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Revitalize Qiang Language and Culture by Designing Serious Games Based on Interactive Projection

Rao Xu[1], Qin Wu[1(✉)], Wenlu Wang[1], Mohammad Shidujaman[2], and Min Wei[1]

[1] Chengdu University of Information Technology, Chengdu, China
{wuqin,weimin}@cuit.edu.cn
[2] American International University - Bangladesh, Dhaka, Bangladesh
mjaman@aiub.edu

Abstract. The Qiang people is an ancient minority in western China. However, Qiang language, as the carrier of Qiang culture and spirit, is rapidly fading as less and fewer people can speak it. Despite the fact that the serious game of indigenous language has been widely discussed, there is still a dearth of research on the Qiang language and culture. This research aims to determine the efficacy of serious games based on interactive projection to encourage people's interest in Qiang language and culture. To better understand the Qiang language and cultural heritage's current state and challenges, we conducted a three-day field investigation in the Qiang village. Based on the field study's findings, we created "WhiteStone", an interactive projection device based on the heroic epic of Qiang. Our user research consists of remote verification and user testing, indicating that serious games based on projected interaction have the potential to create engrossed and interesting experiences, which can attract young people's interest in the Qiang language and culture. This paper examines the design opportunities for serious games based on interactive projection to revitalize the Qiang language and culture.

Keywords: Serious game · Indigenous language · Chinese culture · Qiang people

1 Introduction

Language is not only a means for people to communicate [3], but it is also a cultural carrier [12] and a part of national identity [11]. There are over 6,000 languages spoken throughout the world, yet 80% of them are spoken by barely 5% of the population, putting them in risk of extinction in the next century [18]. Protecting endangered indigenous languages helps to preserve human culture's "biodiversity," which is critical for civilization's inheritance and growth. Especially for indigenous languages without text, the danger of disappearing is more prominent. The Qiang people are an ancient ethnic minority living in the western

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China with. Due to the loss of writing text, Qiang people can only pass on their language and culture orally. In recent years, the Qiang language has been on the danger of extinction, as fewer Qiang people are able to speak it. In order to help the inheritance of Qiang language and culture, many researchers have made efforts. With the development of digital technology [30], the interactive design method [6,31] has brought vitality to the development of art [7] and culture [30]. He et al. [17] designed a mobile application for learning the daily terms of the Qiang language, proving the value of digital technical support. Serious games [1] have proven to be one of the effective methods of helping indigenous language inheritance. Such as web platform [22] based on serious game and computer serious games [32]. However, it is still lacking in the design of a serious game based on interactive projections to revitalize Qiang language and culture.

Our research purpose is to explore whether the serious game based on interactive projections helps to revitalize the Qiang language and culture. Our work consists of the following three stages: (1) we conducted field research in the Qiang people's residential areas, and summarized the design principles based on the findings. (2) Inspired by the design principles derived from field research, We designed and implemented an interactive projection device based on serious games. (3) We verified the validity of the prototype through on-site user tests and remote interviews, and discussed the views of Qiang and non-Qiang people on serious games based on interactive projection.

Through verification, we found that serious games based on projected interaction have the potential to create engrossed and interesting experiences that can attract young people's interest in the Qiang language and culture. In addition, this paper provides the views of the non-Qiang people on the preservation of the Qiang language and culture, which also reveals the opportunities for the development and inheritance of the indigenous language and culture by including the non-Qiang people in the indigenous language learning.

2 Related Work

2.1 Protection of Indigenous Languages

Indigenous languages have gotten a lot of attention in recent years. Recognizing their vulnerability, The United Nations declared 2019 the International Year of Indigenous Languages [9] to highlight the severe loss of indigenous languages and the urgent need to preserve, revitalize, and promote indigenous languages. To that goal, scholars around the world make unrelenting efforts, such as recording minority languages by documentation [10,15] or dominating the immersive revitalization project in the community [2,21,27]. However, the difficulty of the task and the rapid pace of technological change have presented a significant challenge for linguists committed to recording endangered languages. The effect of community immersion projects is also limited to whether there is a solid community communication basis. With the advancement of digital information technology, researchers understood that the use of technical means [8] may open up new avenues for indigenous language protection. For example,

Evaristo Ovide et al. [19] introduced a collaborative work on Wichi language, and co-created a mobile app to learn the basics of the language. Carew et al. [5] talked about the Getting in Touch project, which is working on developing ideas for digital resources that prioritize Indigenous languages and knowledge systems. These studies have supplied knowledge and inspiration for endangered language research around the world. At the same time, a minority in the southwestern mountains of China is also facing the dangers of disappearing in indigenous languages. Qiang language [14] has been used by Qiang people for thousands of years. It is a vital conduit for Qiang culture and spirit. In order to help the inheritance of Qiang language, He et al. [17] proposed a Qiang language learning application, "the tone of Qiang", based on their own corpus, contains daily expressions in multiple scenes. Their work uses multimedia technology to digitally preserve Qiang language. In this paper, we want to explore more interesting ways to help revitalize Qiang language and culture.

