Journal of Technology and Chinese Language Teaching Volume 16 Number 1, June 2025
http://www.tclt.us/journal/2025v16n1/chengzhan.pdf pp. 1-29

An Explorative Case Study of the Integration of a Fully Immersive VR Game Into the Chinese Classroom (融入沉浸式虛擬實境遊戲於中文課程之探索性個案研究)

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Abstract: This case study aims to integrate a story-driven virtual reality (VR) game into a Chinese lesson to investigate the dynamic interactions between teacher facilitation, student engagement, and language learning within a VR environment. Based on the theory of affordance, three VR learning tasks were designed to engage the student with a virtual environment to learn Chinese. Data was analyzed using descriptive analysis and chi-square tests. The findings reveal that while technical assistance played a crucial role in the initial VR game learning stages, questioning strategies and story-driven facilitation techniques proved to be more effective in fostering meaningful language learning. The study highlights the importance of balancing technical guidance with immersive, content-driven questioning to maximize student engagement and language acquisition in VR-based instruction.

摘要: 此個案研究旨在將一款以故事導向的虛擬實境遊戲(VR)融入中文課程並探究此學習環境下教師輔助、學生參與、語言學習間的互動關係。依據賦能理論，研究者設計了三項沉浸式虛擬實境的學習任務，以促進學生在虛擬環境的中文學習。資料分析採用敘述性統計以及卡方檢定，顯示在 VR 遊戲學習的初期階段，教師的技術協助扮演重要角色，而教師的提問策略以及故事內容相關的教學指引更能有效促使有意義的語言學習。研究結果強調，在 VR 融入中文教學中，需在教師技術指導與內容導向的提問策略之間取得平衡，使學習者參與以及語言習得的效果最大化。

Keywords: Virtual reality, story driven game, Chinese learning, affordance theory, case study

關鍵詞: 虛擬實境，故事導向遊戲，中文學習，賦能理論, 個案研究

1. Introduction

Virtual reality (VR) is often referred to as a three-dimensional digital environment in which users can immerse themselves within and interact with the environment. VR has been increasingly applied in foreign language education in recent years. Through different VR apps and games, language learners can practice vocabulary, speaking, reading, and writing in immersive and interactive environments (Alfadil, 2020; Huang et al., 2021; Tai et al., 2020). Fully immersive VR games with wearable devices can create more immersive learning experiences through simulations (Jensen & Konradsen, 2018; Alfadil, 2020). Through interacting with objects offered in the VR game environment, learners can perceive possibilities for doing something with the target language (Aronin, 2014; Kordt, 2018). This practice is well supported by affordance theory which values human-computer and human-environment interactions. In this theory, affordance is not just a physical property but also a relational concept—it depends on both the object's characteristics and the individual's abilities to interact with it.

In the VR game-based learning process, a teacher’s facilitation can encourage learners, guide them in identifying affordance, and help them take actions for learning. With the support of well-designed VR learning procedures, learners can engage in the learning process more effectively, cognitively, and behaviorally (Kordt, 2018; Jong, 2023).

Although the number of studies on digital game-based learning of second languages has increased (Dixon et al., 2022), many studies mainly focus on learning English as a second or foreign language (ESL or EFL). Learning Mandarin Chinese as a foreign language (CFL) through fully immersive VR games still needs more investigation. This research aims to provide a picture of how a Chinese teacher facilitated a single student’s understanding and completion of an authentic story-driven game, and how the student engaged and performed in the fully immersive VR game-based learning process.

2. Literature Review

2.1 Theoretical framework – Affordance Theory in VR game-based learning design

Affordance theory was introduced by American psychologist James J. Gibson in his article “The Theory of Affordance” (Gibson, 1986). The original focus of affordance theory values animal-environment interaction, that is, the understanding of how animals perceive and interact with their surroundings based on opportunities or affordance that the environment provides. Gibson's theory suggests that the environment offers various affordances or action possibilities that are directly perceivable by the observer, without the need for complex cognitive processing. These affordances guide behaviors and facilitate interactions, shaping the way individuals navigate and engage with their environment.

Educators have extended his classic concept of animal-environment relations to human-computer and human-environment interactions (Wang et al., 2018; Lee et al., 2018). With this developed definition, affordance theory expands its observation to what physical or virtual environment offers or affords, and what actions humans can take when interacting with the objects provided in the environment.

Affordance theory has been applied in many disciplines as a theoretical and instrumental guideline for learning design to increase users' interactions and engagement with learning environments. Instructional designers often apply affordance theory in VR game-based learning to create affordance for possibilities of action and interaction. To increase human-computer or human-digital environment interaction, instructional designers must consider cognitive, physical, sensory, and functional affordance in design (Hartson, 2003). These affordances are design features that help users to know something, do something, sense something, and accomplish the task (functional affordance). Hartson (2003) further explains the four affordance types using the example of clicking a button labeled "SORT". Once a user sees the SORT button, its text label tells the user what will happen if he clicks on it (cognitive affordance). The button is large, so the user can click on it accurately (physical affordance). In addition, the label font size is large enough for the user to read it easily (sensory affordance). Lastly, the user can get the information sorted (functional) by clicking on the SORT button.

Affordance theory has also been adopted to support multilingual education (Aronin, 2014; Kordt, 2018). Affordance theory explains how the objects perceived by individual learners and their interaction with the learning environment create many unique opportunities for language and cultural learning. Sun (2016) also pointed out that a language teacher should understand the affordance of the teaching environment as well as learners' perceptions toward it to ensure language learners efficiently interact with the language environment and to provide more opportunities for language input and output. The affordance theory guides the design for interaction, usability, and learning experience, but when using VR games in learning, how teachers facilitate students in the VR-based game to impact learning is worth discussing.

2.2 VR games in teaching and learning of foreign languages

VR has gained increasing attention in foreign language education because of its immersive and interactive features, which are essential factors contributing to the success of foreign language learning (Peixoto et al., 2021; Parmaxi, 2020). Language learners can apply their language skills when experiencing real-life scenes or tasks in the simulated environment, interacting with objects afforded in the environment, or communicating with other people as they do in real life.

Based on the level of immersion, VR is generally classified into three types: non-immersive, semi-immersive, and fully immersive (Villena-Taranilla et al., 2022; Peixioto et al., 2021). Non-immersive VR is the lowest type of immersion, and users can only view and interact with a virtual world through the screen of a digital device. Semi-immersive VR gives users the feeling of being slightly or partially immersed in experiencing a virtual environment. Fully immersive VR allows users to experience and interact in the virtual world within the environment itself as if it were real and authentic.

Each type of VR has valuable and unique merits for the development of foreign languages, but recent reviews have reported that fully immersed VR is more efficient for learning (Alfadil, 2020; Villena-Taranilla et al., 2022; Parmaxi, 2020). Through head-mounted displays, headphones, and gloves, users can experience the virtual world and perform tasks as if they were real using the target language. However, current research findings are mainly based on learning English as a foreign language and integrating fully immersive VR into uncommonly taught foreign languages, like Mandarin Chinese, requires further exploration. In addition, current studies mainly observe the learning of specific skills (for example, speaking and vocabulary, Parmaxi, 2020), user perceptions, satisfaction, and motivation (Peixoto et al., 2021); while other essential elements of learning interactions and teacher facilitation in the VR experience have remained under-investigated.

2.3 Facilitation in VR game-based learning

The affordances mentioned above in VR game-based learning environment design may be perceived differently based on a person's attributes, interests, attention, and level of context awareness. Researchers argue that teachers must first perceive and recognize the affordances and then develop pedagogical strategies to enhance learning opportunities to help students complete game tasks (Sun, 2016). Teachers' mediation becomes more important when experiencing VR games that are not specially designed for subject-based teaching and learning (Kordt, 2018; Poole et al., 2022).

