Designing a VR Speech Simulation Game for Foreign Language Learning and Teaching

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Article Info	Abstract
	This design-based study focuses on a fully immersive Virtual Reality (VR) language learning game developed for Nordic higher-education students of Finnish and Swedish. The study was conducted in collaboration with language teachers, researchers from three universities, and a software engineering laboratory. The study complements existing research, e.g., by focusing on a fully immersive VR game, the higher-education context, and languages other than English. Our objectives are to explore the four steps in designing a VR language learning game: 1) identify the audience, 2) design the linguistic content, 3) design the audio-visual content and game world, 4) reflect on the pedagogical aspects of the game. Our study identifies speaking and listening practice as one of the key skills needed by the target audience, university students of Finnish in Sweden and Swedish in Finland. We reflect on our thematic and linguistic choices when developing the game scripts. We also detail the types of multiple-choice and gap-filling exercises that the real-life-resembling scenarios contain. We discuss the audio-visual aspects of the game, including software, audio recordings, motion capture, speech-to-text, and summer cottage environment. Our game supports developing speaking and listening skills through pedagogical guided independent learning and contextualized multimodal learning. Our data comes from the game itself as well as user surveys.
Research Article	

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1. Introduction

Our study aimed to design a Virtual Reality (VR) game for language learning in the Nordic context. Previous studies have not focused on the game design process nor have they explored Finnish or Swedish fully immersive voice-controlled games like ours. VR has excellent potential to enhance second/foreign language learning, and VR games are increasingly used in language teaching. To provide an illustrative example from the Finnish context relevant to our study: Lakkala and others (2015, pp. 86-87) stated that, as early as 2015, almost half of those who taught Finnish as a second language in upper secondary schools, higher education, or liberal adult education had used virtual worlds or digital games in their teaching. However, Karppinen and Eklund (2023), who tested and researched VR technology at the University of Tampere, found that today's students were wary of VR technology and exercises, and many were still unfamiliar with VR headsets. These studies show that although VR games are increasingly used in the Nordic countries, only some students and educators are familiar with VR technology or have a positive attitude toward it.

We have only recently started to evaluate previous empirical research on VR language-learning applications and set the agenda for future research (e.g., Lin & Lan, 2015; Vesisenaho et al., 2019; Pinto et al., 2021; Hua & Wang, 2023; Parmaxi, 2023). It has been noted that most of the research focuses on English and primary and secondary schools (Pinto et al., 2021; Hua & Wang, 2023). Furthermore, the research recommends that the use of VR be founded on specific pedagogical methods, including studies of fully immersive systems and simulated real-life situations (Parmaxi, 2023) and explore the role and input of the instructor (Lin & Lan, 2015). Our study responds to these gaps in research by examining the challenges and solutions involved in developing a fully immersive real-life VR game in two languages for higher education in two countries: Finnish as a foreign/heritage language in Sweden and as a foreign language in Finland, and Swedish as a second/foreign language in Finland.

Our approach follows the principles of design-based research in education (e.g., Anderson & Shattuck, 2012) and is thus, by nature, not only instructor but also designer and developer-oriented. Our study is aligned with Merchant and others' (2014) emphasis on considering instructional design principles when designing VR-assisted language learning. More specifically, it has been conducted in collaboration between language teachers and engineers: the participants of the VR simulation game project (2023-2024) that this article is based on are Lapland UAS, Uppsala University, and Stockholm University.[6]

We set out to design a VR language-learning game from scratch. Our research questions focus on the steps in designing such a game as follows:

1) Step 1—Identify the target group: What are the needs of the VR language learning game's target group?

2) Step 2—Design the linguistic content: What is the linguistic content of the game like (e.g., grammar and vocabulary, pragmatic functions, audio)?

3) Step 3—Design the audio-visual content and the game world: What is the nature of the visual and interactive game world (e.g., environment, characters, equipment)?

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[6] Lapland UAS, The University of Oulu, and Oulu UAS previously developed a VR speech simulation game for international nursing students to learn the professional Finnish language in nursing, such as discharging patients and treating pneumonia and anaphylaxis reactions caused by antibiotics. The project was called Culture Expert (2021-2023).