2.2 Serious Games Used in Indigenous Languages and Cultures

Serious games [1] have been widely employed in education, ecology, and other sectors because they can boost knowledge acquisition and cognitive skills [28]. Some language related studies have also investigated serious games and suggest that they may be effective as educational tools [13,16]. Serious games have also been shown to have a positive impact on indigenous language and culture learning [25] since they can provide some characteristics absent in traditional teaching methods and engage learners' attention. For instance, Bykbaev et al. [22] proposed an interactive education platform based on serious games to protect the Cañari indigenous cultural heritage in Ecuador. To reintroduce indigenous rainforest sign language to the younger Penan generation, Zaman et al. [32] developed a PC-based digital Oroo' adventure game. In addition to web platforms and computer applications, VR is a research hotspot in serious games due to its immersive experience. Plecher et al. [20] and other researchers [4,26] attempted to employ virtual reality (VR) technology to revitalize indigenous languages and cultures. In contrast, in this work, we try to bring immersion by breaking away from the interaction of traditional screen media. Interactive projection allows players to move freely in the projection range [24]. Different from VR, projection interaction can be easily combined with physical entities [23,29]. These features have the potential to enhance the realistic immersion of projection interactive experience. However, there is still a lack of research on using serious games based on projection interaction to help Qiang language and culture. Our research is to explore the possibility of serious games based on projection interaction for revitalizing Qiang language and culture.

3 Needs Finding

Our objective was to obtain insight into the current situation of Qiang language transmission among the indigenous Qiang people and their perceptions of their

ethnic culture, as well as to provide design concepts for developing serious games for minority languages without a written text. We designed and implemented a series of field surveys, and the research method was based on semi-structured interviews, supplemented by questionnaires.

3.1 Study Instruments

The research instruments used in this study included an interview outline and paper questionnaires.

The following topics were included in the interview outline, which was used to guide the semi-structured interviews: 1) the current state of the Qiang language heritage: the interviewees' and their families' level of mastery of the Qiang language, the main ways and methods of learning the Qiang language, etc. 2) the difficulties encountered by the Qiang people in learning the Qiang language: the possible causes of this situation, existing solutions, and effects, etc. 3) the Qiang people's ethnic and cultural identity: their level of knowledge of their traditional myths and customs, their perspectives on the current state of Qiang's cultural heritage, and their self-perception, etc.

The questionnaire consisted of three main parts: the first part was used to obtain the interviewees' background information. The second part of the questionnaire was used to understand the interviewees' current use of Qiang language and their attitudes toward Qiangic language. The third part assesses the respondents' knowledge of their own cultural content.

3.2 Participants and Procedure

A total of four researchers traveled to Li County at the end of October 2020 for a three-day field survey. Located in the southeastern Tibetan Qiang Autonomous Prefecture of Ngawa of Sichuan, Li County is one of the major Qiang communities. Participants included 21 Qiang people (Aged between 47–76, 16 males and 5 females) from 10 families. They were fluent in the Qiang language and live in three Qiang villages with a high degree of Qiang language preservation: Mukha Qiang Village, Lelie Village, and Taoping Qiang Village.

During the research, the researchers used Sichuan dialect and Mandarin to communicate with the Qiang people. We invited a local Qiang woman as our guide to introduce us to local Qiang people with special status, such as retired teachers, barefoot doctors, village cadres, etc. We conducted semi-structured interviews with some of the villagers. The interview process took between 15 and 40 min. Paper questionnaires were delivered face-to-face to a subset of participants and gathered on the spot to augment the interview content. Some respondents gave verbal response, and the researchers assisted in filling out the questionnaire. All participants took part in our research voluntarily, and the process will be recorded on audio and video. We used social media (WeChat) to keep in touch after we left Qiang village. The interview data were analyzed by summarizing and categorizing respondents' perspectives based on verbatim transcripts of the interview recordings, and then more precisely describing these

categories under the headings. Several excerpts were also chosen to illustrate respondents' attitudes toward the Qiang language's heritage and ethnic perceptions. This data is used to illustrate the needs findings. The questionnaire data are primarily used to identify more appropriate story themes, but they can also be used to corroborate semi-structured interview findings.

