The Impact of Virtual Reality Assisted Listening Instruction on English as a Foreign Language Learners' Comprehension and Perceptions

Mehrak Rahimi (iD)
Shahid Rajaee Teacher Training University, Iran

Mozhgan Aghabarari (iD)
Shahid Rajaee Teacher Training University, Iran

To cite this article:

The Impact of Virtual Reality Assisted Listening Instruction on English as a Foreign Language Learners' Comprehension and Perceptions

Mehrak Rahimi, Mozhgan Aghabarari

Article Info	Abstract
	Virtual Reality (VR) as an interactive, illustrative, and immersive learning environment has ample opportunities for the development of language skills. Despite a growing literature on VR-assisted language learning, the benefit of VR for L2 listening is in need of further investigation. To fill this lacuna, the current study surveyed the impact of using 360° monoscopic VR videos as pre-listening tasks on language learners' development of listening comprehension. Sixty English as a foreign language (EFL) learners participated in the study as the control and the experimental groups. Their entry level of listening comprehension was evaluated by the B1 Preliminary listening paper before the study. Listening was taught to both groups by the comprehension-based model consisting of a pre-during-post listening cycle. The pre-listening activities of the experimental group included watching and working on 360° VR videos related to the topics of the listening parts of the textbook. The pre-listening phase of the control group included the warmup activities of the textbook. Both groups' listening comprehension was evaluated again at the end of the study. The quantitative data analysis revealed a significant difference between the participants' listening comprehension in favor of those who had worked with VR video as pre-listening tasks. Also, larger effect sizes for Parts 3 and 4 of the test that focused on understanding monologues were evident. The experimental group members were asked to express their perceptions of the experience of working with 360° VR videos in listening instruction by taking part in a structured interview. The results showed that almost all participants found the activities to be inspiring and pedagogically valuable.

Introduction

Listening comprehension is viewed to be a challenging and less explicit language skill. The complex cognitive processes involved in listening comprehension demand the listeners be able to attend to both language forms (recognizing phonemes, syllables, words, and phrases) and the gist of meaning (understanding the literal and intended meaning) at the same time. The interplay between these processes and other personal, instructional, and contextual factors makes understanding the aural input daunting for many foreign language learners. As a result, listening research has headed in the direction of making listening tasks less difficult by increasing the effectiveness

of teaching approaches and instructional content in the last decades.

Evolution in cognitive psychology coincided with technological advancements has offered important insights into the human cognitive architecture and the role of multimodal input, mechanisms of working memory, and the way experience and background knowledge would contribute to active learning (Baddeley, 2010; Sweller et al., 2011; Mayer, 2009; 2014). The conception that listening comprehension is influenced by brain mechanisms has widened the scope of listening research and demanded the examination of the pivotal role of multimedia in promoting comprehension.

Research on the role of multimedia in learning outcomes was led by the Cognitive Theory of Multimedia Learning (CTML) postulating that "people learn more deeply from words and graphics than from words alone" (Mayer, 2014, p. 1). In the arena of foreign language teaching and learning this proposition has been scrutinized by incorporating multimedia into teaching and learning vocabulary (Teng, 2023), writing (Alobaid, 2020), grammar (Taghavi Takyar & Jalali, 2016), speaking (Diyyab et al., 2013), and listening (Sayyadi et al., 2024). While most of these studies agree that multimedia promotes learning outcomes and increases language learners' motivation, there is still a need for further research on the role of cutting-edge multimedia technologies in language learning and teaching. This is vitally necessary for listening instruction since it would help to tackle the challenges EFL teachers and learners face in listening classes.

One of the emerging technologies of the 21st century is 360° VR videos, a kind of spherical video recording that yields a view in every direction. The combination of text, movement, narration, and graphics makes the 360° VR video an excellent source of multimodal output. The use of VR videos in the class would familiarize the learners with the context and topic of the task and give them a sense of being immersed in the foreign culture setting as it transfers a sense of reality and being deeply engaged in the environment to the viewer. A VR-assisted learning environment consists of "an immersive, three-dimensional (3D), multimedia, and multi-person simulation environment" (Wagner & Ip, 2009, p. 250) contributing to a sense of presence and amplification of perception of people, interactions, and situations.

The potential of VR videos for dynamic learning experiences (Parmaxi, 2023), the development of cognitive abilities (Parsons & Rizzo, 2008), promoting higher-order thinking (Sun et al., 2021), and enhancing English-speaking performance and motivation (Chien et al., 2020) is immense. While research on the benefits of VR technology in listening is scarce, it can be hypothesized that integrating VR videos into listening instruction would lead to more comprehension and less listening anxiety, as these movies not only provide a good provision of multimedia but also give the listeners the contextual clues that are lacking in many listening activities. Becoming familiar with the context of the listening task is a key element of activating the listeners' background knowledge and giving them confidence in pursuing listening comprehension activities.

Due to the lack of empirical evidence in this regard, this work surveyed the effects of using 360° VR videos as pre-listening tasks on language learners' development of listening comprehension. Further, the perceptions of those who experience working with 360° VR videos in listening instruction are assessed qualitatively. The study

answers the following research questions:

1. Does using 360° VR videos as pre-listening tasks impact language learners' development of listening comprehension?
2. What are language learners' perceptions of working with VR technology in listening instruction?

Review of the Related Literature

Listening Comprehension, Cognition, and Prior Knowledge

Listening comprehension is basically an information processing act (Cutler & Clifton, 1999) whose substantial portion consists of elements of communication and social relations. Listening relies heavily on both internal and external sources as the message can be interpreted and modified by background knowledge, contextual and situational variables, as well as nonverbal paralinguistic messages (Imhof, 2010). The blend of these components demands the listener to listen carefully, understand what was said, and most of the time do something in response to what was heard. Listeners' efforts during comprehension are channeled into four interrelated processing namely neurological, linguistic, semantic, and pragmatic (Rost, 2011).

Neurological processing involves the way the aural message travels as sound waves and is caught and processed by auditory organs which simply means connecting the ear to the brain. Linguistic processing consists of two types of information processing, that is bottom-up and top-down processes. Bottom-up processing is data-driven and demands the activation and accumulation of linguistic knowledge from phonemes, syllables, and words to phrases, sentences, and text (Field, 2006). Conversely, top-down processing is knowledge-driven and requires the activation of appropriate schematic knowledge. This normally takes place during semantic processing that entails comprehension, inferencing, learning, and memory information (Rost, 2011) and pragmatic analysis when the meaning is co-constructed in the stream of interaction between the interlocutors in a given setting.

