OGMA - LANGUAGE ACQUISITION SYSTEM USING IMMERSIVE VIRTUAL REALITY

by

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Presented to the Faculty of the Graduate School of

The University of Texas at Arlington in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE IN COMPUTER SCIENCE

THE UNIVERSITY OF TEXAS AT ARLINGTON

Fall 2015

Acknowledgements

I would like to thank Dr. Fillia Makedon for supervising my thesis. I would also like to thank Heracleia Human-Centered Laboratory for all the support I received. I want to express my gratitude to all the researchers of the lab who motivated me throughout my Thesis 1.

I would also like to thank my committee members Dr. Eric Becker who guided me throughout my starting phase and Dr. John Robb for his useful feedback on work.

Additionally, I would also like to thank Dylan Ebert, my partner in HCI course. With his partnership, I enjoyed and discovered new areas or research and technology to work on. His support and contribution to my thesis project is invaluable, without him this work would not have been possible.

I wish to express my gratitude to the Heracleia Human-Centered Computing Laboratory for providing infrastructural facilities.

I convey my hearty thanks to my parents for the moral support, motivation & encouragement to make this venture a success.

April 11, 2016

Abstract

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One of the methods of learning a new language, or Second-Language Acquisition (SLA), is immersion, seen today as one of the most effective learning methods. Using this method, the learner relocates to a new place where the target language is the dominant language and tries to learn the language my immersing themselves in the local environment. However, it isn't a feasible option for all, thus, traditional, less effective learning methods are used. As an alternative solution, we use virtual reality (VR) as a new method to learn a new language. VR is an immersive technology that allows the user to wear a head-mounted display to be immersed in a life-like virtual environment. Ogma, an immersive virtual reality (VR) language learning environment is introduced and compared to traditional methods of language learning. For this study, teaching a foreign vocabulary was focused only. Participants were given a set of ten Swedish words and learn them either by using a traditional list-and-flash-cards method or by using Ogma. They then return one week later to give feedback and be tested on their vocabulary-training success. Results indicated that percentage retention using our VR method was significantly higher than that

of the traditional method. In addition, the effectiveness and enjoyability ratings are given by users were significantly higher for the VR method. This proves that our system has a potential impact on SLA by using VR technology and that Immersive Virtual reality technique is better than traditional methods of learning a new language.

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Chapter 1

Introduction

Virtual reality systems have a huge impact in education, entertainment, medicine, architecture, and training, but they are not widely used because of their expense and delicacy. However, head-mounted display (HMD) technology have become readily available to the public. Other immersive virtual technologies, such as virtual caves, are less likely to achieve commodity status since they often involve greater expense in the form of large screens, projectors, and a locomotion device such as a treadmill or bicycle that allows a user to move about the environment. They potentially allow people to learn about an environment [12]. The focus of my thesis is using this immersive virtual reality (IVR) for learning. Due to technical advancement, virtual worlds become more and more immersive [8]. The goal of virtual reality systems is to immerse the participant with a computer generated, virtual environment (VE). The ideal VE system would have the participant fully believe he was actually performing the task.

Learning a new language has always been adaunting task. Till date only traditional methods of language learning are used such as learning with flash cards, online systems like Duolingo [13], Google translate [14], Memrise [15], or traditional classroom setup where teacher teaches a new language and course structure is laid out in textbooks. In this thesis, I’m trying to find out whether immersive virtual reality environment can provide a new method of learning a new language and test the feasibility of VR environments as training platforms. There have been studies that conclude immersive VR environments can impact memory and enhance retention [8], [9]. VR applications are being used for education [10], [11]. In terms of HCI, letting user (human) interact with a new computing device (wearables like oculus Rift and Myo Band) is a great area for research. The main aim of this thesis is to compare traditional methods of language learning i.e. using textbooks/language learning software and a new VR platform. The current state of the art in this field is that non-immersive technologies have been used for learning a new language [1-5].

In this thesis, an immersive VR system is designed following user experience design process & principles and tested on participants to check the validity of our hypothesis – *IVR is better than traditional methods of learning a new language.*

Immersion is often believed to be the most effective method of language learning. Being placed in a setting in which the target language must be used provides immense learning motivation and exposes the learner to a vast amount of content. However, it isn't always reasonable for a learner to immerse themselves by, for example, living in another country. There is high economic and social incentive to develop better foreign language learning methods.

Virtual reality is an emerging technology that shows a high degree of potential in a wide array of fields, including entertainment, healthcare, and education [7]. Language learning is a realm in which virtual reality has had very little application, with very little research found. Applying virtual reality to language learning would allow learners to experience virtual immersion, with the convenience of home. The resources required to develop a fully immersive virtual language learning environment would be immense, but reasonable for a large company to develop. Due to these limitations, we focus only on vocabulary in this study, corresponding to tangible objects.

In order to assess the effectiveness of this virtual reality method, we use a control group of participants that use a traditional method of language learning on the same list of vocabulary. This traditional method consists of a list memorization session and a flashcard study session.

Chapter 2

Related Work

A thorough background and related work research was done to find out the existing similar systems and state of the art. Also background research was done on impact of audio visual cues on memory retention as well as Head mounted displays (HMDs) for Virtual reality environment. Doing tasks in virtual environments can be so immersive that a person can forget he is not in a fake world. Presence is often described as the “sense of being there” [6]. In more detail, it refers to the degree to which a person feels rather in the virtual environment than in the laboratory used for creating the presented stimuli [7, 8]. A person’s memory is impacted by audio and visual cues he gets from the environment. Text remains in short term memory if it is not revised till a certain amount of time. [7] describes vividness of visual imagery and source memory for audio and text. [6] describes audio-video correspondence and its role in attention and memory.

Research on using technology to assist with language learning has been ongoing for many years, but technology remains a small part of language learning in the classroom [2]. Research on virtual reality in other areas of learning finds that virtual reality can be successfully be applied in a learning environment where there is a significant lack of knowledge regarding the technology [4]. One of the benefits of learning in virtual worlds is that users don’t face the same risks and consequences associated with making mistakes in the real world. Just as interaction is found to be beneficial to learning, interaction can be simulated in virtual reality for the same benefit [3]. Emotion detection can be used together with virtual reality to tailor the learning to the student’s needs.

In a study assessing the benefits of telepresence in a foreign-language virtual world, higher levels of interaction and investment were found to create increased feeling of immersion, depending on a variety of factors depending on the video game, video, etc. [1]. In an experimental study on display fidelity and interaction methods, it was found that higher fidelity interaction methods, such as Kinect, paired better with high fidelity displays, such as Oculus Rift, where low fidelity interaction methods, such as keyboard and mouse, went better with low fidelity displays, such as a computer monitor [5].