3.3 Key Findings

After analyzing the interview data, we discovered that young people in the Qiang villages had difficulty communicating in the Qiang language on a regular basis. The absence of usage scenarios was also found to be a restriction of Qiang language heritage. There is no writable texts in the Qiang language, hence learning the language is base on memory. In addition, most Qiang teenagers lacked the motivation to learn about their culture. Older interviewees mentioned that when they told the younger generations about the Qiang people's historical hero stories, such as "The Qiang-Ge war", the youths behaved indifferently. We proposed three design principles based on these findings: 1) Involve players in serious games to attract their interest in the Qiang language and historical culture. 2) Through scenario simulation, rebuild the previous use context of the Qiang language. 3) Strengthen their awareness of national culture through nationalized content and visual design. These principles inspired us to design "WhiteStone".

4 System Design of WhiteStone

4.1 Context Design

WhiteStone is an interactive projection device based on the heroic epic of Qiang, including the Qiang language teaching session, interactive games and Qiang language testing session. These three sections are designed based on the above design principles.

Qiang Language Teaching Session: Firstly we taught players some necessary knowledge of qiang language in advance. In the pre-learning session, players can learn the pronunciation of some Qiang words that will be used in the game, so that they can play the games better. The traditional Qiang language teaching methods offer the use for reference to our learning method, such as pointing out objects and repeatedly following the pronunciation. We digitized the process and designed a set of Audible learning cards(see Fig 1). The cards are illustrated with pictures of objects correlating to the Qiang words, making it easy to visualize the meaning of the Qiang words in the mind. In addition, the cards describe the Chinese interpretation of the vocabulary, the harmonic phonetic symbols for the pronunciation, and the role of the word as a skill card in the subsequent game. Players can learn by pressing the buttons on the cards (which are set in the center of the item picture) to listen to the Qiang pronunciation of the word repeatedly. Pre-learning session as the beginning of the interactive process is

Fig. 1. (a) Audible learning cards. (b) Player press button to learn Qiang language

very necessary for the whole serious game. Considering that most players who are new to the Qiang language, it is difficult and unfamiliar and requires repeated practice to acquire. Learning the necessary skills in advance before proceeding with the game can alleviate the frustration of players due to their lack of skill level.

Interactive Games Session: We chose the story in the Qiang epic "Qiang-Ge War" as the main plot of the projection game, including two parts: "Find Rezi" and "Qiang-Ge War"(see Fig 2). In the game, the background of the story is presented in the form of an audio picture book(see Fig 3.a). We invited an Qiang elderly to tell the story in Qiang language to enrich the picture book. In order to immerse the player in the historical tradition of the Qiang people, we simulated the scenarios of adventure in caves and repelling enemy invasions with the help of projection interactive games, in which the player will play the role of the ancestral leader of the Qiang people, Ababaigou, who led the Qiang people through the difficulties.

The story of "Find Rezi" tells the story of the leader of the ancestral Qiang tribe, Aba Baigou, who led his people to migrate in search of a new home. In the "Find Rezi" game, players need to solve the puzzles according to the hints given in the game scenes. This is to emphasize the wisdom and exploration spirit of the Qiang people. To enhance the sense of immersion, we used a combination of physical and verbal gameplay, in which players pass the levels by shouting the Qiang language pronunciation and making the corresponding actions. In addition, during the field research, we also heard some interesting legends from the Qiang people: the sheep ate the scriptures with the writing, which led to the loss of the Qiang writing. When designing the levels of the game, we also added this story into the game's plot.