However, the existing research investigating teacher facilitation in VR game-based learning is still scarce (Jong et al., 2017; Kordt, 2018; Poole et al., 2022). Among a few identified studies relevant to teachers' facilitation in game-based learning, Jong et al. (2017) proposed a teacher-supported pedagogical framework that specified three sequential phases to provide facilitation and scaffolding before, during, and after experiencing VR games. In Phase 1, the teacher scaffolds students with initial abstract knowledge related to the subject matter covered in the game. In Phase 2, the teacher engages students in gaming and reflection upon their learning in the virtual world. In Phase 3, the teacher debriefs students during and after the gaming process, either providing encouragement or discussing gaming strategies and game learning experiences.

In a more current study conducted by Poole et al. (2022) on the affordance and effectiveness of a digital game in the dual Chinese language immersion classroom, seven types of supports (which were named pedagogical affordance in the study) were identified during digital gameplay: quest management (direct learners towards to the next quest), combat strategy discussion (discuss strategies related to winning a battle), meaningful communication (discuss current status/object in the game), encouragement (encourage a player to explore the game or read a text on their own), technology support (show a player how to play the game or help with a technical problem related to the game), confirmations (confirm a question or belief about the game), and linguistic support (help learners read a text or provide a translation to a word). The learning procedures and types of support can guide teachers through a VR game-based learning process, but how a teacher can facilitate student learning of Chinese in a non-combat-, narrative-based, and decision-making VR game in the classroom needs further exploration.

2.4 Engagement and performance in VR game-based learning

Teachers' facilitation, as discussed above, helps students in the learning process, but student engagement during the process directly leads to their learning performance. The importance of engagement in learning can never be over-emphasized. As Perry and Booth (2021) stated, no learning occurs without student engagement. Systematic reviews of the literature on gamified learning in higher education revealed that gamification and game-based learning have a positive effect on student engagement in many disciplines (Subhash & Cudney, 2018), and digital, narrative, game-based learning has positive effects on engagement, motivation, and learning (Breien & Wasson, 2020).

Learning engagement often refers to the ability to cognitively, affectively, and behaviorally be involved in the learning process (Dubovi, 2022). Following these three dimensions of engagement, Xin (2022) found that cognitive engagement and emotional engagement in VR game learning environments contributed to better learning results. Dubovi (2022) found that engagement, particularly during the active VR procedural learning phase, is associated with positive emotions and increased mental effort (cognition). These research findings are reported mainly from English or science education studies. It is still unclear in the literature how teachers guide learners in completing VR game-based tasks, how learners of the Chinese language engage in the learning process, and how their engagement connects to their learning performance.

3. Purpose and Research Questions

The purpose of the study was to investigate how to integrate a story-driven VR game into a Chinese language class. Through the observation of a teacher's facilitation of a single student completing VR game tasks, this study particularly aimed to answer the following two questions.

1. How could the teacher facilitate the completion of an authentic story-driven VR game?
2. What is the relationship between the teacher's facilitation and the student's performance?

4. Methodology

4.1 Design of the study

A single case study is defined by Stake (1995) as the study of the particularity and complexity of a single case (an individual, group, organization, or event), coming to understand its activity within important circumstances. With a pre-selected case or subject, a case study in the natural context can capture the uniqueness and specific characteristics of the case through in-depth observations and analysis. Accordingly, this study adopted a single-case design to explore uniqueness regarding how to integrate a story-driven game into an intermediate-level Chinese class. This class was an independent learning course, not associated with any formal Chinese language curriculum. This design enables teachers and researchers interested in the use of VR games in language instruction to understand the structure of a VR game lesson, how a VR game can be carried out during class, and what type of insight can be gained from VR game-based learning.

4.2 Participants

The exploratory single case investigated in this study was an intermediate Chinese language student, Mike (pseudonym), enrolled in an intermediate Chinese language course during a 4-week summer study abroad program in Taiwan. Mike, a 19-year-old American college freshman, had completed 12 credits of Chinese courses prior to the study abroad program. Mike's oral language proficiency was rated intermediate low based on the Oral Proficiency Interview (OPI)[1] guidelines. During the study abroad program, Mike attended 4 hours of Chinese instruction daily and was the sole student in the class.

Jean (pseudonym), a professor with 15 years of experience teaching Chinese as a foreign language (CFL) and training CFL teachers, served as Mike's VR game-learning instructor. Jean is very experienced in using technology in teaching Mandarin Chinese. During the program, Jean offered three 1-hour sessions of VR game-based class to Mike outside of his regular class time.

4.3 The VR-game–*The Price of Freedom*

The Price of Freedom, a single-player room-scale VR game, was selected for this research. Different from other VR games which feature combat, this game requires users to follow narrative information to make a decision. This game was released by Construct Studio in 2016 and is based on a real story that occurred when the United States was deeply involved in the Cold War with Russia. The player takes the role of CIA Agent Zero, and the mission is to find and assassinate Benjamin Miller to prevent the classified chemical weapons research valuable to nuclear war he has stolen from falling into enemy hands.

The selection of this game was predicated on two principal considerations. Firstly, from a language acquisition standpoint, the material is intended for native speakers, and this study seeks to utilize authentic virtual reality (VR) learning resources for learners of Chinese as a Second Language (CSL). The linguistic complexity of the game was not consistently adapted for specific CSL learners. According to the vocabulary outlined for the learning stages in the study's 4.4.1 session, it is more appropriately suited for students at an intermediate level of Chinese proficiency. Secondly, from a digital game design perspective, the game is supported in both English and Mandarin Chinese in terms of the texts and audio voices. The game is well designed with many authentic documents, historical graphics, theatrical narration, and interactive objects in the game scenes. The game storyline proceeds through entering three rooms in sequence after completing tasks in each room.

[1] https://www.actfl.org/assessments/postsecondary-assessments/opi

The first room is the target Benjamin's office, where Agent Zero killed Benjamin and receives a command to look for a stolen documents that Benjamin hided. The second room is a chamber of secrets full of newspapers posted on the wall and documents stored in drawers. Agent Zero follows the built-in audio commentary, reads the documents and news, finds secret codes with the flashlight, and decodes clues to locate the security box where the important information is located, and the user will learn the truth behind Benjamin's motives. The third room is the ward of a mental hospital to which the players return. There the players will find an unexpected twist. Figure 1 illustrates the game space.

Figure 1 Sample game spaces for *The Price of Freedom*

4.4 Procedures

4.4.1 Instructional stages for each lesson

Based on the development of the VR game storyline and changes in the scenes in three rooms, three one-hour lessons were designed for in this case study for three consecutive days. Each of the three lessons proceeded through four learning stages: (1) vocabulary learning, (2) image-based guidance, (3) virtual reality gaming interactions, and (4) story-telling.

The following section outlines the design of the learning tasks for each stage, with a particular emphasis on Stage 3, where the student was fully immersed in the VR game, which is also the focus of the study.

Stage One was vocabulary learning. Vocabulary was selected based on the story, resulting in an unequal number of vocabulary words across the three lessons (see Table 1 on next page). In this stage, the instructor first presented new words related to the game story to the student. As the pretest, the student was asked to tell the meaning of the words. Then, the instructor explained the new words to help the student understand the vocabulary by using flash cards / word cards to enhance the student's comprehension and retention.

Through explicit vocabulary learning, the student was prepared to interact with the VR game.