The only similar content found on language learning in virtual reality was that of a startup company called Learn Immersive with a similar concept, focused on school children, for students to take a "virtual field trip" to real world locations to in virtual reality to simulate being immersed in the country of the target language [6].

Doing tasks in virtual environments can be so immersive that a person can forget they are not in a fake world. Presence is often described as the "sense of being there" [8]. In more detail, it refers to the degree to which a person feels rather in the virtual environment than in the laboratory used for creating the presented stimuli [9, 10]. A person's memory is impacted by audio and visual cues they get from the environment. Text remains in short term memory if it is not revised till a certain amount of time. [9] describes vividness of visual imagery and source memory for audio and text. [8] describes audio-video correspondence and its role in attention and memory.

Despite significant research and development in the 1990s, the immersive VR experiences did not reach consumers. [11] posited a number of reasons for this, such as that the technical quality of HMDs was considered poor (in terms of resolution, Field of View (FOV), comfort, motion sickness, etc.), socialization was not facilitated (with users unable to interact with others), the graphical quality of the rendered scenes was poor, and the cost was prohibitive. However, many of these issues are on the verge of being addressed, e.g. the Oculus Rift's DK2 features a 1920x1080 low latency OLED display. As such, high quality HMD with accurate head tracking are on the verge of being widely available. However, interacting with reality remains a challenge: existing consumer HMD such as the Oculus Rift or Gear VR1 do not yet incorporate the sensors needed to adequately track hands, identify objects, or provide a wide-angle FOV of reality.

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Chapter 3

User Centered Design Process

User Centered Design (UCD) is a set of processes that focuses on needs, wants and limitations of users of the product being built. In UCD the design problem is solved iteratively, validating the product design with user feedback. Fig 3-1 shows the 3 phases in UCD process i.e. – User Research, Design and Build. It is important to learn how user thinks. So the target audience for whom the product is being built, is interviewed and user studies, notes, specification documents and workflow documents is made. From these ideation process takes place after which early prototypes are formed and constantly user tested.

After this step, designers and developers build user centered solutions on which final user testing is done to ensure usability. Usability is a measure of the interactive user experience associated with a user interface. UCD offers a more efficient, satisfying, and user-friendly experience for the user. By understanding the human emotions, motivations, and beliefs that surround a task, a user interface can be designed to accommodate and support user behaviors in a way that users will experience as natural and satisfying.

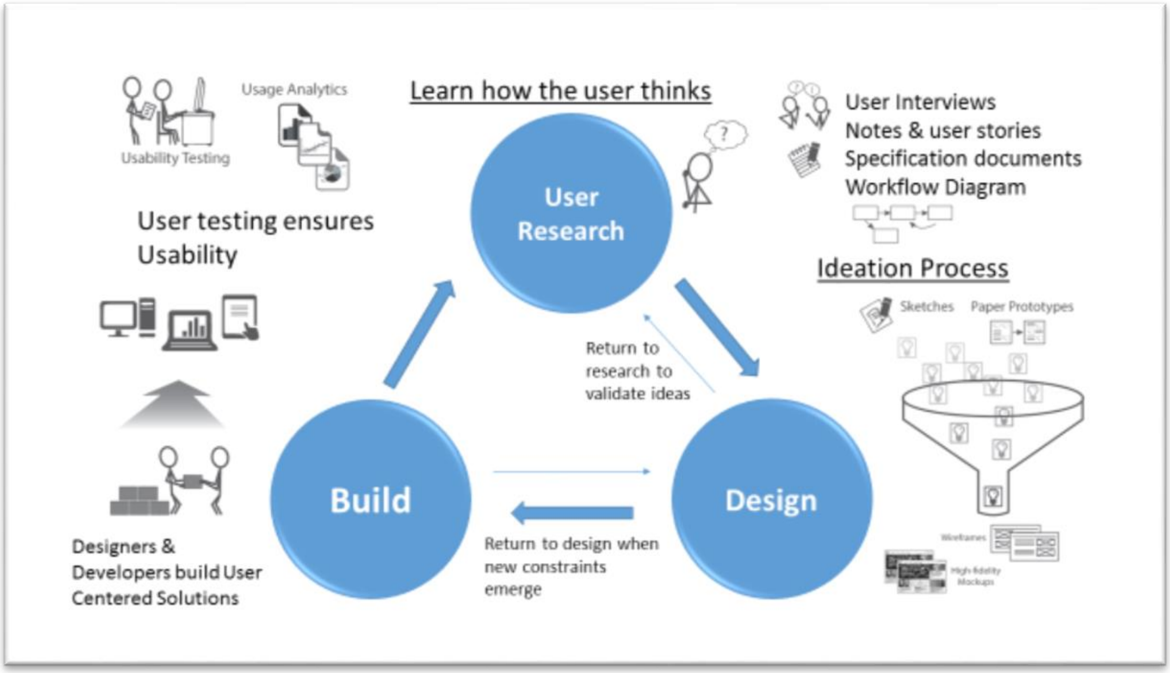

Figure 3-1 User Centered Design Process

User Research

The User Centered Design process is based on user centric design principles. In this phase, the following questions were answered by users to complete and finalize the problem statement of the research. The answers to the following questions were found out by conducting interviews with people who have / are learning a new language. As it a user centered design process, every phase of the research is validated by user views and feedbacks.

1. Why do people learn a new language?

They learn a new language to find new job in a new country, personal interests, travelling, coursework etc.

2. How fast do they learn?

It depends from person to person. Some people can learn in 3 months while others take years.

3. How existing language learning system work?

They are flash card methods, textbooks etc.

4. How VR can improve language learning experience?

VR will give an immersive experience with audio-visual effects which will help in memory retention.

5. What are the assumptions?

VR system is better than traditional methods of learning a new language.

6. Who are the audience/user/stakeholders of the system?

The audience can be any person, any gender, any age who wants to learn a new language.

Figure 3-2 Oculus Rift Development Kit 2

Figure 3-3 Leap Motion

Based on the answers, brainstorming was done for initial system design. Having an interactive game in VR environment was also planned. Wearables such as Oculus Rift DK2 (Figure 3-2) and Leap Motion (Figure 3-3) were decided to be used. For better understanding of the users, personas were created (Fig 3-4 and Fig 3-5).

Alice

Age	22
Gender	Female
Persona group	Student
Job Title	Student
Education	Graduate

Goals and motivations
Alice has taken Swedish language course this semester. She wants to learn the efficiently as she is planning to go to Sweden for higher studies.

Lifestyle
She lives off campus, commutes every day to school. She also works at McDonalds to fund her studies.