Undeniably, background knowledge or schemata have a key role in creating meaning while someone is reading or listening to texts. Prior knowledge is constructed in long-term memory as a result of life experiences. When a sufficient proportion of prior knowledge is activated by warmup activities, people can process the written or oral message more rapidly and efficiently and foresee what is going to be read or listened to. To attain such a goal, many language educationists suggest the use of pre-listening activities to trigger students' schemata and help them predict the content and the theme of the listening task. Throughout this process, a positive attitude is created toward listening tasks (Owolewa & Olu, 2017) and students have enough time to master the language forms (Willis & Willis, 2001). This makes listening less tedious and anxiety-provoking, and thus a better understanding of the aural input is guaranteed.

The benefits of pre-listening activities for listening comprehension are both theoretically supported and empirically verified (e.g., Rajaei, 2015; Amari & Gorjian, 2019). There is also in-depth research to find out exactly what types of pre-listening tasks are more influential in promoting listening comprehension. Alavi and Janbaz (2014), for instance, examined the impact of two types of pre-listening tasks, i.e., question preview and topic preparation, on listening comprehension and found both techniques to be equally influential on language

learners' growth of listening comprehension. Rouhi et al. (2014) examined the impact of previewing questions, repetition of input, and topic preparation on EFL learners' listening comprehension and reported that the topic preparation technique, followed by the repetition technique, was the most influential pre-listening activity. Similarly, Rameshianfar et al. (2015), investigated the effects of two pre-listening techniques, that is input repetition plus background knowledge, and vocabulary instruction plus background knowledge on EFL learners' listening comprehension. They found input repetition plus background knowledge to be the most helpful pre-listening technique.

Karimi and Chalak (2021), investigated the effectiveness of both bottom-up and top-down pre-listening activities on students' development of listening comprehension and found a significant effect for both types of activities as well as an interaction effect for language proficiency. In a recent study, Madani and Kheirzadeh (2022) examined the effectiveness of four pre-listening activities, i.e., pre-teaching vocabulary, content discussion, pre-reading questions, and topic discussion, on EFL learners' listening comprehension across elementary and advanced proficiency groups. It was found that vocabulary preparation and pre-reading questions were the most influential techniques at the elementary level, while vocabulary preparation and content discussion were the most influential techniques at the advanced level.

Undoubtedly, research on pre-listening activities demands attention to brain mechanisms and their key role in the processes of decoding, storing, saving, and retrieving the aural input. Working memory as an essential system for keeping "things in mind while performing complex tasks such as reasoning, comprehension and learning" (Baddeley, 2010, R1. 36) hugely affects the process of listening comprehension. The way working memory handles the input depends on the length (number of chunks) and modality (verbal, visual) of the input and how it captures attention and activates background knowledge. Limitation in working memory span (duration and capacity) causes listeners to encounter difficulty in comprehension and learning, i.e., "storing information in long-term memory" (Sweller, 2017, p. 7). Instructional practices that ignore human memory and its capacity are ineffective and can impose a heavy burden or cognitive load on learners' working memory.

Based on the multicomponent model of working memory (Baddeley, 2010) and the Cognitive Theory of Multimedia Learning (Mayer, 2009) verbal and visual inputs are processed in two independent, though interrelated channels. When there is a need to process multimodal input with high cognitive load, the load is diffused in these two channels and thus the load is lightened. Drawing on these theories, models of the listening process from the perspective of cognitive psychology have been proposed (e.g., Imhof, 2010). In this scheme, it can be assumed that familiarizing language learners with the topic of the tasks through multimedia-enhanced warmup activities can foster the germane load that would link the incoming information with the long-term memory and thus contribute to lower extrinsic load. Despite a thick body of literature on the benefits of multimedia in improving language skills (e.g., Sanrica & Usluel, 2016; Cigerci & Gultekin, 2017; Dehghanzadeh et al., 2021; Yang et al., 2022) particularly with a focus on cognition (Noroozi et al., 2020), there is a dearth of research on how multimedia-supported pre-listening activities can affect language learners' listening comprehension (e.g., Taher & Abdollahi-Guilani, 2019; Barjesteh & Ghaseminia, 2023). There is even more scarcity of research on the benefit of utilizing emerging technologies such as VR videos as pre-listening tasks.

360º VR Videos in Listening

360º videos are "recorded with omnidirectional or multi-camera systems that capture all directions at the same time. Videos are stitched together with software to produce a full spherical field of view" (Snelson & Hsu, 2020, p. 404). Users can view these videos and interact with their environment with VR head-mounted devices or desktop computer devices. Based on the degree of capturing the senses of the users, the extent of VR immersion videos is identified (e.g., Tacgin, 2020; Chen, et al., 2022). The effectiveness of VR videos in improving learners' cognitive abilities like attention, spatial perception, and reaction (e.g., Weiner & Sanchez, 2020) has been surveyed. Also, the influences of 3D virtual contexts on the mental and social development of disabled learners and decreasing their anxiety and depression have been examined (Gilbert et al., 2013).

Due to its unique features, 3D video technology is suggested to provide language learners with the real notion of imagination, immersion, and engagement in teaching and learning English (Yang et al., 2021). A recent meta-analysis of 21 published articles in 2010-2021 shows that VR-enhanced language learning has a medium effect on students' both linguistic and affective gains in comparison to non-VR environments (Chen et al., 2022), meaning that VR environments can both positively affect language learning and improve affection. Notably, the majority of the studies in this scheme are performed in the EFL context (Chen et al., 2022; Hua & Wang, 2023). As is evident, the most frequently investigated language skills are vocabulary, writing, and speaking (Parmaxi, 2023; Chen, et al., 2022; Hua & Wang, 2023; Zheng et al., 2022), while there is insufficient research on the effectiveness of VR videos on listening skill, especially as a motivator of listening comprehension (Parmaxi, 2023; Chen, et al., 2022; Hua & Wang, 2023; Zheng et al., 2022).

