al., 2017; Huang et al., 2010; Huang & Liaw, 2007; Liaw et al., 2006). The possibility of gender being a variable in accounting for differences in student ACL and post-participation scores was also explored by means of an independent *t*-test. That data suggests there is no statistical difference between genders in regards to their attitude towards EAP and their attitude towards using the VRLE for learning writing structure.

## CONCLUSION

This study investigated university EAP students’ perceptions of using a prototype VRLE to learn writing structure at a transnational EMI university within Mainland China. The results highlight several major points. First, students understand there to be both drawbacks and affordances of learning writing structure by means of the VRLE. Drawbacks include discomfort associated with prolonged use of the VR headset, the difficulty of reading 2D text if the headset is not fitted properly, and the inability to take notes. Affordances include the ability to focus more on the task without outside distractions, an increase in motivation or willingness to learn writing structure, and the enjoyment that stems from the feelings of presence and immersion afforded by the novel technology. Second, the results suggest that learners’ attitudes towards the material or content being learned (in this case EAP writing) significantly correlate with learners’ attitudes towards the VRLE that leverages such content.

Because of the limitations of the study, these conclusions are only tentative. Limitations include the cross-sectional design of the study and the number of participants, although the sample size of this study is not uncommon in human-computer interaction research (Caine, 2016).

While the current study is a critical first step into researching how VR can be utilized for teaching and learning writing structure, future research is needed to better understand learners’ perceptions of using VRLEs for the purpose of learning writing structure. The current research utilized a prototype VRLE that, as far as the authors are aware, is the first of its kind as a VRLE designed specifically to help students learn writing structure. The use of other VRLEs may yield different results. In addition, future studies might consider adopting a longitudinal research design to explore how learner attitudes may change with more exposure to the VRLE. Furthermore, future research should investigate whether students’ writing structure will improve with prolonged use of the VRLE. In particular, the authors suggest that investigating whether or not the VRLE helps students’ cohesion and coherence in writing is worth investigating more deeply, as cohesion and coherence relate to the specific task performed by students while using the VRLE. Furthermore, as the novelty factor of using VR technology is only one of many aspects of VR technology that appeals to and helps language learners, other dimensions of the technology should be further explored. Immersion, interaction, perceived ease of use, and perceived usefulness are all dimensions that could be researched, as has been done in fields other than language learning (Huang et al., 2016; Huang et al., 2010). These avenues of research may be fruitful in shaping the design of VRLEs in the future as well as understanding how to best utilize such VRLEs for educational purposes.

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