Nature of work
Studies at University.

Experience and training
She has done regular English Grammar classes.
Environment
University

IT skill level
Advanced, as she is a literature major.

Attitude towards technology
- ☐ Great – it's easy to use and saves me time
- ☐ I like it but it often falls short
- ☐ I don't like it but I have to use it

IT equipment
Desktop, laptop, mobile device, tablet, printer, networked, wireless

How will this person use the VR language learning app?
She will use it to learn the language along with her coursework that suggests her to use textbooks. She will have an edge over other students as she will learn the language more efficiently.

Key tasks
Learning the language fast

Figure 3-4 Persona 1 (Alice)

Prof. Hudson

Age	56
Gender	Male
Persona group	Team lead/ manager
Job Title	Professor
Education	Ph.D

Goals and motivations
Prof. Hudson is the director of HCI lab and he has many PhD students under him. Recently he got a tenured position in one of the leading University at Sweden. He is planning to move to Sweden. So he is looking for ways to learn Swedish fast and effectively.

Lifestyle
He lives near the university but often he is abroad for conferences.

Nature of work
Teaches class

Experience and training
He has never learned a new language

Environment
University

IT skill level
Advanced, as he is a professor

Attitude towards technology
☐ Great – it's easy to use and saves me time
☐ I like it but it often falls short
☐ I don't like it but I have to use it

IT equipment
Desktop, laptop

How will this person use the VR language learning app?
Prof. Hudson likes new gadgets. He will enjoy learning a new language in an immersive environment. Also he will get a chance to introduce his HCI class to a new technology.

Key tasks
Learning the language fast & effectively

Figure 3-5 Persona 1 (Prof. Hudson)

Design, Prototype, User Testing (Iteration 1)

System design – A game for virtual environment was decided in which the user can freely roam around learn basic vocabulary of objects he will look in Virtual environment.

Hypothesis – Language learning experience is better in Immersive virtual reality environment than traditional learning methods.

Choice of language – Swedish language was decided to be used in the study as it is similar to English and unpopular in United States.

Pilot study – An initial pilot study was done to find out how many words would be appropriate for the system. A list of 10 Swedish words were made and participants learnt it. Then after different interval of times they were tested. The list consisted of these words: Apple – äpple, banana – banan, book – bok, bread – bröd, milk – mjölk, coffee – kaffe, pasta – pasta, water – vatten, lemon – citron, shoes – skor

Procedure: Three users were tested for traditional method. Participant A was given this list and was asked to learn them in 5 minutes just by looking at the list. Then the participant used a vocabulary training website (vokabel.com) to practice. They were tested on the words immediately after as well as a week later, and scored 9/10 and 5/10, respectively.

Participant B and C were also given the same list and were asked to learn them in 5 minutes by looking at the list. In this case, there was no practice, because the website wasn't working. Participant B was tested immediately after and scored 4/10. Participant C was tested the next day and scored 8/10.

Observations: Participants had more difficulty with words that were different from English. For example, nobody got water (vatten) correct in the test. In addition, participants tend to remember more if they are given some kind of practice. In our case, we will be using games in our system to help users learn these words.

Conclusion: Considering the lack of training presented in this pilot study, we have decided that 30 words should be a reasonably sized lexicon to use in our study. We also learned that time plays a major role. There is a difference between holding words in memory and actually learning them. Therefore, it would be ideal for us to provide our assessment at least a week after the training.

Design, Prototype, User Testing (Iteration 2)

Based on the user feedback, changes were made in iteration 2. Low and high fidelity prototypes were built to test and find any flaw in system design. Discovering flaws at initial stage of development saves a lot of development time and effort. Also getting user feedback in initial stages of development adds value to the system being built.

Low fidelity prototype

A real room (Figure 3-6) was simulated as our virtual environment. 3 participants were asked to explore the room. A soft music was on in the background. As the participants explored the room, they saw textual cues (other language) over some object. When they looked at it, the music stopped playing and they heard an audio cue (other language) saying the object's name. After this exercise the participants were tested. All of the participants remembered the object's name in the other language very well.

Figure 3-6 Low fidelity prototype (A real room set up)

Testing of myo as interaction medium in VR

Myo band (Figure 3-7) was decided to use over leap motion as it was a better input for VR environment. Keeping in my all the user feedbacks, changes were made in the gestures of Myo for VR input.

Figure 3-7 Myo Band

High Fidelity Prototype

High fidelity prototypes, also known as digital prototype was built to find the user's reaction to VR environment. An open VR environment was created (Fig 3-8). The users were asked to move in VE by wearing Myo band. They were asked to look at a cube and read the word displayed. We tested our hardware (Oculus and Myo) in this environment. The users felt uncomfortable navigating in the VE wearing Myo band they complained that the gestures used for navigating were difficult to maintain in VE. This was an attempt to find the easy of interaction with VE.