Table 1 Descriptions of three tasks

Tasks	Learning Objectives	Task Complicity	Amount of Vocab
Task 1	1. Collecting the personal background information of the victim	Name, passport	23
Task 2	1. Examining the documents in drawer 2. Examining the documents on walls (medical records, CIA documents, news, special symbols) 3. Finding the location of the security box	Recap details Medical records, CIA documents, news, special symbols document format	34
Task 3	1. Finding the password 2. Decoding the symbol 3. Finding out the truth	Numbers. Interpretation of data/graph	18

Stage Two provided image-based guidance for the VR game story. Using the screenshot images captured from the VR game, the teacher helped the student describe the story of the VR game. The learning tasks in this stage served two purposes: to provide a learning context for repeated use of the vocabulary learned in Stage One, and to preview the VR game that the student would experience in the next stage.

Stage Three was set aside for VR game interactions, which lasted for approximately 10-13 minutes in each session. Wearing an HTC Vive mounted headset, the student played the game following the instructor's audial guidance. The student walked into one room in each lesson: lesson one was in Benjamin's office (Room 1), lesson two was in the secret room (Room 2), and lesson three was in the ward of the mental hospital (Room 3). In each room, the student player searched for the document, looked for clues through signs and documents, and asked / answered questions related to the missions.

Stage Four required the student to take off the headset and meet with the instructor. Using visual aids comprised of screenshot images, the student retold the VR game story that they just experienced. The participant's oral report was considered to be the learning assessment and their vocabulary use served as the post-test of vocabulary learning.

4.4.2 The design of VR game-based learning activity based on Affordance Theory

The three tasks designed for the VR game environment were based on the Hartson's four types of affordances: function affordance to accomplish tasks, physical affordance to trigger physical reactions, cognitive affordance to comprehend and acquire information, and sensory affordance to help learners feel something (Hartson, 2003). During each lesson, the student needs to complete one task. Specific learning tasks and each type of affordance in the VR game environment are described in the following section.

Task 1 During Lesson 1

The student explored Room 1 (Benjamin’s office) to collect Benjamin’s personal background information and kill Benjamin. The following affordances embedded in Room 1 of the VR game were identified to help the student complete Lesson 1.

Functional affordance: A clickable button in the elevator, an audio commentary, a key for opening the door, a triggerable gun, documents and a passport could be moved. The instructor provided audial guidance. These functional affordances induce the learner's physical behavior.

Physical affordance: A clickable button with lights in the elevator was available for the learner to click and documents were movable. VR hands were able to move items such as documents. The small room limited the area for exploration, which was designed to help focus the learner’s attention on specific tasks or interactions within the room. It also allowed for a detailed and dense environment where everything can be explored.

Cognitive affordance: Information was provided by documents written in Chinese as well as by audio commentary in Chinese, which helped learners to search for information or listen to commentary. The instructor’s audial guidance provided extra assistance in navigating tasks and the environment, ensuring that the learner stayed on track. This game design aims to help players truly understand Benjamin.

Sensory affordance: Sound effects were triggered for when doors opened, elevators ran, guns were used, and documents were turned so that the player felt immersed and realistic. When the player heard familiar sounds, such as a door opening or an elevator bell, it helped create a sense of presence in the virtual world. A suspenseful soundtrack kept the player on edge and heightened their emotional engagement, making them more invested in the experience. By using headsets, the player was surrounded by the VR environment both visually and audibly. The combination of visual elements and detailed sound effects ensured that the player was fully immersed in the story, making the experience more engaging and convincing.

Task 2 During Lesson 2

The student pressed a button on a statue and entered a secret room to continue finding information. The student discovered secret codes appearing on many documents when they scanned the documents with a special flashlight. The following affordances designed in Room 2 of the VR game were identified to help the student complete Task 2.

Functional affordance: A clickable button on a statue, audio commentary, movable drawers from a cabinet, a movable flashlight, audio sounds from a player, movable documents, invisible codes on documents and news, a board with secret symbols, and a rotating lock were available. These effects allowed the learner to navigate the VR environment. The instructor's audial guidance provided additional support through verbal instructions, helping the player navigate tasks and understand the game's objectives.

Physical affordance: VR hands to move anything such as documents, a board with secret symbols, a flashlight, and the ability to do anything in the VR space that the participant could do in real life (such as rotating a lock, turning on the flashlight, and turning on an audio player) were possible.

Cognitive affordance: Documents written in Chinese as well as audio commentary in Chinese helped the learner to search for information or listen to commentary. A board with secret symbols helped them to find a password. The instructor provided audial guidance.

Sensory affordance: Sound effects for turning documents were triggered so that the student could feel immersed, and suspicious background music was played so that they could feel tensions. With the assistance of a headset device, the learner could be fully immersed in the VR story visually and verbally.

Task 3 During Lesson 3

The student decoded symbols to open a security box hiding the valuable documents that Benjamin stole from the CIA. The student read the documents, discovered Benjamin's motives, and finally burned the documents, returning to the ward of a mental hospital. Finally, the student identified the killer. The following affordances designed in Room 3 of the VR game were identified to help the student complete Task 3.

Functional affordance: Movable drawers from a cabinet, movable documents, invisible codes on documents and news, a rotating lock, audio commentary, a burning fire, and a talking VR character were provided. The instructor provided audial guidance.

Physical affordance: VR hands allowed the learner to move anything such as documents and to do anything in the VR world they could do in real life, such as burning a document.

Cognitive affordance: Documents written in Chinese as well as audio commentary in Chinese helped the learner to search for information or listen to commentary. The instructor provided audial guidance.

Sensory affordance: Sound effects for burning documents allowed the learner to feel immersed. Suspicious background music let the learner feel tension. Using headset devices, the learner could be fully immersed in the VR story visually and verbally.

The three tasks described above were designed with different learning objectives, levels of task complicity, and amounts of vocabulary. More details are listed in Table 1 above.

4.5 Data collection

To answer the two research questions, data were collected from multiple sources, including the teacher's audial guidance during the student VR learning activities, transcriptions of videotaped teacher-student interaction when the teacher provided audial guidance, time logs and counts of appropriateness of the student's oral responses, and the student's reaction to the VR game environment (see Table 2). The unit of analysis is semantic unit in phrases or sentence.

Table 2 Data resources and research questions

Research Questions	Data Sources	Data Type
Question 1: Teacher's facilitation	Teacher's audial guidance	Text, categorical
Question 2: Relationship between teacher's facilitation and student's performance	Transcriptions of videotaped teacher's facilitation and student's performance	Categorical

4.6 Data coding

In this study, two researchers collaboratively coded the same data set concurrently—a process known as pair-coding (Paul et al., 2021)—to strengthen the reliability and consistency of the findings, minimize individual bias, and ensure a more rigorous and well-rounded interpretation of the data. This collaborative approach not only aligns with best practices in qualitative research but also reinforces the methodological soundness of the study (Gao et al.. 2024). To answer the research questions, data were divided into two sets: *the teacher's facilitation* and the *student's performance*.

4.6.1 Teacher's facilitation

Data Set 1 is the teacher's facilitation, which is mainly investigated for Research Question 1. A total of 184 pieces of facilitation were identified (70 from Task 1, 70 from Task 2, and 44 from Task 3) to help researchers to analyze the instructor's instructional facilitations. The observations related to the teacher's facilitation were further categorized as oral response and questioning.

The teacher's oral responses were statements that the teacher used to interact with the student to *offer technical assistance, provide hints, confirm the student's answers*, and *give instructions.* The teacher's questioning were the questions the teacher asked when offering *technical assistance, confirming student's answers, encouraging student's further explorations*, and *helping the student to delve into more details for story-related content*.

4.6.1.1 Coding of variables

Examples, definitions and coding are provided below and listed in Table 3.