Lan et al. (2018) investigated the effects of real and 3D avatars on EFL students' listening performance. They found that students' learning improved as a result of watching the 3D avatars in motion compared to moving their bodies. Lee (2019) surveyed the test-takers' performance in the VR test against that of an audio test and a video test among Korean EFL learners. The results showed that differences in test-takers' performance were not statistically significant between the VR and the video groups, but were statistically significant between these two groups and the audio group. Specifically, the VR group demonstrated a better ability to search for detailed information than the audio group. In general, participants in the VR listening test responded positively to the test, situating VR as useful for listening assessments.

In another study, Tai and Chen (2021) compared the impact of VR via mobile-rendered head-mounted displays on listening comprehension, sense of presence, and perceptions of listening with a video-watching group. It was found that the VR group's comprehension and retention improved significantly in comparison to video watchers. The VR group found the experience engaging and beneficial. Similarly, Ye and Kaplan-Rakowski (2023) investigated the impact of VR on Chinese language learners' listening comprehension, enjoyment, sense of presence, and cognitive load. Two conditions of an interactive multimedia story in VR and watching a screencast recording of the same story were implemented. The results showed that the VR group had significantly higher listening comprehension scores, reported significantly more enjoyment and sense of presence, and experienced significantly less cognitive load. Shokri (2023) investigated the impact of 360° videos on Iranian EFL learners'

vocabulary retention and development of listening comprehension. The instruction was given to the participants in two different conditions of watching the VR videos and doing educational activities based on the watched videos, and just watching the VR videos and enjoying the experience. The results supported the significant effectiveness of the first condition on both vocabulary retention and the development of listening comprehension. Unlike these few studies, Ji et al. (2019) researched the effect of two presentation modes, that is traditional versus VR modes, on EFL learners' listening comprehension and cognitive load in higher education context. The results demonstrated a nonsignificant difference between the two groups' listening comprehension and a higher cognitive load for the VR group.

To shed more light on this matter, the current study surveyed the effects of 360º VR videos being included in the pre-listening phase of a comprehension-based listening instruction with a three-phase cycle of pre-during-post listening on language learners' listening comprehension. The VR videos were integrated into the pre-listening phase because carefully designed pre-listening tasks in general (Madani & Kheirzadeh, 2022) and technology-based listening activities in particular (Sayyadi et al., 2024) have been found to contribute to the development of listening comprehension.

Method

Participants

Sixty female EFL learners participated in the study. English is one of the foreign languages that is taught in the Iranian educational system. The students were studying at a public high school in a rural area of the capital Tehran. The sample ranged in age between 15-16. Utilizing a random sampling approach, the students were put in a control group and an experimental group with 30 participants in each.

Instruments

B1 Preliminary

To assess the participants' improvement of listening comprehension, the listening paper of B1 Preliminary was used both as the pre-test before the study and the post-test after the experiment. B1 Preliminary is a member of English tests, labeled as Cambridge English Qualifications, developed and administered by Cambridge University. Cambridge English Qualifications have three proficiency levels, that is, basic, independent, and proficient. There are seven tests from pre-A1 to C2 in this system that are designed based on the Common European Framework of Reference (CEFR). The first test of level 'independent' is B1 Preliminary.

B1 Preliminary has four papers including reading, writing, listening, and speaking. These papers are administered and scored independently, while a general score of language proficiency is also given to the candidates. The listening paper was used in this study. This test has 25 questions organized in four parts and takes approximately 30 minutes. The questions are in different formats and assess understanding of the aural input in social, professional, or academic contexts. The "candidates need to show they can follow and understand a range of spoken materials including announcements and discussions about everyday life" (Cambridge English

Qualifications, B1 Preliminary, 2020, p. 5).

The Interview

To assess the participants' perceptions of using 360º VR videos in listening instruction, 10 students from the experimental group voluntarily participated in a structured interview. To develop the interview questions, the literature on VR in education was critically studied (e.g., Parmaxi, 2023; Snelson & Hsu, 2020; Legault et al., 2019) and ten questions were adapted based on the users' feelings towards and experiences with 360º VR videos; the challenges they had while using 360º VR videos; and the role of teacher to soundly integrate this technology into the instruction. Two colleagues were asked to review the questions for appropriacy of the content and wording. Based on their comments, the wording of some questions was changed and three questions were deleted. As a result, seven questions were utilized to gather the qualitative data. The questions clustered in the following 4 themes:

- Students' experience with 360º VR videos (2 questions)
- Students' perceptions of the educational value of 360º VR videos (2 questions)
- Students' challenges of 360º VR videos (2 questions)
- Teacher role in using 360º VR videos appropriately in listening instruction (1 question)

The interviews were conducted individually and lasted 15-20 minutes. All interviews were recorded and then transcribed for the qualitative data analysis.

Materials

360º VR Videos

Six sets of 360º VR videos with an average length of 4 minutes were selected from YouTube 360 or Aparat 360 (a local platform) to be used as the pre-listening activities. The topics of the videos were related to the themes of the lessons and listening activities of the students' main textbook including understanding people, lifestyle, and art and culture. The videos were checked by two teachers for the appropriateness of linguistic difficulty, relevance to the topics, and cultural issues.

Pre-listening Activities

The students' main textbook consisted of three lessons with different sections. Each lesson begins with warm-up activities (called Get Ready) followed by a conversation as the main listening task of the lesson. Get Ready aims to review the already known language features and familiarize the students with the theme of the listening task (Alavi Moghaddam et al., 2018). The activities focus on both lower and higher-order thinking skills with an emphasis on lower-order cognitive processes. The activities have different formats such as matching, fill-in-the-blanks, and ask-and-answer questions. The activities are done with the help of textual and pictorial clues and no video or audio accompanies the activities. The pre-listening activities of the experimental group were designed based on watching 360° VR videos by considering the same cognitive goals and formats. Examples of pre-listening activities and their cognitive processes and goals are summarized in Table 1.