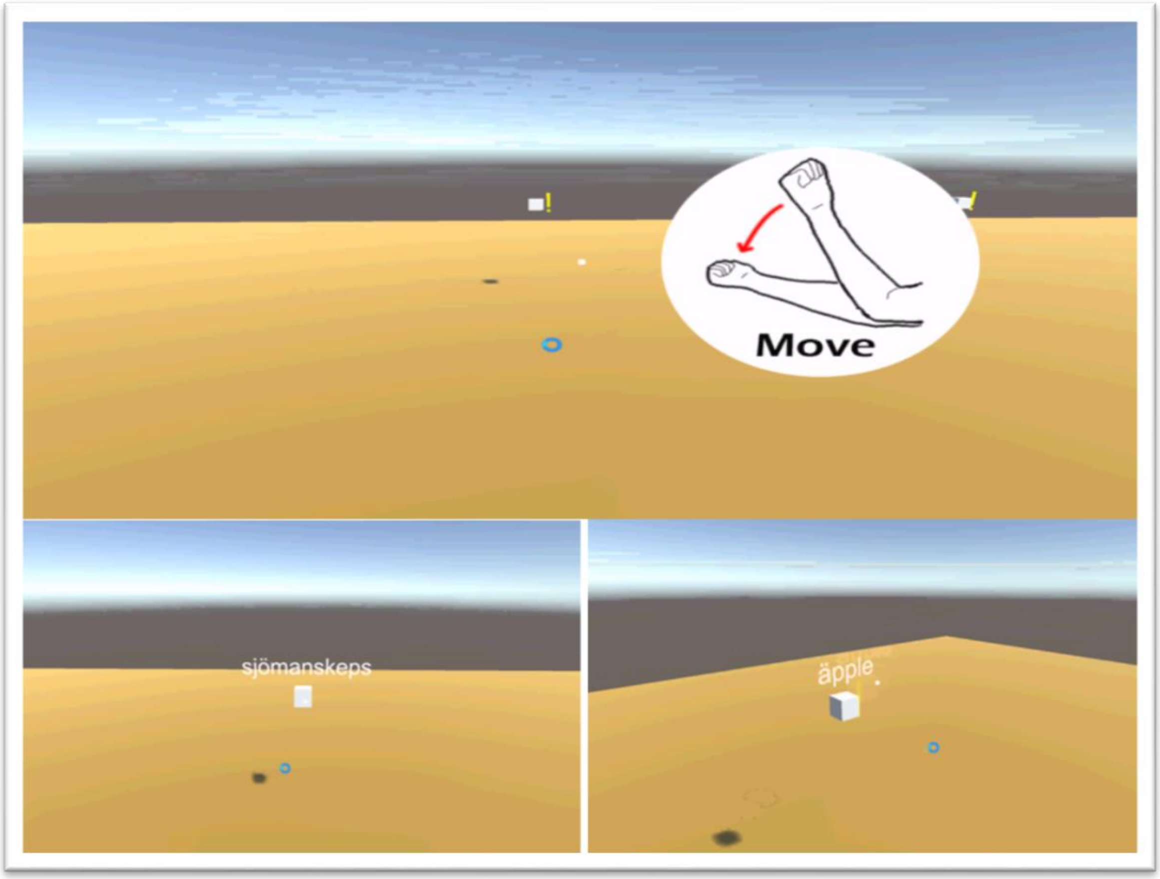

Figure 3-8 High Fidelity prototype

Game Specifications

The following game specifications were decided based on user feedback and system design. After learning the words in the environment, the user will then play a game to learn and test his learning with a game play. The game will be

• The user will be instructed how to play the game with a simple user interface

• The user will hear a sound of an object or see the text on UI.

• The user will have to go near the object and look at it to gain points

• If the user is unable to find the object after certain amount of time, the user will be guided to the object by a trail of lights/glowing path.

• In this way the user will have to find all the objects to complete the game.

Learning Outcome: With the help of his game, the user will identify the objects by sound and text. Besides these changes, music was decided to be added in the environment. Audio cues were also decided to be given when the object’s name was displayed.

Evaluation Methods

These 4 evaluation methods were decided to be followed - Formative evaluation (Informal feedback), Summative evaluation (Interviews), Standardized test & Questionnaire

Design, Prototype, User Testing (Iteration 3)

Apartment – The VR environment was built (Fig 3-9). It was an apartment having living room, bedroom, kitchen and balcony. 10 objects were placed in the apartment.

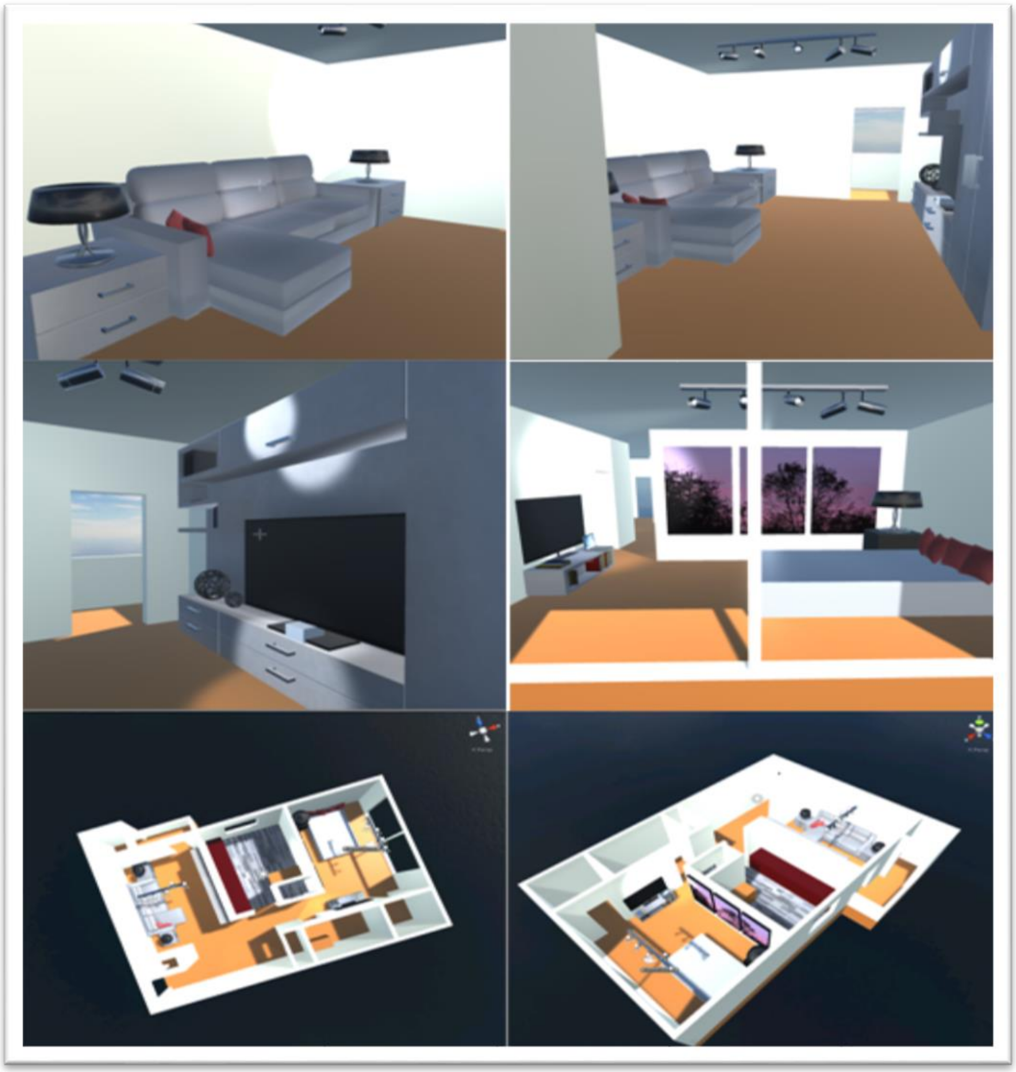

Figure 3-9 VR Apartment

User Feedback

- “Music is good, but should be instrument - no lyrics” The user liked the concept of music but suggested it should be instrumental as it will not interfere with the pronunciation of the words.
- “Oculus is too heavy”. The DK2 headset was heavy and wired. This caused discomfort.
- "Need for practice environment”. The user felt very uncomfortable directly dealing with the new VE without any practice. A need for practice environment became necessary.
- “Objects don’t need English translations, but should be easily recognizable”
- “Slower pronunciation” The pronunciation were fast for some users.