Table 3 Examples, definitions, and coding of instructors' responses

Facilitations	Variables	Values		Examples
		1	0	
Teacher's oral response		Provided	Not provided	
	(TtechAS)- Technical assistance	14	170	就是你戴着的时候,可以按这里, 它就会动(Task 1) (When you are wearing it, you can press here. It will move.)
	(Thints)- Hints	27	157	找 找 看 密 碼 (Task 3) (Please look for the password.)
	(Tconf)- Confirm	42	142	對, 入眠。好，那你的手電筒 (Task 2)。 (Yes, fall asleep. Good. Then use your flashlight.)
	(Tins)- Instructions	19	165	慢一點 (Task 3) Slowly please.
Questions				
	(TQtechAS)- Technical assistance	29	155	你看得到了吗？（TA is testing the function of the remote control hands and gave the hands to S） (Task 1) Can you see it?
	(TQconf)- Confirm	9	175	你在找甚麼? (Task 2) What are you looking for?
	(TQexp)- Explorations	29	155	那另外一张是什么？(Task 1) What is the other piece of paper?
	(TQcontent)- Content	71	113	你觉得密码是什么 (Task 3) What do you think the password is?

Teacher's oral responses

1. Technical assistance (TtechAS): Refers to the teacher's oral responses for technical assistance. A code of 1 is assigned when the response addresses technical assistance, while a code of 0 is assigned when no such response is provided.

2. Hints (Thints): Refers to the teacher's oral responses that provide hints. A code of 1 is assigned when the response provides a hint, while a code of 0 is assigned when no hint is provided.

3. Confirm (Tconfirm): Refers to the teacher's oral responses for confirmation. A code of 1 is assigned when the response includes confirmation, while a code of 0 is used when no confirmation is provided.

4. Instructions (Tins): Refers to the teacher's oral responses for providing instructions. A code of 1 is assigned when the response includes instructions, while a code of 0 is used when no instruction is provided.

Teacher's questions

1. Technical assistance: Refers to the teacher's question related to technical assistance (TqtechAS). A code of 1 is assigned when the teacher's question involves technical assistance, while a code of 0 is used when no such question is provided.

2. Confirm (Tqconf): Refers to the teacher's questions for confirmation. A code of 1 is assigned when the teacher's question seeks confirmation, while a code of 0 is applied when no such question is provided.

3. Exploration (Tqexp): Refers to the teacher's questions that encourage students to explore further. A code of 1 is used when the teacher's question prompts exploration, while a code of 0 is applied when no such question is provided.

4. Content (Tqcontent): Refers to the teacher's questions related to VR content. A code of 1 is assigned when the question pertains to the VR content, while a code of 0 is used when no such question is asked.

4.6.2 Student's performance

Data Set 2 includes the student's reaction to the teacher's responses, which was investigated for Research Question 2. Based on the video recording of the three VR-based learning tasks, 187 instances of the student's reactions to the teacher's responses were identified (71 from task 1, 71 from Task 2, and 45 from Task 3). Seven variables were extracted from these reactions: *Appropriateness, Promptness, Verbal Reaction, Responsive Action, Active Action, Reading VR Prompt*, and *Listening VR Promp*t. These variables provide insights into how the student engaged with and responded to teacher feedback in a VR learning environment. They are defined below and presented in Table 4 (see next page).

1. Appropriateness (ApproP): Refers to whether the student correctly answers the question. Responses were coded as 1 for appropriate responses and 0 for inappropriate answers, based on errors in sentence structure or word use.
2. Promptness (Promp): Refers to the length of a pause between the end of the teacher's question / responses and the beginning of the student's response. Measured in seconds.
3. Verbal Reaction (VerbR): Refers to whether the student responds verbally to the teacher's questions. Coded as 1 if the student provided a verbal response and 0 if no verbal response is required.

4. Non-verbal Action (NonVerb): Refers to non-verbal actions taken by the student in response to direct or indirect teacher questions or instructions. Coded as **1** when a non-verbal action is observed and **0** when no such action occurs.
5. Active Action: Refers to actions initiated by the student. Coded as 1 if the student takes an active initiative and 0 if no active action is necessary.
6. Reading VR Prompt (RVRP): Refers to whether the student reads VR prompts to obtain information. Coded as 1 if VR reading is involved and 0 if no VR reading occurs.
7. Listening VR Prompt (LVRP): Refers to whether the student listens to VR prompts or instructor's verbal facilitations to obtain information. Coded as 1 if VR listening is involved and 0 if no VR listening occurs.

Table 4 Coding of the response variable and six explanatory variables

Variables	Values	
	1	0
Response Variable		
(*APProP*) – Appropriateness (*Y*)	145	39
Explanatory Variables:		
(Promp) – Promptness (X_1)	Scale	
(*VerbR*) – Verbal Reaction (X_2)	145	39
(Non-Verb) –Nonverbal Reactions (X_3)	142	42
(*ActA*) – Active Action (X_4)	156	28
(RVRP) – Reading VR Prompt (X_5)	148	36
(LVRP) – Listening VR Prompt (X_6)	149	35

Note. Promptness was measured by seconds.

5. Data Analysis and Results

This study integrated a story-driven VR game into a Chinese lessen to investigate instructor's facilitations, a student's performances, and the student-teacher interactions. This section describes the results of the data analysis.

5.1 Data analysis and results for Question 1

Research Question 1. How could the teacher facilitate the completion of an authentic story-driven VR game?

This session delineates the findings pertaining to research question 1. A descriptive analysis was employed to address this research question. The teacher's facilitation strategies across the three tasks predominantly involved oral responses and inquiries. The data were analyzed by calculating the frequencies and percentages of various strategies. The results of this analysis are presented below.

1. The types of instructor facilitation: Oral responses and questions

Among the instructor's audial guidance, oral responses and questions emerged as the primary facilitation strategies. The frequencies of oral responses and questions were

54% and 52%, respectively, indicating that both types of guidance occurred in more than half of the instructor's interactions with the student (see Figure 2).

During the VR gaming activities, where the student wore VR goggles and lacked visual contact with the instructor, questioning and oral guidance appeared to be more effective in eliciting feedback. This finding suggests that the instructor played a **proactive role** in facilitating and guiding the learning process, actively engaging the student through a combination of responses and questions.

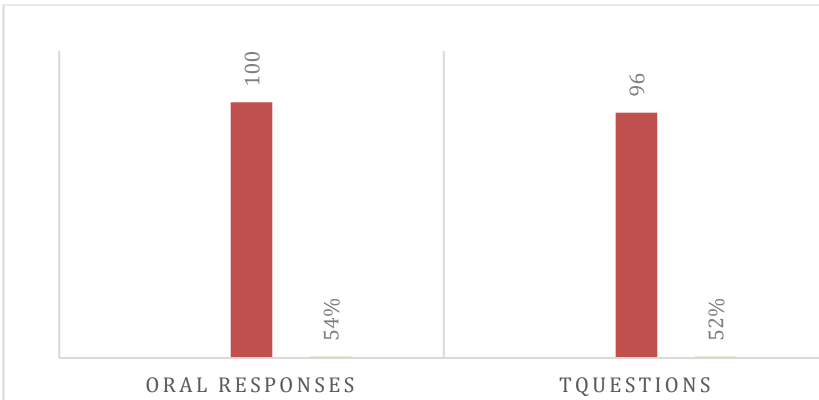

Figure 2 Frequency of instructor's audial guidance

2. The uses of oral responses and questions among the three tasks

The line chart below (Figure 3 on next page) illustrates a decreasing trend in the instructor's use of oral responses for technical assistance, hints, confirmation, and instruction across tasks. The frequency dropped from 45% in Task 1 to 35% in Task 2 and further to 20% in Task 3. In contrast, the frequency of questions did not follow a consistent trend across tasks, with occurrences at 34% in Task 1, increasing to 42% in Task 2, and then declining to 24% in Task 3.