Fig. 2. (a) "Find Rezi" somatic interactive game. (b)"Qiang-ge War" tangible interactive game

"Qiang-Ge War" come after the Qiang people lived a stable life in Rezi, the village was invaded by the Gegi people. Ababaigou led the Qiang people, with the help of the King of Heaven, to use the white stone to repel the Geji people and defend their homeland. The "Qiang-Ge War" game recreates an exciting battle scene to demonstrate the Qiang people's bravery, unity, and power. Considering that the Qiang elders we interviewed consistently stated that the Qiang people both are valiant warriors, and we want to help strengthen this national identity in our games. In addition, during the interview, we were informed that throwing stones is one of the Qiang people's favorite childhood games. Therefore, we use the throwing action as the main game interaction method and, choose the white stone worshiped by the Qiang people as the throwing object. Players can defeat enemies by throwing white stones at the walls. (The Qiang people believe that the white stone is the incarnation of the god Aba Baigou. They put the white stone on the highest part of the roof to show respect.) Considering the safety factor, we substitute hard white stones with soft and low-elastic tennis ball props. In order to enhance the player's sense of engagement, our game allows voice input to encourage players to speak the Qiang language. For example, yelling a certain Qiang language pronunciation can assist you in gaining more points. The game characters will deploy unique powers to achieve a greater score. For instance, if the playershouts"bu per sa (the pronunciation of "Qiang flute")," the Qiang warriors will play the Qiang flute to stun and immobilize the enemy.

In addition to the integration of mythological stories and life elements in the game. The design of the visual materials integrates the cultural elements of Qiang to enhance intimacy. We attempted to depict the charm of Qiang culture by drawing on the artistic style of an important cultural relic, Qiang's Shibi Painting "Shuarile" (see Fig 3.b), paired with distinct Qiang components such as Qiang flute and Qiang towers.

Qiang Language Testing Session: Finally, in order to test the results of the Qiang language learning, we designed a game-based test session called "Qiang blockhouse messenger". In order to make the testing session lively and interesting, we used melody Qiang music and beautiful village scenery to simulate

Fig. 3. (a) Audio picture book of Qiang heroic epic. (b)Qiang's Shibi Paiting "Shuarile"

the life of the Qiang people after the battle. This helps reduce players' rejection of the testing process and allows them to use their learned Qiang language as naturally as possible.

In this session, players take on the role of ordinary villagers standing on the Qiang blockhouse and speak the corresponding Qiang language based on the pictures above the Qiang villager. The picture of the items will appear randomly as a question, and players need to say the correct Qiang language pronunciation within five seconds, otherwise the question will fail and switch to the next picture. In a test, there are 20 questions to complete. To visualize the score, the correct Qiang words will be turned into corresponding items (e.g. Yunyun shoes and Za Jiu), which will fall between two Qiang towers and pile up one by one into a sea of items. We want players to feel more accomplished when they see the words they have answered correctly.

4.2 Interactive Design

First, players use the audio cards to learn the words that will be used in the game. After the preview session, players reach the game area to start the game. The game starts with a picture book that tells the background of the story, and the player takes on the role of the Qiang leader Aba Baigou who leads his people on an adventure. The first experience is "Find Rezi", a story of solving puzzles in a cave. Players can solve puzzles by shouting out Qiang pronunciations and body movements. For example, the game's characters will follow the player's walking movements. When encountering an obstacle vine, the player needs to shout out the Qiang pronunciation of fire (mo) and make a pose to draw a bow and shoot an arrow, then the game character will shoot an arrow with fire to burn it. After solving all the puzzles, the main character arrives at his new hometown, Rezi, and the "Qiang-Ge War" comes immediately after. In order to defend the home, players pick up prop balls from the box to smash the enemies on the wall, just like the Qiang ancestors threw white stones to fight. In the game, players can show their Qiang language ability by shouting out Qiang language pronunciation to get a higher score. For instance, if the player shouts "bu per sa,"? The pronunciation of "Qiang flute", a traditional musical instrument of

Qiang.? the Qiang warriors will play the Qiang flute to stun and immobilize the enemy. Our game enables multiple players to throw and roar in unison to attack the enemy, enabling people to recognize the spirit of their Qiang ancestors and battle the attackers bravely. After a tense battle lasting 120 s, players will get their battle score. The Qiang people in the story also successfully repelled the enemy and live a peaceful and happy life again. Players can test their Qiang language learning in the game "Qiang blockhouse messenger". Players play as villagers standing on the Qiang blockhouse, according to the pictures of the objects above the Qiang villager to speak out the corresponding Qiang language pronunciation. Finally, the number of correct answers will be the score of testing session.