Design, Prototype, User Testing (Iteration 4)

Figure 3-10 Practice Environment

The following changes were done based on user feedbacks.

- Instrumental Music was added as in the learning environment.
- Practice Room was created. This was an empty room with a painting on the wall as seen in Fig 3-10
- Easy to recognize without English translation – 10 Swedish objects were chosen.
- Final User Testing was done before Data collection.

User testing – One participant tested the system. After using the system, a small assessment was done to check how many words he remembered. Table 6.1 shows the performance of the participant.

Table 3-1 Scores of the participant

Word	Similar to English?	Spelling	Pronunciation
Word 1	yes	correct	almost
Word 2	no	correct	almost
Word 3	no	correct	correct
Word 4	yes	correct	correct
Word 5	yes	correct	correct
Word 6	yes	almost	almost
Word 7	no	correct	correct
Word 8	no	almost	almost
Word 9	no	correct	almost
Word 10	yes	correct	almost

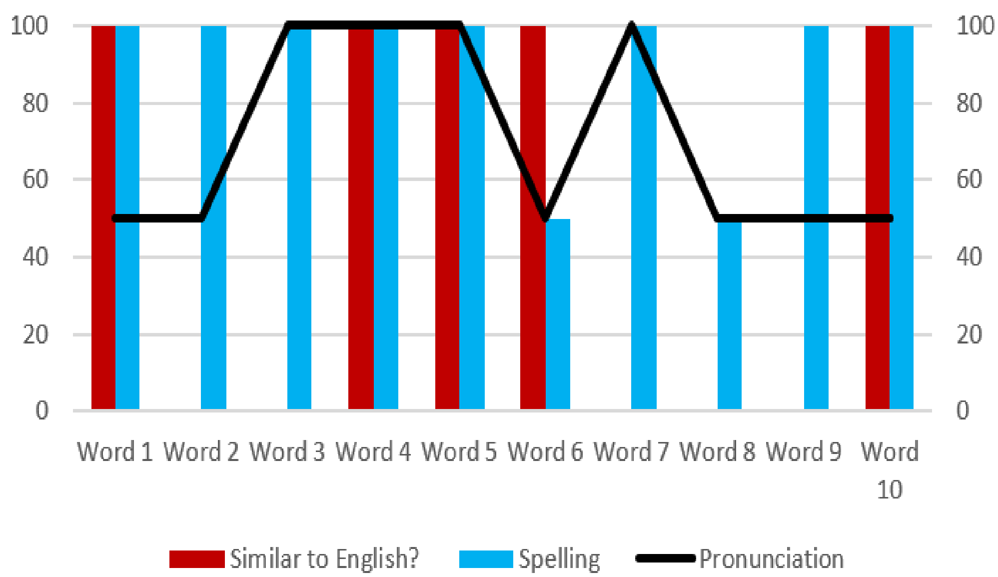

Figure 3-11 Analysis of user performance

As seen in Figure 3-11, the red bars represent words similar to English, blue bars represent how correctly did the user write the spelling of each word and black graph line shows pronunciations for each word.

User Feedback – The following were the comments from the user.

- Movement was the most difficult part
- Arm movement bounds should be raised about 20 degrees
- Lack of sense of firm control when moving - afraid of going off balcony/out door
- Music is good for immersion; not distracting
- Good learning environment; better than written or picture-matching

Based on these feedback, the system was modified for the last time before data collection and user study started. An IRB protocol was filed to do user study.

Chapter 4

Experiment Setup

Final Apartment (VR environment) - A practice environment was used to train users how to interact with VR environment using Myo Band and Oculus rift. After they are comfortable with the hardware, the apartment is used for actual language learning. Fig 4-1, 4-2, 4-3 shows living room, kitchen and bedroom respectively. There are in all 10 objects that teaches Swedish vocabulary (with audio and visual cues) which are marks with yellow exclamation marks.

The 10 objects were – umbrella, door, shoes, chair, pen, bed, computer, banana, ice cream and book. We selected 5 Swedish words which were similar to English and other 5 which were very different.

Figure 4-1 Apartment (Living Room)

Figure 4-2 Apartment (Kitchen)

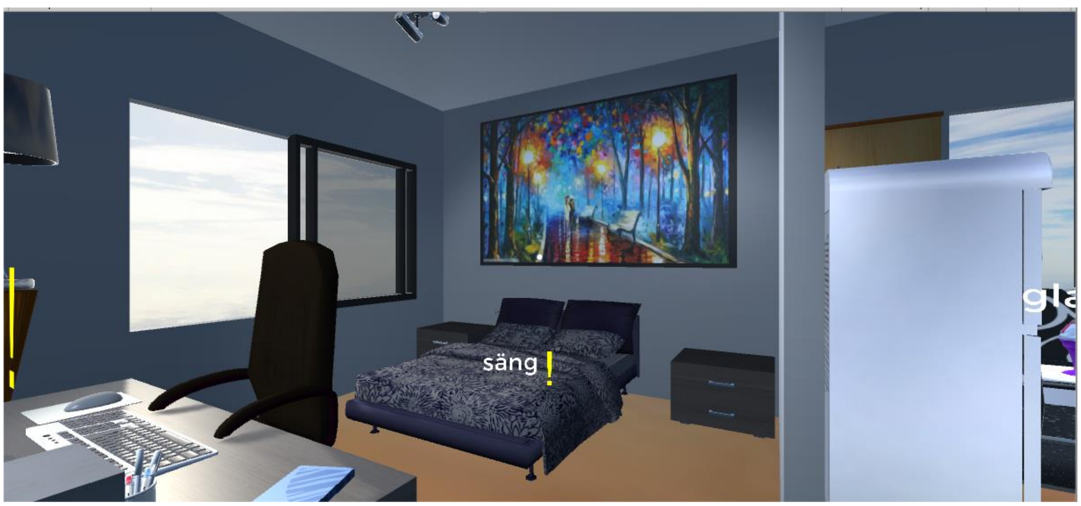

Figure 4-3 Apartment (Bedroom)

Participants

Number of participants: 36, Age Range: 13-50yrs, 50% Male, 50% Female

The experiment had two equal groups of participants (18 participants for VR study 18 Participants for traditional study). One for the traditional study and one for the virtual study. Both groups had different participants i.e. no person participated in both studies.

Experiment Design

The experiment design were decided to be as follows:

a. There will be two groups of participants. One group will study the word using traditional flashcard method. Other group will learn words using our virtual reality system.

b. Then immediately after learning the words, the participants will give a test.

c. After one week, the participants will be called and asked to give the test again.

d. After completing the test, they will fill out our questionnaire.