Table 1. Pre-listening Activities with their Cognitive Processes

Cognitive process	Goals	Sample activities
Creating	Generating new ideas, products, or ways of viewing things	Generate personal opinions
Evaluating	Justifying or defending a position or course of action	Compare answers with classmates
Analyzing	Breaking information into parts to explore connections and relationships	Compare and contrast pictures
Applying	Solve problems by applying knowledge, facts, techniques, and rules	-Complete the missing information -Write similarities and differences
Understanding	Demonstrate an understanding of facts, concepts, and ideas	-Explain/describe reasons -Summarize the information -Organize materials based on certain criteria
Remembering	Recalling information	-Identify/label different parts of a picture Match words with their pictures/ meanings

Procedure

Before the study, the school administration's approval and the consent of the participants and their parents for doing the experiment and gathering the data were gained. Then, the participants took part in the B1 Preliminary pre-test. Then, both groups received listening instruction based on a cognitive model consisting of a three-phase cycle of pre-during-post listening. In the pre-listening phase, the topic and theme of the listening task were introduced to the students. The experimental and control groups received different materials in this phase. The experimental group members were required to install a 360º video viewer app on their devices to view and work on 360º VR videos based on the teachers' instruction and guidance. The control group just went through the warm-up activities of their textbook. In the listening part, both groups were required to listen carefully to the audio tracks to understand the general meaning and the details. In the post-listening phase, both groups' understanding of the text and textual interpretation was assessed by various activities such as question and answers, fill-in-the-blanks, role plays, etc. The length of the instruction, the textbook, and the teacher of both groups were the same. During the pre-listening phase, the teacher was the director and manager of the class activities and tried to facilitate learning. The study lasted for five months. At the end of the experiment, both groups took part in the B1 Preliminary post-test. The members of the experimental group were also asked to take part in the structured interview.

Data Analysis

To answer research question one, descriptive statistics and inferential statistics were utilized and the collected

data from B1 Preliminary were analyzed. Descriptive statistics included the mean, standard deviation, and range of the scores. The missing data and normality of the distribution of scores were also checked (Pallant, 2020). The inferential statistics included Multivariate Analysis of Variance (MANOVA) that examined both groups' listening comprehension after the experiment by comparing their B1 Preliminary post-test scores. The mentioned analyses were performed using SPSS 23. The transcripts of the interviews were analyzed by a qualitative content analysis to gain "insights into inner processes of learning and development" (Mayring, 2023, p. 322). The content analysis was done by both manual and computer-assisted coding. Computer software NVivo 12 Pro was used to analyze qualitative data.

Results

The Impact of VR -assisted Listening Instruction on the Development of Listening Comprehension

To examine if using 360º VR video as a pre-listening task has impacted the participants' listening comprehension, a one-way MANOVA was run. Post-test scores functioned as the dependent variable and the type of pre-listening tasks (2 levels: 360º VR videos, versus conventional activities) served as the independent variable. The results of Multivariate Tests indicated a statistically significant difference between the two groups' B1 Preliminary post-test scores (Wilks' Lambda=.662, F=7.034; p=.000<.05; partial eta squared=.338). Also, the results of Tests of Between-Subjects Effects (see Table 2) showed significant differences in four parts of the B1 Preliminary post-test. It should be noted that to avoid error Type I, the alpha level of .0125 was adapted according to Bonferroni adjustment (.05/4=.0125).

Table 2. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Group	Part 1	20.417	1	20.417	12.014	.001*	.172
	Part 2	36.817	1	36.817	14.157	.000*	.196
	Part 3	18.150	1	18.150	14.480	.000*	.200
	Part 4	18.150	1	18.150	14.401	.000*	.199
Error	Part 1	98.567	58	1.699			
	Part 2	150.833	58	2.601			
	Part 3	72.700	58	1.253			
	Part 4	73.100	58	1.260			
Total	Part 1	993.000	60				
	Part 2	519.000	60				
	Part 3	235.000	60				
	Part 4	395.000	60				
Corrected Total	Part 1	118.983	59				
	Part 2	187.650	59				
	Part 3	90.850	59				
	Part 4	91.250	59				

As is shown in Table 2, while the effect sizes for the intervention for all parts are large (partial eta square > .14) (Cohen, 1988), the values of effect sizes for Parts 3 and 4 are larger than those of Parts 1 and 2. Based on descriptive statistics (see Table 3), the experimental group (360º VR videos) outperformed the control group (conventional activities) in B1 Preliminary and its four parts.

Table 3. Descriptive Statistics for B1 Preliminary Pre-test and Post-test Scores across Groups

Variables	Groups	Pre-test		Post-test	
		Mean	SD	Mean	SD
Part 1	Control	3.235	1.349	3.233	1.278
	Experimental	3.038	1.280	4.400	1.328
Part 2	Control	1.705	1.528	1.566	1.501
	Experimental	2.961	2.009	3.133	1.716
Part3	Control	1.500	1.331	1.000	1.082
	Experimental	2.115	1.478	2.100	1.155
Part4	Control	2.029	1.114	1.700	.702
	Experimental	2.500	1.303	2.800	1.423

Learners' Perceptions of VR-assisted Listening Instruction

To discover the perceptions of the students who experienced working with 360º VR videos in the pre-listening phase of their listening class, their responses to the interview questions were qualitatively analyzed. The data were coded both manually and by the computer software NVivo 12 Pro. First, both researchers read the texts carefully and independently and coded the responses manually. In two elaboration sessions, the codes were compared and disagreements were resolved. The codes, classes, and themes were decided upon as the software output, and manual codes were checked and rechecked (see Table 4). Finally, the qualitative data were explicated, inferences were drawn and conclusions were arrived at (Table 5-7).

Table 4. Main Themes and Subthemes

Themes	Rank	Word	Count	Weighted Percentage (%)	Subthemes
Students' experience with 360° VR videos	1	exciting	4	5.13	Feeling
	2	interesting	4	5.13	
	3	really	4	5.13	
	4	see	4	5.13	Perceptions/
	5	experience	3	3.85	Senses
Students' learning outcomes	1	listening	4	4.76	Motivation
	2	movies	4	4.76	
	3	stress	3	3.57	
	4	anxiety	2	2.38	Understanding
	5	exams	2	2.38	
Challenges of	1	see	5	4.95	Easiness/diffic

Themes	Rank	Word	Count	Weighted Percentage (%)	Subthemes
360° VR videos	2	easier	4	3.96	ulty of using
	3	movies	4	3.96	the videos
	4	dimensions	3	2.97	
	5	interesting	3	2.97	
Teacher role	1	effective	4	12.12	----
	2	familiar	3	9.09	
	3	perfect	3	9.09	
	4	great	2	6.06	
	5	excellent	1	3.03	

Students' Experience with 360° VR Videos

Generally, students described their experience to be exciting and captivating, particularly because they liked the panoramic view of the environment. Most students were astounded by the sense of reality that existed in the videos (see Table 5).