4.3 System Development

WhiteStone's system architecture is depicted in Fig 4. For the audible learning

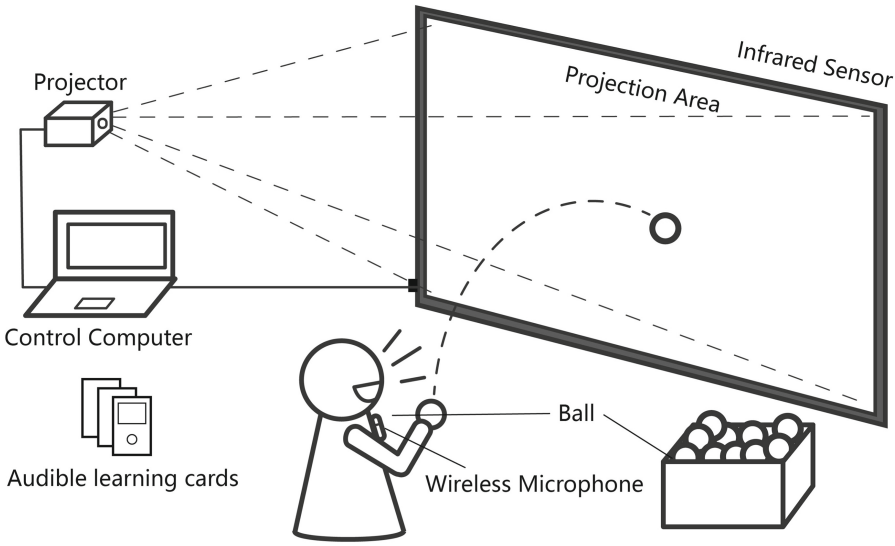

Fig. 4. System architecture of WhiteStone

cards, we record in advance through the built-in Microphone movement to preset the pronunciation of Qiang words, and then seal the cover of the card, and place the button on the painted picture position on the card. Players play audio by pressing a button to trigger.

Both two projected interactive games were developed by Unity3D. A Kinect depth camera is placed below the projection area for somatosensory input. Kinect 2.0 has a depth camera, an infrared camera, a color camera, and 25 default skeletal points. The device acquires the position of a person in a three-dimensional

space through a depth camera and an infrared camera, and judges the distance relation between the corresponding positions of the skeletal points. With the help of skeletal point binding of Kinect motion sensing device, we define specific gestures in code. The specific action of the player during the game will be recognized to trigger the corresponding operation in the game. These operations are fed back to the screen of the projection area.

In addition, the recognition of the throwing position is realized by the infrared touch frame installed outside the projection area. The infrared technology touch screen is composed of infrared transmitting and receiving sensing elements installed on the outer frame of the touch screen, and an infrared detection matrix is formed on the surface of the screen. The occlusion of any object will change the infrared grid on the contact point, thus realizing the positioning of touch. The projector and the infrared touch control frame are connected with the control host through a data line; The prop tennis ball is thrown to the projection area, the position of the prop tennis ball is obtained through the infrared touch frame, and the data is transmitted to the host and fed back to the projection area.

At the same time, the wireless microphone worn by the player on the collar receives the voice audio emitted by the player and transmits it to the host for processing through Bluetooth. Speech recognition technology uses speech recognition interface based on Deep Peak2 end-to-end modeling, and makes corresponding game feedback after comparing with the established Qiang language corpus.

5 Evaluation

5.1 Study Design

To validate the potential of "WhiteStone" to motivate Qiang language learning, we conducted a user study that included both field testing and remote validation. In the remote test for the Qiang people, we focused on several research questions: (1) Is the format of a serious game based on projection interaction an appropriate way to stimulate interest in the Qiang language learning? (2) The ethnic and cultural identity of the players.

In addition, we wanted to understand the potential of "WhiteStone" in teaching the Qiang language to non-Qiang people. In our field test, we focused on (1) the effectiveness of a serious game based on projection interaction in helping indigenous language learning (2) whether the gamified learning process of the Qiang language affects the perceptions of the Qiang language, and culture among the interracial people.

Based on these questions, we hope to better understand the personal feelings that Qiang and other ethnic participants derive from our system so that we can stimulate the value of serious games based on projective interaction for the Qiang language learning.

5.2 Remote Study

Participant Due to the impact of Covid, we were unable to return to Qiang Village for field testing, we led a qualitative study with one-on-one video presentations and online interviews with Qiang people online. A total of 11 Qiang people (1 elderly, 1 middle-aged, and 9 young people) participated in the remote verification. Among them, the elderly and middle-aged people are proficient in Qiang language, only 2 young people can use Qiang language fluently, and the remaining 7 young people are in the state of understanding but not speaking, or completely incomprehensible.