4) Step 4—Reflect on the pedagogical features of the game: How does the linguistic and audio-visual content of the game world support learning?

By focusing on the research questions above in the design process, our study can facilitate future VR game development and language learning methods and bridge the gap between the different types of knowledge (pedagogical, subject, technological) required for computer-assisted language learning (see section 2).

Our theoretical, method, and data sections are followed by our analysis of the four steps. We then consider the challenges of linguistic content and our solutions to them, and then we discuss the game's technical, visual, and non-verbal specifications. Our final analysis section combines our pedagogical framework, which considers the linguistic and non-verbal framework. Our primary data comes from the game itself as well as user surveys. We conclude the article with a summary and conclusions, and limitations and suggestions for further research.

2. Literature Review

The Literature Review consists of two parts: first, describing the former studies and literature about VR and game-based learning, and second, discussing the situation of Finnish and Swedish learners in Finland and Sweden to provide a comprehensive view of the related field.

VR and game-based language learning and teaching

A VR game like ours aims to introduce, activate, or consolidate various linguistic functions, situations, themes, vocabulary, and grammar to the learner-player. The benefits of a VR game have been detailed, for example, in Parmaxi (2020) and Lakkala et al. (2015, p. 87) (see also Huang et al., 2010; Vandercruysse et al., 2012; Zheng et al., 2012; Lappalainen et al., 2015; Dooly et al., 2023). We summarised these previous studies and projects using a Strengths, Weaknesses, Opportunities and Threats - SWOT approach (Benzaghta et al., 2021) and presented the findings as a table for easier reading.

Table 1. SWOT for language learning in the VR gaming context

Strengths	Weaknesses
- meeting native speakers of the target language - exposing the learner to many different varieties of the target language - learning to communicate with different types of speakers - practicing speaking in interactive situations reminiscent of real-life - stepping outside the classroom environments to practice communicative	- VR glasses do not fit everyone; might cause dizziness and headaches to some users - resources are required to create and access VR games - time-consuming and complex - technical difficulties - VR glasses are not yet available for all the users, e.g. universities do not have them nor the space to use them in campus

functions, like making an appointment at a hair salon ● applying language knowledge in authentic or near-authentic yet safe communicative context ● learning through self-direction, freedom, and independence ● strengthening students' information and communication technology skills ● concretely preparing for real-life language use	
Opportunities	**Threats**
● improving study motivation with the help of experientialism, functionality, and authenticity ● boosting language learning through a cooperative, playful, visual and interactive VR environment ● enabling differentiation by taking students' skill levels into account ● activating emotional responses ● consolidating learning and using VR as revision exercises or homework ● testing language levels or evaluating language skills ● enhancing learning by multimodality	● teachers fear losing their jobs to AI and other technology, like VR, might cause a lack of willingness to test VR language learning games in universities and upper secondary schools

Technology-assisted or computer-assisted language learning (Levy 1997) is a subcategory of Applied Linguistics. Therefore, it is useful to connect VR games in language learning and teaching to the Applied Linguistic concept of ecological and sociocultural language learning and functional language skills. These concepts highlight the role of dedicated problem-solving, cooperation, and social interaction, much like games developed for entertainment and other educational purposes. (Lehtonen et al., 2015, pp. 20–21; Lehtonen & Vaarala, 2015.) These concepts are at the foundation of the language learning game developed in our design process.

Our research questions reflect the fact that a language teacher needs not only information about the subject matter taught but also about pedagogical methods and processes, relevant technologies and their applications in teaching, and an ability to adapt to changing technologies; these three types of information interact with each other: pedagogical subject information is the ability to tailor the content to the teaching situation based on the student's needs. On the other hand, technological subject knowledge means that a teacher understands the connection between technology and subject matter, how the content is limited or dictated by the technology, and vice versa. Finally, technological pedagogical knowledge is about how

teaching and learning can change when particular technologies are used. (Koehler & Mishra, 2008; Blin & Jalkanen, 2014; Lamminpää, 2021.)