Table 5. Students' Experience with 360º VR Videos

Subtheme	Example quote
Feelings	"It was fun and very exciting".
	"I found the videos to be very engaging and captivating."
Perceptions/Senses	
• panoramic view	"It was very interesting to me that we could see all the dimensions of the film at the same time, it made us feel as if we were really in that environment and we traveled to those cities at the same time with the narrator".
• sense of reality	"It was a great experience. I felt that I was in that environment and I could see all the people, cars, and buildings very close. It was really interesting".

Learning Outcomes

The students believed that the use of 360º VR videos motivated them to follow the difficult task of listening, lowered their task and exam anxiety, and helped them remember new words longer (see Table 6).

Table 6. Learning Outcomes

Subtheme	Example quote
Motivation	
• anxiety	"It reduced our anxiety. We were more eager to watch the movies".
	"Listening exams have always been stressful for me, but now I feel that if we had smart classes to use such kinds of videos, we would

Subtheme	Example quote
	experience listening examinations without any stress".
• learning environment	"I used to watch a lot of movies to improve my language proficiency, but I had never seen such films before and I think these 360º videos are very effective in motivating and also improving our language skills. I liked them very much".
	"Using this kind of technology makes language learning much easier".
Understanding	"This method helps us a lot to keep the new words in our minds because everything seems to be completely real".

Benefits and Challenges of 360º VR Videos

Almost all students said that they did not experience any particular problem with watching 360º videos on their devices. One or two students had some problems with understanding the narrations or concentrating while watching the movies (see Table 7).

Table 7. Benefits and Challenges of 360º VR Videos

Subtheme	Example quote
Easiness	"It was much better and easier than other kinds of movies".
	"They were easy and comprehensible."
Difficulty	"Being able to see all the angles of the film in this way was really interesting and exciting, and I think the only challenging thing is understanding the description presented in the video accurately and completely".
	"It was easy for me, but sometimes seeing the different dimensions of the film made me pay attention to other parts and also made it difficult to understand what the narrator was saying, but when the movie was played for the second time, this problem was solved".

Teacher Role

The students found the teacher to be quite helpful and effective and were appreciative of her for making them familiar with this technology.

Discussion

Listening is largely neglected in the growing literature on VR-assisted language learning. This study was carried out to address this matter by incorporating VR videos into the pre-listening phase of listening instruction and scrutinizing the effect of this strategy on students' learning gains and perceptions. Utilizing a mixed methods

research design assisted the researchers in studying the variables more deeply by gathering and analyzing quantitative and qualitative data.

The results of the study primarily showed that using immersive learning environments as pre-listening activities led to EFL learners' improvement in listening comprehension. This finding corroborates the theoretical assumptions and empirical evidence that making students familiar with the topic of listening before doing the task would ease information processing as students' anxiety and apprehension of the unknown decline. What the findings add to the literature is that the type of pre-listening activities matters and the use of certain types of technologies can influence the comprehension of aural input more profoundly. It is known that incorporating multimedia into the cycle of teaching listening can influence listening comprehension and listening anxiety (e.g., Cigerci & Gultekin, 2017).

The finding of the current study showed that 360° VR videos have also considerable potential to be used as instructional aids and can increase students' listening skills over time. There are certain reasons for this finding. First, these videos provide a type of instructional content that observes human cognitive architecture and lowers the cognitive burden of information processing by yielding multimodal input. Working memory is "capable of holding multidimensional episodes or chunks, which may combine visual and auditory information" (Baddeley, 2010, R138); therefore, when students are immersed in the context of the listening, both audio and visual channels are used to process the information. This assists students to promote their bottom-up and top-down processing which ultimately leads to better comprehension of the message. In this process, particular types of listening strategies that are essential for listening comprehension such as listening for the gist, activating schemata, and making inferences (Vandergrift et al., 2006) are also utilized more efficiently to compensate for the parts that are not understood very well (Park, 2018).

Second, this type of input is not only multimodal but also immersive and provides the listeners with a sense of presence and reality. In this learning context, the listeners can travel to places that are not possible in the real world from the undersea world and wildlife to the famous historical relics and ancient sites. By using this technology, no boundary exists for language learners' imagination and thus they feel they are really in the context of a foreign country. This gives a genuine reason for learning the language by doing meaningful activities that have ties with the real world and its attributes. Further, as key aspects of the listening situation including the participants and the surrounding scene calibrate the listener orientation (Imhof, 2010) being involved and immersed in the listening context would make 360° VR videos an ideal environment conducive to comprehension and learning.

Third, the pre-listening activities with immersive videos helped learners activate their background knowledge and thus the germane load of the listening task increased. In this way, more cognitive resources are devoted to listening comprehension through schemata building or information retrieval (Sweller et al., 2011). When the germane load is fostered, more capacity of the working memory becomes free to control the intrinsic load that is generated by either the complexity of the task or the instructional approach (Paas et al., 2010). "As germane load is stated to be associated with processes that directly contribute to learning" (Kirschner et al., 2011), using 360° VR videos as

pre-listening activities contributed to the promotion of listening comprehension. The outcome, in line with past literature, suggests that well-designed multimedia can manage extraneous cognitive load and generate adequate germane load crucial for learning (Banihashem et al., 2023).

Further, it was found that the effect sizes for the intervention in Parts 3 and 4 of the listening post-test were larger in comparison to Parts 1 and 2. Parts 3 and 4 focused on understanding monologues while Parts 1 and 2 focused on understanding dialogues and conversations. The reason is that many 360º VR videos are narrated by a single person and they do not have any interaction among people. This actually shows that despite the many benefits these types of videos have for listening instruction, they are more appropriate to be used for teaching monologues rather than conversations and dialogues. The finding suggests that to promote the influence of 360º VR videos on language learners' oracy skills, the production of interactive and dialogic VR videos be given special attention as well.