Procedure and Data Collection Based on the contact information collected during field research, we conducted remote presentations and telephone interviews with nine Qiang people using social media (WeChat) as a platform. All remote validations followed the same process, with a project introduction prior to the interview, and permission to record was sought. First, a pre-interview was conducted to understand the basic information and mastery of the Qiang language and the level of knowledge of the ethnic culture of the participants. Then a remote presentation in the form of a video was given, with appropriate explanations based on the queries raised. This is followed by a core interview. Recorded interviews will be transcribed verbatim into documents and coded by the researcher for qualitative analysis.

Results (1) Is a serious game based on projection interaction an appropriate way to stimulate interest in the Qiang language learning?

The majority of respondents ($n = 10$) found WhiteStone to be interesting and innovative. The innovative interactive approach and the Qiang elements represented in the game were able to attract their interest. Among them, some respondents volunteered to try it for themselves after seeing the demo video. In addition, the respondents confirmed that the projection-based interactive serious game was effective in teaching simple Qiang vocabulary ($n = 7$), especially in engaging children's interest in learning ($n = 3$). However, respondents also mentioned that the corpus of games is still relatively small and needs to continue to be expanded.

(2) Players' national identity and cultural identity

Some interviewees said that they had completely forgotten the myths and legends of their own nation, and through our game, they learned about their own people's myths and legends again. This game made them start to reflect on their own attitude towards their own national culture.

Two respondents specifically mentioned that the interactive form of rock throwing evoked their childhood memories.

Proof. P3: "It reminds me of the scene when I was a kid dancing around a triangular fire pit (with a lit bonfire on top) in a potlatch, very lively." P6: "This makes me miss the days when I was a kid going around the mountains with a bunch of kids picking wild flowers, climbing, and running around."

All the interviewed Qiang people expressed positive attitudes towards the Qiang elements represented in our game, and believed that WhiteStone could make more people understand the Qiang language and culture. One of the middle-aged Qiang people expressed high encouragement and praise for our work.

Proof. P7: "I think it's great and meaningful for you young people to express Qiang culture in the form of a game for more people to understand."

5.3 Field Experiment

To investigate whether White Stone can promote effective Qiang language learning in interracial people, we conducted a controlled experimental study. We compared the memory curve of Qiang's vocabulary and pronunciation after learning the Qiang language using the ordinary learning method and using White Stone. Additionally, we interviewed participants who used White Stone to learn the Qiang language. The purpose of this study was to verify the effectiveness of White Stone in helping Qiang language learning and to gain non-Qiang people's insights into serious play based on projected interaction.

Participant. We used social media to recruit 20 undergraduates (Age between 18–22, 11 males, 9 females) from a local University. In terms of academic background, 11 students majored in computer science, while the rest majored in atmosphere, resources and environment, and communication engineering, etc. Each participant was randomly assigned to an experimental or control group on the first day, with 12 participants in the experimental group and 8 participants in the control group. The experiment takes place on a one-on-one basis for three consecutive days:

- Experimental group: Participants learn through the use of audible learning cards, and the learning content is reinforced through games.
- Control group: Participants listen to recordings of a single vocabulary in a Qiang language through their mobile phones.

Procedure. Before the experiment, we first conducted an interview to confirm with the participants whether they had learned the Qiang language and whether they knew about the Qiang culture, so as to determine the baseline ability of the participants. Among the 20 participants recruited this time, one participant in the experimental group had lived in the Qiang community for one year, and three participants had little understanding of the Qiang culture. One participant in the control group had little understanding of Qiang culture. But none of the 20 participants had studied the Qiang language and had no knowledge of the design elements involved in this experiment.

Both the experimental group and the control group were set up with two parts: the learning part and the testing part. For three consecutive days, participants were asked to complete the learning part and the testing part each day.

The Learning Part

Experimental group: The entire part is limited to be completed within 20 min, including learning Qiang language through the audible learning cards three times, playing Find Rezi once and Qiang-Ge war once. First, the participants were asked to learn the Qiang language of a single vocabulary for the first time through the audible learning cards, and the learning time of each participant was limited to 5 min. Afterward, participants were required to use the Qiang language they had learned to complete a Find Rezi, and the game time of each participant was limited to 5 min. After the first game, the participants were asked to learn the Qiang language of a single vocabulary for the second time through the audible learning cards. This time, the learning time of each participant was limited to 3 min. Finally, the participants are required to complete a Qiang-Ge war using the Qiang language they have learned, and the game time of each participant is limited to 5 min. After both games, participants were required to learn the Qiang language of a single vocabulary for the third time through the audible learning cards. This time, the learning time for each participant was limited to 2 min.