Ma and Zheng (2011) list three categories of VR systems. A non-immersive VR system includes a computer, screen, and mouse to move through the VR world (cf. SecondLife). In a semi-immersive system, the display is projected on a screen, and there might be some gesture recognition system for interaction (cf. Wii). The third type is VR, a system where the user wears a VR headset and is fully immersed in the world.

The purpose of a scripted VR game is to provide opportunities for structured practice of language skills in simulated interactive and immersive situations that can be repeated endlessly. Scripted games are also flexible regarding time as they do not require other participants - the learner can practice independently and at their own pace in a safe environment. Another advantage of scripted games is that they are often built around specific predictable schemata, such as ordering a pizza or making an appointment at the doctor's. Less predictable situations, including job interviews or small talk, can also be practiced using a scripted VR game. Listening comprehension and speaking skills are a natural part of scripted games. (Lappalainen et al. 2015, 93, 94, 121.)

Finnish and Swedish situations

Our VR game is designed to help people learn Swedish and Finnish languages in Finland and Finnish in Sweden. In Finland, approximately 280,000 people speak Swedish as their mother tongue, slightly more than 5% of the population[7]. According to the Government Decree on Universities of Applied Sciences (1129/2014 7 §), "Students shall demonstrate attainment of their proficiency in Finnish and Swedish in the studies included in the program for a Bachelor's or Master's degree, or in some other manner which, under the Act on the Knowledge of Languages Required of Personnel in Public Bodies (424/2003), is required for public posts in bilingual administrative districts where the eligibility requirement for the post is a tertiary degree and which is necessary for the practice of the profession and professional development." In other words, all university students must be able to use the country's official languages at work after graduation. Swedish language courses are mandatory for Finnish-speaking university students and vice versa.

According to the Common European Framework of Reference for Languages (Council of Europe 2021), Swedish's minimum written and oral competence level is B1 (Finnish National Agency for Education 2015). In reality, however, many students have level A2 in Swedish competence after upper secondary level (Juurakko-Paavola & Åberg, 2018). This is partly because the Swedish language was made an optional subject in matriculation examinations in 2005, which led to a decrease in the number of people preparing for and taking the matriculation exam (Juurakko-Paavola & Åberg, 2018). Matriculation exam results show that only around 40 % of those taking the Swedish exam reach the minimum level of B1 (e.g., Juurakko-Paavola & Takala, 2017). The decline in Swedish language skills depends also on other factors, such as general attitudes toward Swedish and how it is taught in schools. (Juurakko-Paavola, 2012). Based on our experience, it is worryingly clear that higher education students' Swedish language skills decrease year by year. Some higher-education students can hardly produce any output in Swedish. It is difficult for them to distinguish word classes, not to mention being able to conjugate verbs or nouns. For this reason, engaging and innovative teaching and learning materials, like a VR game, are welcome. Juurakko-Paavola (2024)

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[7] https://www.stat.fi/tietotrendit/artikkelit/2021/ruotsinkielisilla-keskimaaraista-enemman-lapsia-jo-lahes-puolet-kaksikielisia/#:~:text=Vuonna%202020%20Suomessa%20asui%20noin,on%20runsaat%20viisi%20prosenttia%20v%C3%A4est%C3%B6st%C3%A4.

has noted that learning English is easier for most Finnish students because of the international multimodal games they play in their free time. She is a well-known expert with the Swedish language learning situation in Finland and is calling for new solutions in teaching Swedish, and she mentions games as one of the potential options.

Finland has seen an increase in the number of international students. In 2021, the number of international university and applied university BA-level students was 22,791, which is 7.2 % of all university students.[8] This number is set to increase after the resident permit rules were simplified in 2022: students who have completed a degree in Finland are now allowed to stay in the country for two years.[9]

According to university-level degree curricula in Finland, in degrees where the medium of instruction is English, students must take 5-20 ECTS credits in the Finnish language. At several Finnish universities, most students begin their studies without knowledge of Finnish. The groups are heterogeneous, and the students' study skills vary greatly. Especially in the Finnish universities of applied sciences, international students are encouraged to take the National Certificates of Language Proficiency (YKI) as passing it entitles them to a fee scholarship (e.g., Lapland UAS scholarship requirements). Finland in general, but especially Lapland as a region, has long suffered from a labor shortage in all industries (Nieminen & Tolonen, 2023). However, it is difficult for international students to find employment in Finland because of insufficient Finnish language skills so they may seek work in other countries (Kinnunen 2003). Currently, only half of the international students gain employment in Finland, and the goal is to increase it to 75 %.[10] This supports the need for innovative language learning methods.