Last, two contentious issues should be addressed while generalizing the findings of the current study to the population of EFL learners. The first one is the role of gender in listening comprehension. While some studies set forth that male and female listeners process the oral input differently (e.g., Zohrabi et al., 2015) and women benefit from pre-listening activities more than men in comprehending the listening tasks (Rajabi, 2015), non-significant differences in the value of schemata-based pre-training activities in comprehension across gender have been reported (e.g., Oroji & Hajiqorbani, 2012). Also, gender is suggested to be one of the issues that need further investigation in technology-enhanced (Dehghanzadeh et al., 2024) and VR-assisted language learning environments (Hua & Wang, 2023). The second concern is that although the participants' familiarity with the general theme of the listening task was checked before beginning the pre-listening phase, any possible differences in students' knowledge of the content before and after the study were not examined. Deeper insights into the effect of VR-supported learning environments on knowledge development (e.g. Sichterman et al., 2023) and the role of the amount and accuracy of students' knowledge in the success of knowledge activation techniques for comprehension (Hattan et al., 2024) will be gained by follow-up research.

The results of the interviews showed that almost all participants believed that the pre-listening activities planned based on 360º VR videos were inspiring and pedagogically valuable. They hold positive perceptions of their general experience with 360º VR videos, the way these videos were effective in performing listening tasks, and how this new technology was adapted and used appropriately by their teacher for instructional purposes.

This finding generally corroborates previous postulations concerning immersive technology that in designing VR-based instruction, instructional design principles should be considered (Merchant et al., 2014). In this study, incorporating 360º VR videos into the cycle of comprehension-based listening instruction, whose main purpose is comprehension and activating the schemata, was found to be fruitful and beneficial. As students' answers show, this instructional design was quite suitable as they not only believed that their learning improved greatly but also their listening and test anxiety declined significantly. The instructional design roused students' levels of interest in listening and at the same time captured their attention and helped them remember the learned materials longer. Also, the findings of the study support the benefits of VR-based instruction for language learning including

facilitating interaction and collaboration, promoting language learning motivation, building communicative competence, and giving a sense of presence and authenticity to language tasks (Parmaxi, 2023).

Conclusions

The current study probed into the effects of 360º VR videos on EFL learners' development of listening comprehension through a quasi-experimental research method and also examined the participants' perceptions of the educational values of this cutting-edge technology by gathering qualitative data through a structured interview. The results generally showed that 360º VR videos used as pre-listening activities are beneficial for listening instruction and can guarantee the development of listening skills, promotion of motivation, decline of listening anxiety, and enhancement of students' interest and engagement in doing listening tasks.

The study suggests illuminating insights into the benefits of VR for listening instruction, despite the limitations the researchers encountered in the process of conducting the study. First and foremost, the 360º VR videos were not prepared by the researchers, although they were carefully selected considering content appropriacy (difficulty level, cultural issues, technical aspects, etc.). This was not technically and financially possible for the researchers. Further, the study was carried out among female students of the lower-intermediate level of English proficiency, and performing the experiment among other groups of language learners was not possible due to practicality issues.

It is therefore suggested that future researchers compare and contrast the effects of created and curated 360º VR videos on the development of language skills in general and listening comprehension in particular. Further, considering the participants' individual differences such as gender, language proficiency, and age is recommended for follow-up studies to shed more light on the educational values of VR technology in language learning and teaching.

Also, as it was mentioned earlier, to manage the germane cognitive load and consequently the extraneous cognitive load during the task of listening comprehension, the 360º VR videos were integrated into the pre-listening phase of the instruction. Future research may be conducted by implementing VR-based instructional content across three phases of pre-during-post listening to cross-compare the students' learning gains from each phase.

References

Alavi, S. M., & Janbaz, F. (2014). Comparing two pre-listening supports with Iranian EFL learners: Opportunity or obstacle. *RELC Journal, 45*(3), 253-267. https://doi.org/10.1177/0033688214546963

Alavi Moghaddam, B., Kheirabadi, R., Rahimi, M., & Davari, H. (2018). *Vision 2, English for Schools (English for K-10)-Teacher's Guide.* Ministry of Education of Iran, Organization for Educational Research and Planning.

Alobaid, A. (2020). Smart multimedia learning of ICT: Role and impact on language learners' writing fluency-YouTube online English learning resources as an example. *Smart Learning Environments, 7,* 24.

https://doi.org/10.1186/s40561-020-00134-7

Amari, A., & Gorjian, B. (2019). The effect of eliciting tasks on listening comprehension among Iranian pre-intermediate EFL learners. *International Journal of Research in English Education, 4*(2), 42-60. https://doi.org/10.29252/ijree.4.2.42

Baddeley, A. (2010). Working memory. *Current Biology, 20*(4), R136-R140.

Banihashem, S. K., Dehghanzadeh, H., Clark, D., Noroozi, O., & Biemans, H. J. A. (2023). Learning analytics for online game-Based learning: A systematic literature review. *Behaviour & Information Technology*, https://doi.org/10.1080/0144929X.2023.2255301

Barjesteh, H., & Ghaseminia, M. (2023). Effects of pre-listening task types on the development of EFL learners' listening comprehension ability. *International Journal of Listening, 37*(2), 156-170.

Cambridge English Qualifications: B1 Preliminary. (2020). Cambridge University Press.

Chen, B., Wang, Y., & Wang, L. (2022). The effects of Virtual Reality-assisted language learning: A meta-analysis. *Sustainability, 14*, 3147. https://doi.org/10.3390/su14063147

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

Cigerci, F. M., & Gultekin, M. (2017). Use of digital stories to develop listening comprehension skills. *Issues in Educational Research*, *27*(2), 252-268.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Cutler, A., & Clifton, C. (1999). Comprehending spoken language: A blueprint of the listener. In C.M. Brown, and P. Hagoort (Eds.)., *The neurocognition of language* (pp. 123-66). Oxford University Press.

Dehghanzadeh, H., Fardanesh, H., Hatami, J., Talaee, E., & Noroozi, O. (2021). Using gamification to support learning English as a second language: A systematic review, *Computer Assisted Language Learning, 34*(7), 934-957. https://doi.org/10.1080/09588221.2019.1648298

Dehghanzadeh, H., Farrokhnia, M., Dehghanzadeh, H., Taghipou, K., & Noroozi, O. (2024). Using gamification to support learning in K-12 education: A systematic literature review. *British Journal of Educational Technology, 55*(1), 34-70. https://doi.org/10.1111/bjet.13335.