This variability suggests that the instructor's questioning strategy was influenced by evolving instructional guidance and learning objectives rather than a fixed pattern. Notably, questions were used more frequently than oral responses in Tasks 2 and 3, indicating the important role of questioning in guiding the student through the VR tasks. As the student became more familiar with the VR game environment, the instructor's approach shifted toward questioning rather than direct oral responses, reflecting a more natural, authentic, and conversational interaction within the VR story game.

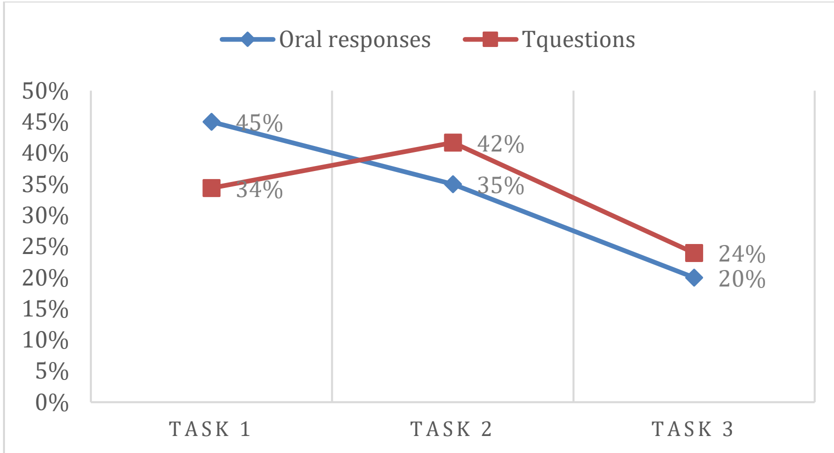

Figure 3 The variable frequency of the instructor's responses among three tasks

3. The uses of oral response for technical assistance, hints, confirmation, and instruction

When oral responses were used, instructors aimed to offer technical assistance, provide hints, confirm the answers from the students, and give instructions. The line chart in Figure 4 below illustrates these four facilitation strategies in oral response. In these instances, it was not always necessary for the student to respond verbally to the instructor's guidance. Instead, the student typically processed the information and reacted non-verbally, demonstrating comprehension through actions rather than spoken responses. This finding suggests that oral responses served as a direct instructional tool, facilitating the student's engagement without requiring continuous verbal interaction.

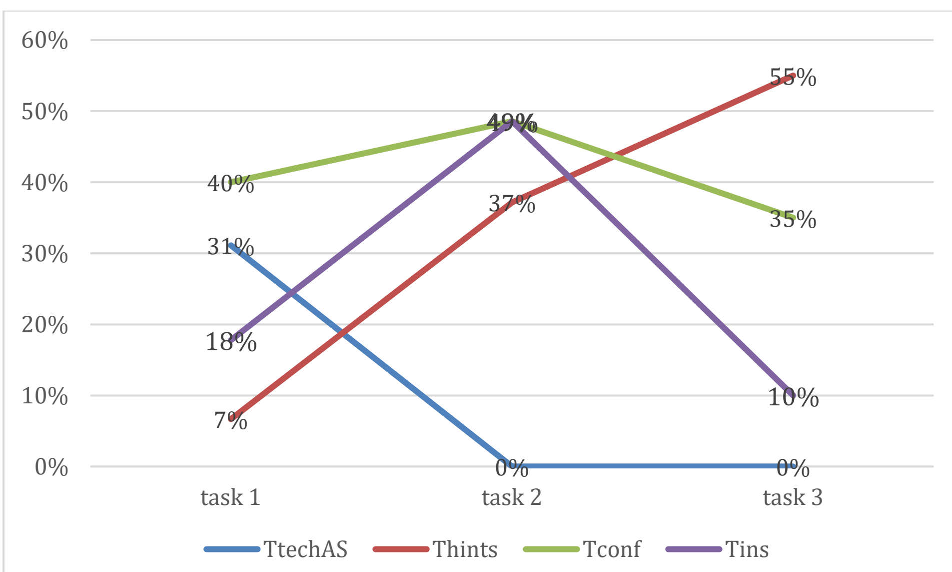

Figure 4 Instructor's frequency of oral response used for technical assistance, hints, confirmation, and instruction

The four facilitation strategies used across different tasks were further analyzed to understand their contributions to different learning activities. The findings of the three tasks are provided below.

Task 1. Technical assistance (31%) was only provided in Task 1. At the beginning of the VR games, the instructor ensured that the student understood how to operate the VR devices, making technical assistance a crucial strategy in Task 1. However, as the VR techniques were not challenging for young learners, further technical guidance was not necessary in Tasks 2 and 3. Confirmation strategy was a predominant (40%) strategy, allowing the instructor to interact with and support the student. Instructions strategy (18%) was used less frequently than confirmation but still played a role in guiding the student through the task. Hints (7%) were rarely provided in Task 1, which focused on collecting personal background information about the victim. This task is relatively less challenging, so the instructor offered minimal hints to encourage the student to explore and uncover information independently.

Task 2. Strategies of hints and confirmations were used most frequently in Task 2. Among the four strategies, hints increased significantly from 7% in Task 1 to 37% in Task 2, and confirmations remained the most frequently applied strategy (49%). In Task 2, the student needed to (a) examine the documents in a drawer, (b) examine the documents on walls (medical records, CIA documents, news articles, special symbols), and (c) locate the security box. These specific tasks made Task 2 the most challenging because the student had to understand and analyze multiple details within the storyline and comprehend and process 34 Chinese words to successfully accomplish the tasks. Given these complexities, the instructor relied more heavily on hints and confirmations than on other strategies to facilitate learning and task completion.

Task 3. Hints (55%) were the most frequently used strategy, while confirmation (35%) and instructions (10%) were applied less frequently. The use of instructions decreased significantly compared to previous tasks, dropping to 10%. In Task 3, the student needed to (a) find the password, (b) decode the symbol, and (c) find out the truth. Since these tasks involved working with codes, numbers, and documents to unlock the security box and piece together the storyline, the instructor relied heavily on hints (55%) to guide the student toward discovering the truth in the VR story. As a result, hints and confirmations were prioritized over direct instructions, allowing the student to engage more actively in problem-solving and critical thinking within the VR environment.

4. The use of instructor questioning for technical assistance, confirmations, explorations, and content

Similar to the oral responses, technical assistance questions were used only in Task 1. Across all tasks, the majority of questions focused on story content, with content-related questions increasing steadily across three tasks (Task 1 at 48%, Task 2 at 83%, Task 3 at 96%). The use of exploration and confirmation questions among three tasks did not show a consistent pattern across tasks. Similar to the instructor’s oral responses, the use of exploration and confirmation questions may have been influenced by the learning objectives of each task. In Task 2, which required more complex messages and information, the instructor applied exploration questions (38%) more frequently than confirmation questions (3%), suggesting a greater emphasis on encouraging deeper engagement and discovery.

The instructor's questioning approach was greatly influenced by the nature and complexity of each task. A detailed analysis of the four questioning strategies used in each task is provided below (and see Figure 5).