The status of the Finnish language in Sweden is different. Sweden and Finland have a long shared history, and Finnish has been spoken in Sweden at least since the Middle Ages (e.g., Tarkiainen, 1990). Today, it is estimated that there are about 200,000 to 250,000 Finnish language speakers in Sweden.[11] In 1999, Sweden recognized Finns as one of the five national minorities (Jews, Roma, Sami, Sweden Finns, and Tornedalians), and by this recognition, the Finnish language and cultural heritage were acknowledged. The Act of National Minorities and Minority Languages entered into force at the beginning of 2010. Nowadays, pupils have the right to receive Finnish instruction as a subject in primary school, but the education might differ both in extent and form depending on the municipality (e.g., Lainio, 2017; Vuorsola, 2022).[12]

Finnish can be studied at Swedish universities from the beginners' level at Umeå University, Uppsala University, and Stockholm University, and as a mother tongue at Stockholm University. Uppsala University has a training program for mother-tongue teachers of Finnish. The students often have Finnish roots: their parents or grandparents might have immigrated from Finland to Sweden to work in industry during the 1960s or 1970s. Not everyone has had an opportunity to learn Finnish at home or school. During assimilatory policies, linguistic support for Finnish speakers in Sweden has been lacking. Therefore, the

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https://www.oph.fi/sites/default/files/documents/Ulkomaalaiset%20opiskelijat%20ja%20uudet%20ulkomaalaiset%20opiskelijat%20korkeakouluissa%202011-2021.pdf

[9] https://www.sttinfo.fi/tiedote/69957060/ennatysmaara-kansainvalisia-opiskelijoita-on-muuttanut-suomeen-tana-vuonna?publisherId=69817837

[10] https://yle.fi/a/74-20013032

[11] https://minoritet.se/finska-spraket-i-sverige

[12] In the majority of the municipal-schools the average teaching time in the national minority languages is about 40 minutes per week (Lainio 2017, 39). However, there are 5 independent Sweden Finnish schools in Sweden in which Finnish is not only one of the subjects, also other subjects are taught in Finnish as well (e.g. Vuorsola 2022, 375).

language skills among the Swedish Finns minority and other national minorities vary greatly (e.g., Lainio 2017, 100). So, although the Finnish language is nowadays guaranteed by legal rights and institutions in Sweden, there is a significant need for language education for adults, including innovative pedagogies like our VR game. There is an increasing interest in studying Finnish at the university level in Sweden, but the problem is the limited number of students who complete a degree.

3. Methodology and data

Participants

The target groups for our VR speech simulation game are students of Finnish as a foreign and heritage/home/community language in Sweden and as a foreign language in Finland and Swedish as a foreign/second language in Finland. The second language for most Finns and Swedes is in practice English. Swedish, although an official language of Finland alongside Finnish, is mostly learned as a foreign language after English, while Finnish has a long history as a migrant and community language in Sweden. Finnish is also learned by complete beginners as a foreign language in Sweden, especially in adult or higher-education settings, and by foreign students in Finland.

The Finnish game test users of the game were studying Finnish as a foreign language in Lapland UAS for the first year, and the Swedish game test users were studying Swedish as a compulsory part of their BA degree in Lapland UAS. The test users fulfilled a survey after a testing session at the university. Of the testers of the Swedish game, only 12% had played digital language games before, and 59 % had never used a VR headset (see Table 2). For the testers of the Finnish game, 62% had played digital language games, and 38% had used a headset (see Table 2). Most respondents were either 18-24 or 25-34 years old, with those who tested the Swedish game being slightly younger.