Diyyab, E. A., Abdel-Haq, E. M., & Aly, M. A. S. (2014). Using a multimedia-based program for developing student teachers' EFL speaking fluency skills. *Journal of Faculty of Education, 99*(3). https://doi.org/10.12816/0021993

Field, J. (2006). *Psycholinguistics: A resource book for students*. Routledge.

Gilbert, R. L., Murphy, N. A., Krueger, A. B., Ludwig, A. R., & Efron, T. Y. (2013). Psychological benefits of participation in three-dimensional virtual worlds for individuals with real-world disabilities. *International Journal of Disability, Development & Education, 60*(3), 208-224.

Hattan, C., Alexander, P. A., & Lupo, S. M. (2024). Leveraging what students know to make sense of texts: What the research says about prior knowledge activation. *Review of Educational Research, 94*(1), 73-111. https://doi.org/10.3102/00346543221148478.

Hua, C., & Wang, J. (2023). Virtual reality-assisted language learning: A follow-up review (2018–2022). *Frontiers in Psychology, 14*, 1153642. https://doi.org/10.3389/fpsyg.2023.1153642

Imhof, M. (2010). What is going on in the mind of a listener? The Cognitive Psychology of Listening. In Wolvin

A. D. (Ed.), *Listening and human communication in the 21ˢᵗ century* (pp. 97-126). US: Blackwell.

Ji, S., Li, K., & Zou, L. (2019). *The effect of 360-degree video authentic materials on EFL learners' listening comprehension.* [Paper presentation]. International Joint Conference on Information, Media & Engineering (IJCIME), Osaka, Japan, pp. 288-293, https://doi.org/10.1109/IJCIME49369.2019.00065

Karimi, F., & Chalak, A. (2022). Role of bottom-up and top-down pre-listening activities on Iranian EFL students' listening comprehension. *Journal of Modern Research in English Language Studies, 9*(1), 53-72. https://doi.org/10.30479/jmrels.2020.12364.1536

Kirschner, K., Kester, L., & Corbalan, G. (2011). Cognitive load theory and multimedia learning, task characteristics and learning engagement: The current state of the art. *Computers in Human Behaviour, 27*(1), 1-4, 2011. https://doi.org/10.1016/j.chb.2010.05.003

Lan, Y.J., Fang, W.C., Hsiao, I.Y.T., & Chen, N.S. (2018). Real body versus 3D avatar: The effects of different embodied learning types on EFL listening comprehension. *Educational Technology and Research Development, 66*, 709-731. https://doi.org/10.1007/s11423-018-9569-y

Lee, A. (2019). Using Virtual Reality to test academic listening proficiency. *Korean Journal of English Language and Linguistics, 19*(4), 688-712. https://doi.org/10.15738/kjell.19.4.201912.688

Legault, J., Zhao, J., Chi, Y. A., Chen, W., Klippel, A., & Li, P. (2019). Immersive Virtual Reality as an effective tool for second language vocabulary learning. *Languages, 4,* 13.

Madani, B. S., & Kheirzadeh, S. (2022). The impact of pre-listening activities on EFL learners' listening comprehension. *International Journal of Listening, 36*(1), 53-67.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed.). Cambridge University Press.

Mayer, R. E. (2014). Research-based principles for designing multimedia instruction. In V. A. Benassi, C. E. Overson, and C. M. Hakala (Eds.), *Applying science of learning in education: Infusing psychological science into the curriculum* (pp. 59-70). Association for the Advancement of Computing in Education (AACE).

Mayring, P. A. E. (2023). Qualitative content analysis. In R. J. Tierney, F. Rizvi, and K. Ercikan (Eds.), *International Encyclopedia of Education* (4th ed.) (pp. 314-322). Elsevier.

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education, 70*, 29-40. https://doi.org/10.1016/j.compedu.2013.07.033

Noroozi, O., Pijeira-Díaz, H.J., Sobocinski, M., Dindar, M., Järvelä, S., & Kirschner, P. A. (2020). Multimodal data indicators for capturing cognitive, motivational, and emotional learning processes: A systematic literature review. *Education & Information Technology, 25,* 5499-5547.

Oroji, M. R., & Hajiqorbani, M. (2012). The effects of gender differences and schema-based pre-reading activities on reading comprehension skill. *Iranian Sociological Review, 2*(1), 55-61. Retrieved March 2024 from https://sanad.iau.ir/Journal/ijss/Article/805029

Owolewa, O. O., & Olu, O. (2017). Effects of listening strategies' instruction on students' attitude to listening. *European Journal of Education Studies, 3*(7), 624-642. http://dx.doi.org/10.46827/ejes.v0i0.902

Paas, F., van Gog, T., & Sweller, J. (2010). Cognitive load theory: New conceptualizations, specifications, and integrated research perspectives. *Educational Psychology Review*, *22*(2), 115-121. https://doi.org/10.1007/s10648-010-9133-8

Pallant, J. (2020). *SPSS Survival Manual: A step by step guide to data analysis using IBM SPSS*. Routledge.

Park, M. (2018). Innovative assessment of aviation English in a virtual world: Windows into cognitive and metacognitive strategies. *ReCALL, 30*(2), 196-213. https://doi.org/10.1017/S0958344017000362

Parmaxi, A. (2023) Virtual reality in language learning: a systematic review and implications for research and practice. *Interactive Learning Environments, 31*(1), 172-184.

Parsons, T.D, & Rizzo, A.A. (2008). Initial validation of a virtual environment for assessment of memory functioning: virtual reality cognitive performance assessment test. *Cyberpsychology & Behavior, 11*(1), 17-25. https://doi.org/10.1089/cpb.2007.9934

Rajabi, Z. (2015). The role of pre-listening activities on EFL learners' listening comprehension. *International Journal of Foreign Language Teaching & Research, 3*(10), 35-43.

Rajaei, Z. (2015). The role of pre-listening activities on EFL learners' listening comprehension. *International Journal of Foreign Language Teaching & Research, 3*(10), 35-43.

Rameshianfar, A., Shahnazari, M. T., & Tavakoli, M. (2015). The effects of two pre-listening vocabulary and enhanced content-related supports on Iranian intermediate EFL learners' listening comprehension sub-skills. *Journal of Applied Linguistics and Language Research, 2*(8), 284-302.