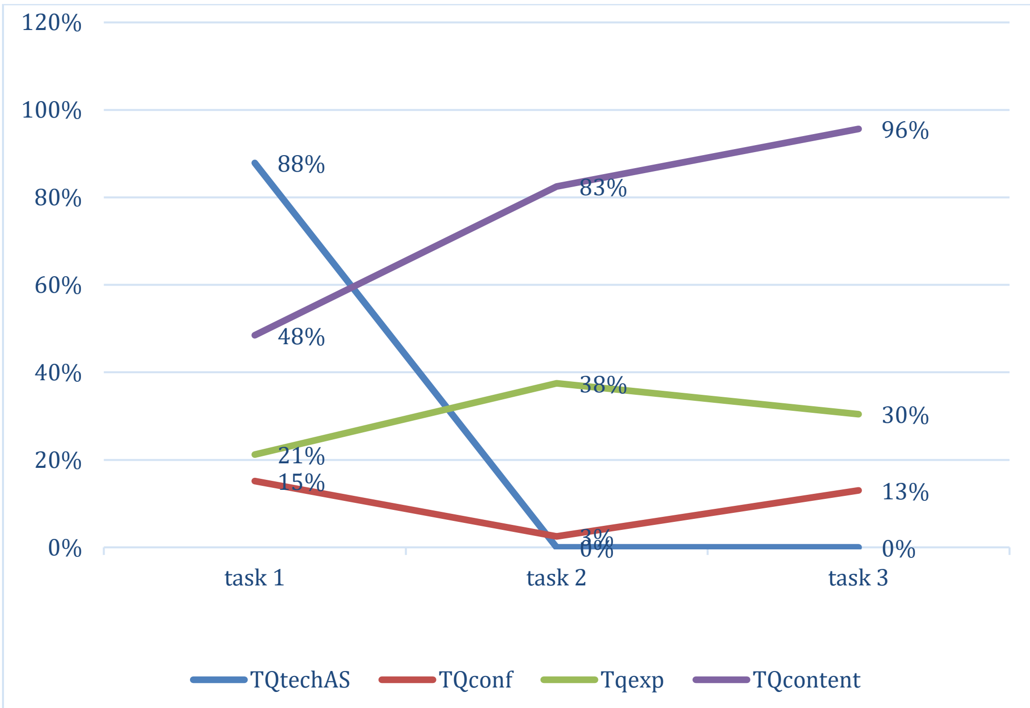

Figure 5 Instructor's frequency of questioning used for technical assistance, confirmations, explorations, and content

Task 1. In Task 1, many questions focused on technical issues (88%), followed by VR content related (48%), exploration (21%), and confirmation (15%). Since Task 1 was the student's first VR task, the instructor asked more technical questions to help him familiarize himself with the VR environment. Additionally, story-content questions were frequently used to aid in navigation and guide the student through the task. Like the instructor's oral responses, questions related to technical issues were the most frequently used in Task 1, reinforcing the need for initial support as the student adapted to the VR learning environment.

Task 2. In Task 2, the instructor primarily focused on content-related questions (83%), followed by exploration (38%) and confirmation (3%). No technical questions were asked, as the learner did not encounter any technical challenges. The presence of various functional VR objects (e.g., movable drawers, flashlights, documents, and game sounds) and the high challenge level of this session across all three tasks led the instructor to reply more content-related questions than exploration and confirmation questions to assist the learner in navigating and completing the tasks effectively.

Task 3. In Task 3, the instructor primarily used content-related questions (96%), followed by exploration (30%) and confirmation (13%). The tasks required decoding symbols to open a security box and solve mysteries, making guiding questions essential for effective exploration of the VR environment. Consequently, content-related questions played a crucial role in helping the learner navigate the challenges and complete the tasks successfully. Given the nature of the activity, all the instructor's questions were directly related to the VR game itself, reinforcing the importance of content-driven questioning in facilitating problem-solving and engagement within the VR experience.

5.2 Data analysis and results for Question 2

Research Question 2. What is the relationship between the teacher's facilitation and the student's performance?

This session presents the findings and Chi-square tests pertaining to research question 2. To examine the relationship between teacher facilitation and student performance, 2 x 2 Chi-Square (*χ2*) tests were conducted. These tests determined whether a statistically significant association existed between one variable for teacher facilitation (oral responses and questions) and one variable for the student performance. A total of 48 Chi-Square (*χ2*) tests were performed, with eight variables identified in teacher facilitation and six in student performance. Table 5 and Table 6 report significant variables. In both tables,

- rows in Column A = Each variable for student performance, categorized as 0= absent, 1= present, and
- variable in Column B = Each variable for teacher's oral responses or teacher's question variable, categorized as 0= absent, 1= present.

Table 5 Teacher oral responses

Variable A Student Performance		Variable B Teacher's Oral Responses		Chi-Square Results df=1, n=184		
		TtechAS				
		0a n=170	1b n=14	X2	P	Phi(ϕ)
*NonVerb	0c	35 (21%)	7(50%)	6.352	0.012	-0.186
	1d	135 (79%)	7(50%)			
*ActA	0	19 (11%)	9(64%)	28.278	<0.001	-0.392
	1	151 (89%)	5(36%)			
*RVRP	0	22(13%)	14(100%)	62.29	<0.001	-0.582
	1	148(87%)	0 (0%)			
		Thints		Chi-Square Results df=1, N=184		
		0 n=157	1 n=27			
*VerbR	0	28(18%)	11(41%)	7.237	0.007	-0.198
	1	129(82%)	16 (59%)			
*ActA	0	28(18%)	0(0%)	5.68	0.017	0.176
	1	129 (82%)	27(100%)			
		Tconf		Chi-Square Results		

		0 n=142	1 n=42	df=1, n=184		
*RVRP	0	34(24%)	2(5%)	7.578	0.006	0.203
	1	108(76%)	40(95%)			
		Tins		Chi-Square Results df=1, N=184		
		0 n=165	1 n=19	X2	P	Phi(ϕ)
*VerbR	0	309(18%)	9(47%)	8.689	0.003	-0.217
	1	135(82%)	10(53%)			

Notes:

(*) significant student performance

a. responses are not provided; b. responses are provided; c. student's performance is found; d. student's performance is not found.

After analyzing all 48 Chi-Square (*χ2*), 16 significant correlations were identified, including both positive and negative associations between teacher facilitation and student performance. The results are further discussed from two key perspectives: the teacher's oral responses and the teacher's questions.

Teacher's Oral Responses

Table 5 reports the significance variables on teacher's oral responses. A total of seven correlations were identified in Table 5, including five significant negative correlations and two significant positive correlations.

Negative correlations. Five negative correlations indicate that certain teacher facilitation strategies may hinder specific aspects of student performance.

1. Technical support (TtechAS) is negatively correlated with the student's non-verbal reactions (NonVerb) ($\chi2(1, N=184) = 6.352$, $p=0.012$, $\varphi = -0.186$, small effect), active actions (ActA) ($\chi2(1, N=184) = 28.278$, $p<0.001$, $\varphi = -0.392$, medium effect), and reading VR prompts (RVRP) ($\chi2(1, N=184) = 62.29$, $p<0.001$, $\varphi = -0.582$, strong effect). These results indicated that when the teacher provided technical support, the student was less likely to engage in non-verbal interactions, active participation, and reading VR prompts. This finding implies that direct technical guidance might limit student autonomy in the VR environment.
2. Hints (Thints) and verbal reactions (VerbR) ($\chi2(1, N=184) = 7.237$, $p=0.007$, $\varphi = -0.198$) are negatively correlated. The more hints the instructor provided, the less likely the student was to respond verbally, possibly indicating that excessive guidance reduced opportunities for students to articulate their own thoughts.
3. Instructions (Tins) also show a modest negative correlation with verbal reactions (VerbR) ($\chi2(1, N=184) = 7.237$, $p=0.007$, $\varphi = -0.198$). When the instructor provided explicit instructions, the student was less likely to respond verbally, suggesting that structured guidance may limit spontaneous verbal engagement in the VR learning environment.