Control group: The entire part is limited to 20 min to complete. Participants were asked to learn the Qiang language by listening to the recordings of individual words repeatedly through their mobile phones without any external props. The control group experiment and the experimental group had the same learning phase process, but the participants in the control group did not participate in the interactive game but were asked to rest quietly.

The Testing Part

Both the experimental group and the control group required participants to use the Qiang language they had learned in the learning part to complete the test game-Qiang blockhouse messenger. The test game requires participants to speak the corresponding Qiang pronunciation according to the picture of the item within the specified time. Participants in the control group were presented with patterned silent cards that familiarized them with the appearance of objects corresponding to individual Qiang words before the game. Data for each test will be recorded.

With the consent of the participants, after the experiment, we conducted interviews and audio recordings of the participants in the 12 experimental groups, focusing on the participants' interactive experience in the game. Interview recordings will be transcribed verbatim and coded.

At the same time, through the data collected by the system during the test part, the three-day test scores of the experimental group and the control group were analyzed.

Results. Qiang language learning efficiency. For learning efficiency, t-tests were performed for independent samples between the control and experimental conditions ($\alpha = .05$). Invalid data from one of the controls were excluded. Overall, players could achieve scores between 0 and 200. After three days of intensive learning. Players who played the game had higher scores for correct responses

(M = 183.33, SD = 11.55) than those in the control group (M = 168.57, SD = 26.1), t(19) = −1.418, p = 0.197.

Table 1. Analysis results of testing score.

Group	Day 1	Day 2	Day 3
Experimental group (n = 12)	118.57 ± 45.98	158.57 ± 38.91	168.57 ± 26.1
Control group (n = 7)	130 ± 35.68	173.33 ± 19.23	183.33 ± 11.55
t	−0.607	−0.939	−1.418
P	0.552	0.376	0.197

Feedback on the Use of the System

Following the experiment, we conducted semi-structured interviews with the participants to collect perceptions and perceptual feedback on the use of WhiteStone from the interracial population.

Audio Cards: Nine participants thought that the audible learning cards in the pre-reading session were helpful in learning Qiang language. Reasons included being fun; being able to repeat the sounds; the physical cards being tactile; and being impressive. One player mentioned that he was impressed by the combination of the learning content and the in-game skills (A4). Some negative feedback emerged on the instability of the homebrew hardware, which could be improved by upgrading to standard hardware.

Proof. A4: "The cards incorporate the game, so the impression is a little deeper. And some text descriptions on the cards also help to remember, such as the words marked with a sure kill technique, I remember it very clearly."

Interaction and game preference: Half of the participants in the experimental group (n = 6) had experienced public projection interactivity devices in the past, e.g. in science museums, amusement parks, etc. However, 75% of the participants (n = 9) were still novel to the form of interaction in this game (physical interaction/tangible interaction/voice recognition) and indicated that the game was engaging and could hold their interest. In the interviews, we asked participants about their favorite games and why they like it. Participants' preferences for the three games were 25% (n = 3) for the "Find Rezi" tangible interactive game, 58.3% (n = 7) for the "Qiang-Ge War" tangible interactive game, and 16.7% (n = 2) for the Qiang blockhouse messenger test game. Among them, 3 participants focused more on the flow of the game and narrative, and thus were more favorable to the physical interactive games with subdivided levels and more character dialogues. The most popular game was the Qiang-Ge War, which involved throwing a prop ball, for reasons such as being challenging, more immersive with tangible objects that can be touched, physical movement that enhances engagement, and the ability to combine it with one's hobby of playing basketball. However, one female participant indicated that the throwing motion

was difficult for her, so she preferred the simple test game, which was consistent with the reasons given by another participant. This reminds us of the need to adjust the difficulty of the game according to the different levels of ability of the players.

Immersion Qiang language environment creation: 8 participants felt that the game succeeded in creating an environment for the use of Qiang language due to the novel interaction, the Qiang-inspired visuals and sound effects, and the game mechanics that encouraged players to speak Qiang. In particular, The combination of projection and physical movement is considered enjoyable and immersive. The low-light environment created by the projection also helps to keep the player focused and immersed in the game. We also asked them about their perceptions of the testing game, which simulates the daily life of the Qiang people. 9 participants agreed that the gamified approach to testing made them feel more relaxed and natural. This somewhat reduced anxiety about the aptitude test.