Graphical representation

A diagram describing the different steps of the experiments and how the different modules of your work will interact with each other (Fig 7.5).

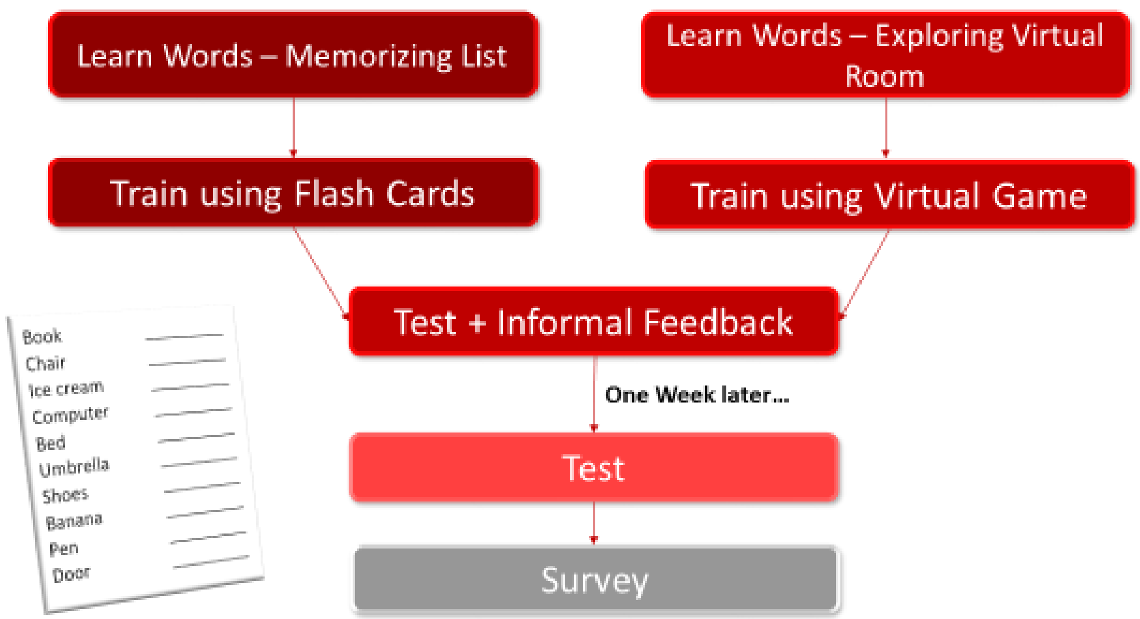

Figure 4-4 Graphical Representation

Experiment Design

36 student volunteers were chosen as participants out of which nineteen participants successfully completed the user study. They were randomly placed in either the traditional or virtual reality group. Traditional group participants were first given a list of ten Swedish words and their English equivalents and told to study them for up to five minutes. The words were read out loud to them, repeated upon request. Then, they were given flash cards corresponding to the words, and told to study them until they felt they were ready for the test.

Figure 4-5 Virtual Reality Experiment

The virtual reality environment, shown in Figure 4-1,4-2,4-3, was created in the Unity game engine, using a combination of custom-made and downloaded assets. Choosing the best input method was initially an obstacle, and many possibilities were explored for locomotion in the virtual environment. We decided upon using a Myo armband for locomotion, with the user pointing their arm forward to move as shown in Figure 2. In pilot studies, users found this to be the easiest method of locomotion. In addition, classical music was set to play in the background during learning, as users found this to add to the immersiveness of the environment and improve their focus.

Virtual reality group participants (Figure 4-5) entered a virtual practice environment where they could become accustomed to navigating virtual reality. Then, they entered the virtual apartment and were allowed to explore freely for up to five minutes, looking at objects to see and hear the corresponding Swedish words, as shown in Figure 4. Afterward, they entered the second phase, in which the Swedish words were displayed and pronounced and participants had to point to the corresponding object, until each was complete.

Because of the learning curve associated with navigation, a practice environment, shown in Figure 3-4, was developed so participants could practice moving around using the Myo armband before entering the learning environment. They were given ample time to become familiar and comfortable in virtual environment and navigate it with ease. Participants were given a pair of headphones, as well. Objects relevant to learning in the virtual environment were marked with exclamation points, as shown in Figure 1. When users approach and look at the object, the Swedish text is displayed above the object and pronounced. Meanwhile, a five-minute timer runs down. Once the timer runs out or the user chooses to skip forward, a second phase is entered, in which the explanation points are removed and objects no longer display text. Instead, the Swedish words is shown and pronounced directly in the user's view, and they must point to the corresponding object by going near the object in the virtual environment. Once each object has been completed, a message is displayed that they may remove the headset.

After training, both groups took a test in which they were given the list of English words and told to write and pronounce the corresponding Swedish words. For each word, participants were graded on both spelling and pronunciation with correct, almost correct, and incorrect, with correct being completely accurate, almost correct being fully comprehensible but not completely accurate, and incorrect being incomprehensible or missing. 5 points were given for correct, 2.5 points for almost correct, and 0 points for incorrect, for a maximum total 100 points.

Participants then made an appointment to return one week later for a follow-up, and were told not to review the terms. Upon return a week later, they took a post test that was exactly the same as the first. Finally, participants filled out a survey to provide feedback on their experience.

Questionnaire

The following questions were asked in questionnaire. The questionnaire was filled by all the participants after the post test.

- Aptitude of language
- Have they learned any language before?
- Which other methods did they use for learning language?
- How was it different from our method?
- Enjoyability Rating (ranging from Very Enjoyable to Very Unenjoyable)
- Effectiveness Rating (ranging from Very Effective to Very Effective)
- Other Feedback

Chapter 5

Results

There were two types of results generated by questionnaire and tests taken during final user study.