Rouhi, A., Nabavi, S. M., & Mohebbi, H. (2014). The effects of previewing questions, repetition of input, and topic preparation on listening comprehension of Iranian EFL learners. *Iranian Journal of Language Teaching Research, 2*(2), 73-85.

Rost, M. (2011). *Teaching and researching listening* (2nd ed). Longman

Sanrica, H. C., & Usluel, Y. K. (2016). The effect of digital storytelling on visual memory and writing skills. *Computers & Education, 94,* 298-309. https://doi.org/10.1016/j.compedu.2015.11.016

Sayyadi, M., Rahimi, M., Ebrahimpour, R., & Amiri, S. H. (2024). Applying multimedia learning principles in task design: Examination of comprehension development in L2 listening instruction. *English Teaching & Learning, 48*(1), 73-96. https://doi.org/10.1007/s42321-022-00132-7.

Shokri, R. (2023). *The impact of Virtual Reality on EFL learners' vocabulary retention and development of listening comprehension*. [master's thesis]. Shahid Rajaee Teacher Training University. Iran.

Sichterman , B., van Ginkel, S., van Halteren, van Tilborg, R., & Noroozi, O. (2023). The effects of a constructively aligned Virtual Reality setting on professionals' knowledge, motivation and perceptions. *International Journal of Technology in Education, 6*(4), 561-582. https://doi.org/10.46328/ijte.462

Snelson, C, & Hsu, Y.C. (2020). Educational 360-degree videos in virtual reality: A scoping review of the emerging research. *TechTrends, 64*, 404-412. https://doi.org/10.1007/s11528-019-00474-3

Sun, F. R., Pan, L. F., Wan, R. G., Li, H., & Wu, S. J. (2021). Detecting the effect of student engagement in an SVVR schoolbased course on higher level competence development in elementary schools by SEM. *Interactive Learning Environments, 29*(1), 3-16. https://doi.org/10.1080/10494820.2018.1558258

Sweller, J. (2017). Cognitive load theory and teaching English as a second language to adult learners. TESL Ontario. *Contact Magazine,* 1-10.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive load theory.* Springer.

Tacgin, Z. (2022). *Virtual and Augmented Reality: An educational handbook*. Cambridge Scholars Publishing

Taghavi Takyar, S. F., & Jalali, M. (2016). The effect of multimedia-based instruction on improvingIranian EFL learners' grammar knowledge and their attitudes. *Journal of English Language Pedagogy and Practice,*

9(19), 161-177.

Taheri, P., & Abdollahi-Guilani, M. (2019). Investigating the effectiveness of using podcast, video short programs and topic preparation as pre-task activities on the performance of EFL learners' listening comprehension task types. *Journal of Foreign Language Research, 9*(3), 879-910. https://doi.org/10.22059/jflr.2019.273237.594

Tai, T-Y, & Chen, H. H-J. (2021). The impact of immersive Virtual Reality on EFL learners' listening comprehension. *Journal of Educational Computing Research, 59*(7), 1272-1293. https://doi.org/10.1177/0735633121994291

Teng, M. F. (2023). The effectiveness of multimedia input on vocabulary learning and retention. *Innovation in Language Learning and Teaching, 17*(3), 738-754. https://doi.org/10.1080/17501229.2022.2131791

Vandergrift, L., Goh, C.C.M., Mareschal, C.J., & Tafaghodtari, M.H. (2006). The Metacognitive Awareness Listening Questionnaire: Development and validation. *Language Learning, 56,* 431-462. https://doi.org/10.1111/j.1467-9922.2006.00373.x

Wagner, C., & Ip, R. K. (2009). Action learning with Second Life–A pilot study. *Journal of Information Systems Education, 20*(2), 249-258. Retrieved from: http://jise.org/volume20/n2/JISEv20n2p249.html

Weiner, E. J., & Sanchez, D. R. (2020). Cognitive ability in virtual reality: Validity evidence for VR game-based assessments. *International Journal of Selection & Assessment, 28*(3), 215-235. https://doi.org/10.1111/ijsa.12295

Willis, D., & Willis, J. (2001). Task-based language learning. In R. Carter & D. Nunan (Eds.), *The Cambridge Guide to Teaching English to Speakers of other languages* (pp. 173-179). Cambridge University Press.

Yang, G., Chen, Y. T., Zheng, X. L., & Hwang, G. J. (2021). From experiencing to expressing: A virtual reality approach to facilitating pupils' descriptive paper writing performance and learning behavior engagement. *British Journal of Educational Technology, 52*, 807–823. https://doi.org/10.1111/bjet.13056

Ye, Y., & Kaplan-Rakowski, R. (2023). Practicing listening comprehension skills in high-immersion virtual reality. SSRN, https://ssrn.com/abstract=4335690

Zheng, C., Yu, M., Guo, Z., Liu, H., Gao, M., & Chai, C. S. (2022). Review of the application of virtual reality in language education from 2010 to 2020. *Journal of China Computer-Assisted Language Learning*. https://doi.org/10.1515/jccall-2022-0014

Zohrabi, M., Sabour, H., & Behgozin, M. (2015). The impact of pre-listening activities on Iranian EFL learner's listening comprehension of authentic English movies. *International Journal on Studies in English Language and Literature, 3*(2), 42-56.

Author Information

Mehrak Rahimi

https://orcid.org/0000-0003-4376-0045

Shahid Rajaee Teacher Training University

Iran

Contact e-mail: *rahimi@sru.ac.ir*

Mozhgan Aghabarari

https://orcid.org/0000-0003-3783-5581

Shahid Rajaee Teacher Training University

Iran

Appendix. Interview Questions

Theme 1- Experience with 360-degree videos

1. Have you ever had the experience of working with any 360º VR presentations/videos before?

2. If this is your first VR experience, how do you describe your experience with 360º videos?

Theme 2- Perceptions of the educational value of technology

3. Compared to your previous experience of working with computers, what did this new experience (i.e., working with 360º videos) add to the value of using technology for language learning?

4. Compared to two months ago, generally when you listen to English, do you feel any difference in your listening in terms of comprehension, motivation, and anxiety?

Theme 3- Benefits and challenges of 360º VR videos

5. Were 360º VR videos difficult to understand or easy? What was interesting? What was challenging?

6. Did you have any technical problems when you were watching VR videos?

Theme 4- Teacher role

7. How do you evaluate the role of your teacher in encouraging you to watch these videos?