Positive correlations. Two positive correlations suggest that certain teacher strategies enhanced student engagement in VR activities:

1. Teacher's hints (Thints) and student's active actions (ActA) ($\chi 2(1, N=184) = 5.68$, p=0.007, effect size Phi(φ) =0.176) are positively correlated with modest effects. When the instructor provided hints, the student was more likely to take active actions, suggesting that subtle guidance encouraged exploratory learning and participation.
2. Teacher's instructions (Tins) and student's reading of VR prompts (RVRP) ($\chi 2(1, N=184) = 7.578$, p=0.006, effect size Phi(φ) =0.176) with modest effect. When the instructor provided instructions, the student was more likely to read VR prompts, indicating that structured guidance helped direct students' attention to relevant in-game information.

The significant findings suggest that teacher-provided technical support may hinder students' non-verbal interactions, active engagement, and VR reading activities, possibly by reducing their autonomy and problem-solving opportunities. However, hints and instructions can positively influence students' engagement by fostering active participation and VR-related reading behaviors. These insights highlight the importance of balancing guidance with opportunities for independent learning in VR-based instruction, ensuring that facilitation strategies enhance rather than limit student interaction and engagement.

Teacher's Questions

Table 6 (next page) shows significant variables on teacher's questions. As can be seen in Table 6, A total of nine significant correlations were identified, including three negative correlations and six positive correlations.

Negative correlations. Technical questions (TQtechAS) are negatively associated with nonverbal reactions (NonVerb) ($\chi 2(1, N=155) = 9.460$, $p = 0.002$, $\varphi = -0.227$, small effect), active actions (ActA) ($\chi 2(1, N=155) = 9.904$, $p = 0.002$, $\varphi = -0.232$, small effect), and reading VR prompts (RVRP) ($\chi 2(1, N=155) = 4.868$, $p = 0.027$, $\varphi = -0.163$). These three negative correlations suggest that technical questions (TQtechAS) may hinder certain aspects of student engagement. When the instructor asked technical questions, the student was less likely to engage in non-verbal reactions, active participation, and VR reading prompts. This finding suggests that technical questions primarily serve a problem-solving function rather than promoting immersive engagement.

Positive correlations. Three types of questions created six positive correlations, suggesting that certain questioning strategies enhanced student interaction and engagement.

1. Technical questions (TQtechAS) are positively related to students' verbal responses (VerbR) and the appropriateness of their answers (Approp) (both $\chi 2(1, N=155) = 6.492$, $p = 0.011$, $\varphi = 0.188$, small effect). While technical questions reduced non-verbal engagement, they positively influenced verbal responses and the appropriateness of student answers. This finding indicates that the student

understood these questions and responded correctly, showing that technical questioning reinforced comprehension and accuracy in verbal responses.

2. Exploratory questions (TQexp) are positively linked to the student's VR reading prompts (PVRP) ($\chi 2(1, N=155) = 5.682$, $p = 0.017$, $\varphi = 0.176$, small effect). When the instructor used exploratory questions, the student was more likely to read VR prompts, suggesting that exploratory questioning fostered deeper engagement and active exploration within the VR environment.
3. VR content-related questions (TQcontent) are positively associated with verbal reactions (VerbR), active actions (ActA), and VR reading prompts (PVRP), with the strongest effect on reading prompts (PVRP) ($\varphi = 0.363$, medium effect). Content-related questions were strongly associated with verbal engagement, active student participation, and VR reading prompts. This finding highlights the effectiveness of content-related questions in guiding student attention, facilitating exploration, and creating a more immersive learning experience.

Table 6 Teacher's questions

Variable A Student Performance		Variable B Teacher's Questions		Chi-Square Results df=1, N=184		
		TQtechAS				
		0 n=155	1 n=29	X2	P	Phi(ϕ)
*VerbR	0	38	1	6.492	0.011	0.188
	1	117	28			
*NonVerb	0	29	13	9.460	0.002	-0.227
	1	126	16			
*ActA	0	18	10	9.904	0.002	-0.232
	1	137	19			
*Approp	0	38	1	6.492	0.011	0.188
	1	117	28			
*RVRP	0	26	10	4.868	0.027	-0.163
	1	129	19			
		TQexp		Chi-Square Results df=1, N=184		
		0 n=155	1 n=29	X2	P	Phi(ϕ)
*RVRP	0	35	1	5.682	0.017	0.176
	1	120	28			
		TQcontent		Chi-Square Results df=1, N=184		
		0 n=1137	1 n=71	X2	P	Phi(ϕ)
*VerbR	0	34	5	13.865	<0.001	0.275
	1	79	66			
*ActA	0	22	6	4.103	0.043	0.149
	1	91	65			
*RVRP	0	35	1	24.218	<.001	0.363
	1	78	70			

Notes: (*) significant student performance

These findings indicate that there is a complex interplay between question types and student engagement in VR learning environments. Technical questions (TQtechAS) demonstrate a negative impact on the student's nonverbal reactions, active actions, and reading of VR prompts, suggesting that questions that are associated with technical issues aiming to resolve the technical problems the student encountered. However, these technical questions positively increase the frequency of the student's verbal responses and answer appropriateness, indicating that the student understands these questions and also properly responds to the instructor. Additionally, exploratory questions (TQexp) enhance student interaction with VR reading prompts, fostering deeper engagement. Content-related questions (TQcontent) show the strongest positive correlations with verbal reactions, active actions, and reading prompts, particularly highlighting their effectiveness in guiding student attention and facilitating immersive experiences.

6. Summary of findings

Throughout the story-driven VR game used for this case study, the instructor progressively relied more on questioning rather than simply responding orally to the student's reactions, especially in the later VR sessions.

Among the three tasks:

1. Technical support responses were most frequently used during the first Chinese learning session, as the student needed guidance on operating the VR system.
2. In later sessions, the instructor relied more on hints, confirmations, story-content questions, and exploration questions to facilitate learning and engagement.

Key findings on question types and responses:

1. Technical questions and responses did not promote non-verbal interactions, active participation, or VR reading activities. However, they were positively associated with the student's verbal responses and the appropriateness of their answers, suggesting that technical facilitation enhanced comprehension but reduced autonomous exploration.
2. Story-content and exploration questions showed significant positive correlations with verbal reactions, active participation, and reading prompts, highlighting their effectiveness in guiding students through the VR environment.
3. Student verbal engagement was linked to answer appropriateness—the more verbal actions a student took, the more accurate their responses tended to be.

These findings suggest that questioning strategies, rather than direct technical support, play a crucial role in fostering active learning and engagement in VR-based Chinese language instruction. Figure 6 (see next page) provides a visual map of key findings of this research.

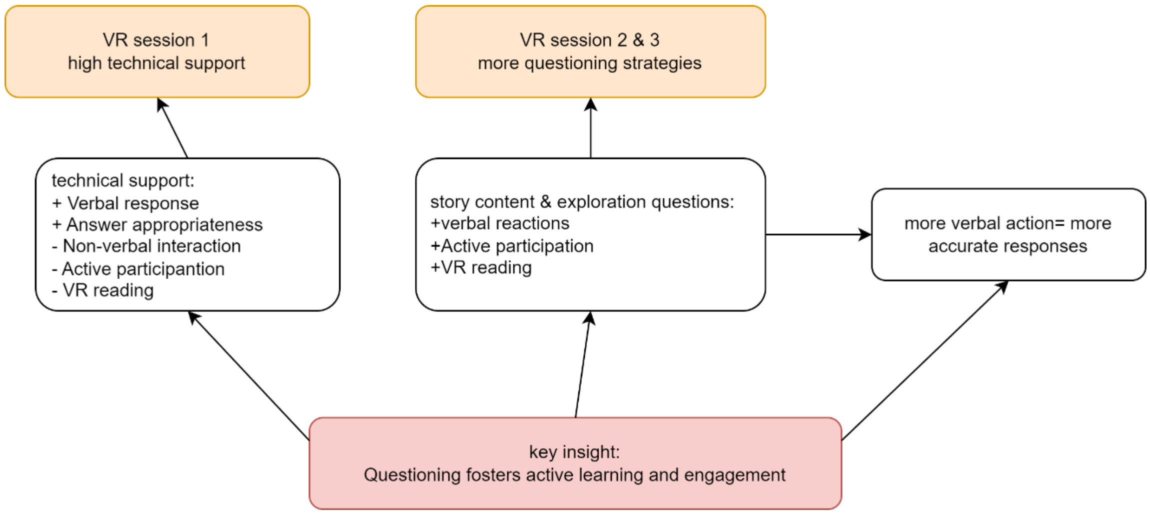

Figure 6 A Summary of key findings

7. Discussion and conclusion

This study explored a Chinese lesson that integrated a story-driven VR game with three learning tasks. It aimed to investigate how a teacher facilitated a Chinese learner in VR-based learning, and how the teacher's facilitation influenced the student's performance.