Objective Metrics

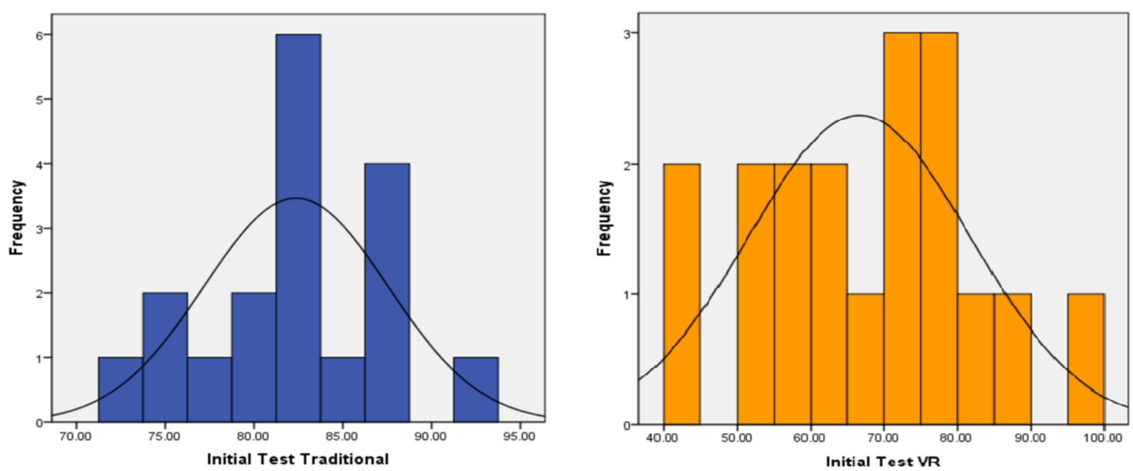

Figure 5-1 Initial Test Scores

Initial test scores, taken immediately after training, can be seen in Figure 5-1. There was a significant difference in these initial test scores, with traditional scores (M=82.3, SD=5.17) being higher than virtual reality scores (M=66.66, SD=15.14); $t(20.921)=4.160$, $p=.000<.05$.

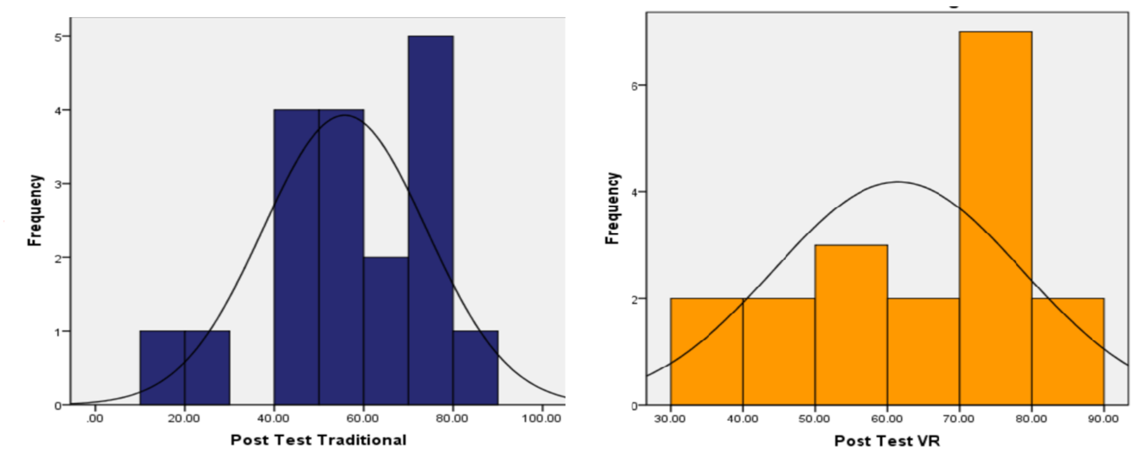

Figure 5-2 Post Test Scores

Post test scores taken a week later, however, as seen in Figure 5-2, were not significantly different, with traditional scores (M=82.3, SD=5.17) being similar to virtual reality scores (M=66.66, SD=15.14); t(20.921)=4.160, p=.000<.05.

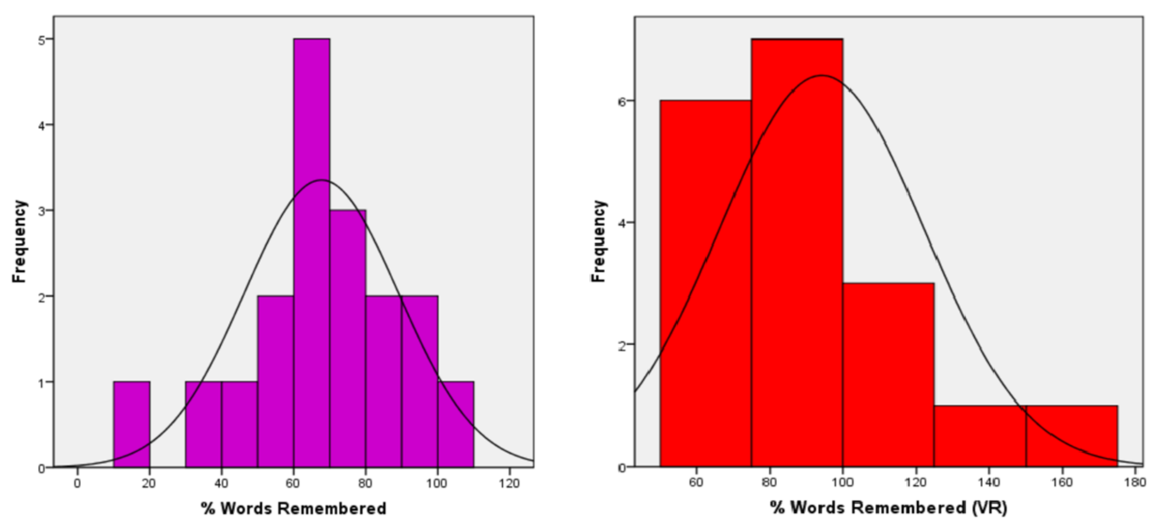

Figure 5-3 Word Retention

In Figure 5-3, memory retention is shown. Retention is calculated as (post test score / initial test score) * 100, or as the percentage of the initially correct words the participant "retained" a week later. There was a significant difference in memory retention, with virtual reality retention (M=67.66, SD=21.41) being higher than traditional retention (M=67.66, SD=21.41); $t(31.800)=-3.187$, $p = .003 < .05$.

Abnormalities in the data include two participants who scored better on the post-test than the initial test. Participants waiting to take their test may have reviewed with each other, or studied without out knowledge. Or, they may have simply had better recall a week later.