The impression of Qiang culture: Eleven participants shared with us in the interviews what they learned about Qiang culture during the game, including Qiang distinctive items and Qiang mythology. The Qiang flute ($n = 3$), and the legends of white stone and the sky god ($n = 7$) were impressive elements. 10 participants expressed interest in the Qiang language and culture and wanted to learn more about it. This suggests that WhiteStone helps to spread the appeal of Qiang culture to outsiders.

6 Discussion

The findings indicate that WhiteStone has the potential to be an effective tool for conveying Qiang language and culture in a fun and interactive way. Compared with ordinary learning methods, WhiteStone achieved higher learning efficiency, albeit the difference was not significant due to insufficient samples. But participants in both the remote and field trials agreed that WhiteStone was able to attract their interest in learning about the Qiang language and culture. The Qiang people fully affirmed the significance of our work for the heritage of the Qiang language and culture.

6.1 Indigenous Language Without Written Text

This study focuses on the Qiang language, which has no written text and suffers greater obstacles in its inheritance than other languages. The paper teaching of Qiang language is inefficient, so its inheritance depends on oral transmission. In our field research, we found that the Qiang people's ability to listen is greater than their ability to speak. In other words, some Qiang people can't speak Qiang language even if they can understand what others said. One reason is the lack of a language environment. Listening to the elders speak Qiang language at home can be passive practice of Qiang listening ability, but how to improve the oral ability of young people? Since they usually use Chinese to communicate with their classmates and friends at school, they have no desire to use Qiang

language. WhiteStone offers them a chance to use their Qiang language skills. We create immersion through somatosensory interaction, tangible interaction, voice input and other ways to create the use environment of Qiang language. At the same time, through the rules of the game, we limit the clearance conditions to encourage players to open more Qiang language. Our validation shows that these designs are effective. This provides ideas for the study of other endangered languages without writing.

6.2 Participation of Non-Qiang People

In this process, the non-Qiang people can also be included, through the competition mechanism to stimulate the opponent's desire to get higher scores. But we believe they are not limited to providing tension as competitors. During the remote verification, the Qiang people said, "I feel ashamed to see that other person attach so much importance to our Qiang language and culture, but we don't cherish it." We are glad to see the reflection of the Qiang people on the inheritance of their own culture caused by WhiteStone and hope that this reflection can further urge the Qiang people to take practical actions for the inheritance of their own culture. The cultural reflection of the Qiang people also brings us thinking. Is the inheritance or extinction of a language only the responsibility of ethnic minorities themselves? It is also an important part of protecting endangered languages to make people of other nationalities realize the value of minority languages and make efforts for them. The active participation of non-Qiang people may bring new vitality to the inheritance of minority languages. The inheritance and development of a national culture require the joint efforts of the ethnic minorities and other people in the language ecosphere.

6.3 Limitation and Future Work

So far we've delivered an effective serious game, WhiteStone, and evaluated it in the lab. However, due to limited conditions, we only studied the short-term effects on motivation and learning efficiency for three days in this validation, and it is unclear whether these effects are widespread over a longer period of time. Therefore, we hope to conduct field deployments to Qiang communities in the next work and conduct experiments in a longer time span to understand whether WhiteStone will motivate players to stay involved in the long term, so as to achieve long-term learning effects. In addition, due to the influence of COVID-19, we only invited non-native people to conduct field tests in this study, so the number of samples was limited. We plan to increase the sample size in the following study and invite Qiang people to participate in the game with other people. We were curious about how their experiences of competition and cooperation affected cultural consciousness. Given the diversity of potential audiences, we will also discuss topics including age at scheduled field deployments.

7 Conclusion

Revitalizing endangered indigenous languages is an important step in protecting world civilization and linguistic diversity. In particular, the Qiang language, a minority language with no written language, is in crisis as the number of people proficient in it decreases. We came up with a set of serious games called "WhiteStone" based on the design principles of field research in Qiang community. It consists of Qiang Language Teaching session, Interactive Games Session and Qiang Language testing session. To verify WhiteStone's effectiveness, we conducted a user study consist of a remote verification test and a field test to obtain insight from Qiang and non-Qiang people, respectively. Our work shows that serious games based on projective interaction have the potential to create engrossed and interesting experiences, which can attract young people's interest in learning Qiang. At the same time, the immersive game experience allows players to engage in cultural reflection as they bring their characters into the game, which helps revitalize the Qiang language and culture.

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