This section first presents the findings of current study, followed by a discussion of its implications, limitations, and suggestions for future research.

7.1 Findings of the interactions between teacher and student in a story-driven VR game

7.1.1 Teacher's facilitation strategies during the VR learning game

For language learners, an effective instructional approach involves creating a rich learning environment that enables students to explore and engage with language elements freely. Research suggests that teacher guidance plays a crucial role in capturing students' attention and fostering motivation in the learning process (Kordt, 2018). In this case study of a story-driven VR learning environment in the VR game, *The Price of Freedom*, the student was immersed in a virtual space where the teacher's facilitation and guidance served as a key learning affordance.

A teacher's facilitation aims to scaffold learning, which "leads to new affordances—after a period of practice—that emerges even without teacher or peer support" (Kordt, 2018, p. 141). Additionally, scaffolding helps develop the learner's ability to self-scaffold. Due to the absence of physical eye contact in a fully immersive virtual game, the student in this study not only searched independently for information, documents, and objects within the VR environment, but also relied on social interactions with the instructor to navigate challenges throughout the VR experience. Such VR environment also empower instructors to design more interactive language learning environment. Echoing the findings of Martin et al. (2020) and Çakır (2024), the instructor's support served as a key learning affordance, helping to sustain students' motivation and interest within the learning environment. This aligns with Çakır's literature review, which highlights the importance of instructor involvement. In turn, this affordance encouraged students to engage more actively with virtual objects, messages, and information within the virtual rooms.

From the conclusion of Çakır's (2024) literature review, the teacher's role shifts towards facilitator of immersive learning experiences, which naturally influence the interactions with students. In this study, the instructor used two primary facilitation strategies: oral responses and questions in the nature of authentic communications in the VR environment. The oral responses strategy was used to provide *technical assistance, hints, confirmation*, and *instruction*, and the questions strategy was used to provide *technical assistance, confirmations, explorations*, and *content guidance*. These facilitation strategies provided evidence that the teacher created new learning affordances which enabled the learner to accomplish the three VR tasks. Among the three VR tasks, the instructor relied heavily on technical assistance to ensure the student could fully operate the VR system in Task 1. As a result, oral responses and questions related to technical issues were applied only in Task 1.

Tasks 2 and 3 required deeper cognitive engagement due to their complexity, so the instructor increased the use of hints, confirmations, and exploratory questions. Unlike traditional second / foreign language learning materials, this study integrated authentic VR content rather than pre-designed, language-specific instructional material. The three learning tasks were structured based on the natural story flow and scene settings. Due to the commercial nature of the VR game, the complexity of tasks was not intentionally controlled for language learners. Task 2 was the greatest challenge, requiring the most instructor support.

7.1.2 Relationship between teacher facilitation and student performance

From an affordance theory perspective, learning environments provide numerous affordances that student perceive to guide their behaviors (Cheng et al., 2017; Wang et al., 2018). Similarly, the instructor's perceptions of learning affordances and facilitation also directly affects the student's learning achievement (Martin et al., 2020). In the context of VR language learning environments, this study focuses on how teacher facilitation—through oral responses and questions—interacts with student performance, with the support of virtual affordances.

Chi-square tests revealed the following key findings:

1. The teacher's technical oral responses and questions significantly hindered the student's nonverbal interactions, active actions, and VR reading activities. However, when the teacher' oral responses were used to provide hints and instructions, they positively fostered student's VR actions and VR reading activities.

2. Technical questions positively correlated with the students' verbal responses and the accuracy of their answers. Content-related questions significantly enhanced students' verbal responses, active participation, and engagement with VR reading prompts, highlighting their effectiveness in immersive learning.

7.2 Implications

When applying digital devices into Chinese language learning lessons, the instructor may initially focus on technical support to ensure that the devices are functioning properly. However, excessive focus on technical troubleshooting could shift the attention from the main lesson content. While these technical responses and questions may not necessarily foster nonverbal interactions, active learning actions, or immersive VR reading activities, they can promote verbal communication by encouraging students to speak and respond in the target language, which in this study is Mandarin Chinese. To ensure that learners focus on language practice rather than technical issues, it is recommended that technical troubleshooting be conducted in the students' native language rather than in Chinese. This approach minimizes lesson disruptions and maximizes the time spent on meaningful language learning rather than on resolving technical difficulties.

Besides technical support facilitations, the instructor may incorporate hints, confirmations, story-content questions, and exploration questions to enhance VR learning sessions. Story-content questions focus on the narrative elements of the VR experience, helping students engage with the storyline. Exploration questions encourage students to discover new advantages within the virtual environment, fostering active learning and problem-solving skills. The combined use of story-content questions and exploration questions encourages verbal responses from students, helping them to practice using the target language (e.g., Chinese) more actively. These types of questions also foster active engagement and reading virtual prompts, which means that students interact more dynamically with the content and practice language skills in a context that is linked to the VR story.

The immersive nature of the VR environment is particularly effective for language learning, as it creates a more engaging and contextually rich setting where students can practice both verbal and nonverbal communication in the target language. The instructor's role in using strategic questioning techniques is critical for maximizing the learning potential of VR sessions.

The instructor in this case study that used this story-driven VR game tended to ask more questions rather than simply providing oral responses to the student's reactions across the three VR tasks. When the student responded more frequently to the instructor's oral guidance (likely in response to more instructor questions), the responses tended to become more appropriate. This finding implied that encouraging students to practice language as much as possible during VR learning experiences creates more opportunities for negotiation and problem-solving interactions. In the immersive single-player virtual learning environment, students without eye contact support with the instructor become more focused on the affordances of the virtual learning environment and on the instructor's oral guidance, and they can thus obtain more opportunities to produce language output.

Such interactions help students adjust their language use, leading to more appropriate responses. This contributed several perspectives on the use of VR in language learning, as highlighted by Parmaxi (2023) and Çakır (2024). These include the need for further research on the design of real-life tasks—such as the story-driven VR game featured in the study—to promote greater language production, the social dynamics of collaborative learning (particularly teacher-student interactions), and valuable insights into the pedagogical dimensions of using VR games in language education, such as teachers' responses and questioning techniques.

7.3 Limitations and future studies

There are several limitations to this study. First, as a single case study, it collects one Chinese learner's VR learning experience, which did not include a sufficient sample to generate broadly generalizable results. Future research should include more empirical studies with larger sample sizes, incorporating different learning themes and diverse student learning backgrounds. Second, this study focused on a single-player VR game, which did not include data associated with group interactions or language practice with other learners. For further research, a multiple-player game for language learning is suggested to observe the impact of learners' interactions on language performance. Finally, this study integrated a story-driven virtual game into a Chinese lesson facilitated by an instructor, rather than employing a self-directed learning mode. Since language learners progress at varying paces, implementing a virtual game in a classroom setting may not accommodate all learners equally. For future investigations, a self-paced game design could be explored to assess the effectiveness of different learning models.

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