Subjective Metrics

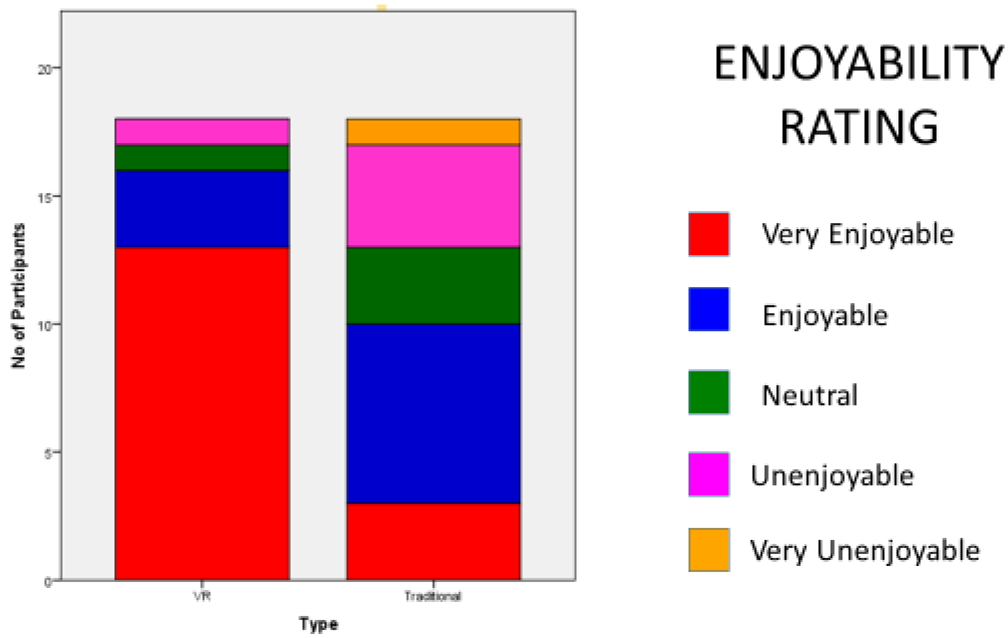

Figure 5-4 Enjoyability Rating

Figure 5-4 represents the enjoyability ratings for each method given by participants. Ratings were much higher for virtual reality than for the traditional method, with the majority of participants rating virtual reality as “Very Enjoyable”.

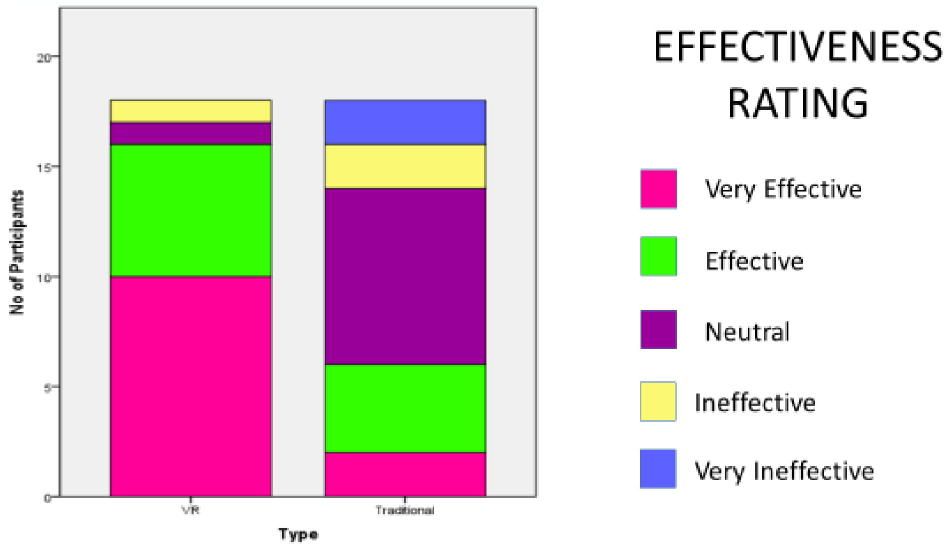

Figure 5-5 Effectiveness Rating

The same trend can be seen in Figure 9 for effectiveness, in which the majority of virtual reality participants rated the system as “Very Effective”.

Open-ended feedback given in the “Other feedback” section of the questionnaire included a variety of notable comments. Participants who used the traditional method suggested that it was easy to remember ten words, but that it required much focus and attention, and would be difficult to apply to a larger list of words. Many traditional group participants suggested that it was a familiar, effective method, but not very interesting. Participants who used the virtual reality method almost unanimously that they found it very enjoyable. Many reported dizziness from using the Oculus Rift, and some discomfort with the wires and weight of the Rift. Several virtual reality group participants stated that it felt easy and natural to navigate the virtual environment. Finally, some virtual reality participants commented that they were able to mentally explore the apartment and visualize the objects when taking the test.

Discussion

Table 5-1 Comparison Table (Traditional and VR)

Traditional	Virtual Reality
• Higher initial test score	• Higher memory retention • Higher perceived enjoyability • Higher perceived effectiveness

Table 5-1 shows a comparison of the benefits of the traditional and VR methods. The traditional method causes better memory immediately after training, where virtual reality causes better retention of the words, being able to remember them almost equally as well a week later. The virtual reality method also has higher perceived enjoyability and effectiveness.

Given that the goal of language learning and vocabulary training is to remember words long-term, we can assume that this virtual reality method is a better method of vocabulary training. The reason why the VR method causes better retention may be because, as participants stated - it allows them to visualize objects.

In addition, the virtual reality method is first-language free, meaning that no other language is used to teach the target language. This is advantageous is that one can use the system regardless of their first language. The disadvantage as that there is more limitation in explaining grammatical rules and more complex features of language that may arise later in learning.

Furthermore, some other factors may have influenced test scores. First is the familiarity of the learning method. Traditional method users commented that the method was familiar. They may have used this method in school - especially to pass a test. They are accustomed to quickly memorizing and forgetting information in this way before a test, whereas virtual reality users have never used this method to study for a test. This may have caused higher initial test scores for traditional users. Also, virtual reality test scores may in fact have been negatively affected by users being distracted by the new experience, thus less focused on actual learning

Chapter 6

Conclusion & Future Work

Conclusion

The findings show excellent potential for virtual reality in immersive language acquisition. Participants had higher initial test scores using the traditional method, but were significantly more capable of recalling the words a week later using the virtual reality method. Participants using the virtual reality method reported significantly higher perceived enjoyability and effectiveness. Using immersive virtual reality for language acquisition is a novel area for research. The initial hypothesis has been proved successfully in this thesis. Memory retention is enhanced when a person is made to interact with the VR system along with audio and visual cues. Along with this, the user experience is less stressful and process of learning becomes more enjoyable when IVR is used. It not only helps in learning but helps in retention by activating the long term memory.

Future Work

This project has shown promising results and has given leads and insights for further research and investigation. Some potential directions for future work are

-Include numbers, simple expressions and other common words/phrases in the IVR environment.

-Design avatar co-learners or coaches with whom users can interact and speak the foreign language words they learned in a particular context. This will give more realistic and immersive feeling to the user while learning the new language.

-Include voice recognition so that the user can see, listen and speak the foreign language and also practice it efficiently.

-Use crowdsourcing to make the 3D environment more accessible and flexible.

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