Instruments

The game we designed is entirely immersive and 3D, requiring a VR headset. Another key feature of our game is that it is voice-controlled, meaning that the player interacts with VR characters through speech. To our knowledge, there are no prior studies of games that are fully immersive and voice-controlled. Our unique game could also be classified as a single-player narrative in which the student-player receives instructions. The game has three scenarios for the learners to practice their oral skills in the target language.

As a data collection tool, we used our observations of the game design process, the test day, and the survey from the test users. The selected data collection methods reflect that design research is needed for real-life situations (e.g., Andersson & Shattuck, 2012, p. 17; Blin & Jalkanen, 2014). It may be based on observations, interviews, surveys, or testing. Following the flexible design-based research approach (Dalsgaard, 2014, pp. 145-146), we focus on documentation, observations, and self-reflection. In other words, our data comes partly from the game we designed and our reflections around them. The results of our testing day surveys have also been included in the present study. The surveys were conducted anonymously in January 2024 and with informed consent, following data protection laws. We received 17 responses from those who tested the Swedish version of the game and 13 from those who tested the Finnish version. These responses are related to the beta version of scenario 1.

Procedure

Our procedure followed the principles of design-based research through data gathering, project meetings, surveys, and reflection. Our method employs design-based research, whereas the first step is to identify the problem and describe the objectives (research question 1). The next two steps involved the design and development of a product, the VR game (research questions 2 and 3). (Kiviniemi 2015, 226; see also Herrington et al., 2007.) The final three stages of design-based research (test, evaluate, and communicate the product) were examined through a series of game-testing days in Finland and Sweden. This is in line with the principles of design research where development and design are cyclical: analysis, design, production, and additional design follow each other iteratively (see e.g., Cobb et al., 2003, p. 10; Anderson & Shattuck, 2012, p. 17) and cannot be neatly separated from each other.

In design-based research, the product under development is in focus, so the theoretical and methodological frameworks are dynamic and subject to change in response to practical challenges and solutions (cf. Anderson & Shattuck, 2012, pp. 16-17), which in our case is the higher education language learning environment where there are limited options to practice speaking skills. Furthermore, the purpose of design research is that the product design can be applied to other similar environments and products (e.g., Barab and Squire, 2004, p. 6), which is also our project's goal. The development phase is followed by reflective practice (research question 4).

A design researcher collaborates closely with practitioners, which benefits the design work (cf. Barab & Squire, 2004, p. 4). This is true for our team of researchers and language teachers. A pedagogical design researcher develops a product using existing research whilst simultaneously seeking new information about pedagogical methods or phenomena (Dalsgaard, 2014, p. 145; Kiviniemi, 2015, p. 230). This research/design work takes place in a network that, in our case, involves game developers. The strength of our project is not only this collaborative approach but also an examination of the pedagogical implications in step 4 (research question 4) that involves reflection of the product we designed.

The data collected by the survey from the test users is presented in Table 2 and designed into claims and percentages of the respondents who agreed with the claim. The answers to the open-ended questions are not presented in Table 2.

Table 2. Test user survey of the beta version of scenario 1 in January 2024

Claim	Finnish game test users	Swedish game test users
I have played digital games before.	62 %	12 %
I have used VR glasses before.	38 %	41 %
The volume of the game was appropriate.	62 %	94 %
The game's font size and font were appropriate.	100 %	81 %
I liked the game's visuals (appearance) and characters.	92 %	94 %

The characters in the game were helpful in learning	85 %	82 %
I would like to play this game in my free time.	50 %	41 %
The game's language skill level corresponded to my target language skill level.	62 %	94 %
The game situations were similar to what I might encounter in real life.	85 %	100 %
The game was technically easy to use.	77 %	100 %
I would like more language support in the game.	75 %	29 %
I would have needed additional material or additional support to play the game.	54 %	24 %

To summarise, the design research process aims to produce valuable results and information for everyone active in the research context while gaining more comprehensive scientific application and significance through product design and testing.

4. **Results and Discussion**

Step 1—Identify the target group: What are the needs of the VR language learning game's target group?

This section describes the learning contexts in the two countries in light of the target groups described in the literature review.

To meet the needs of these target groups, one of the critical features in game design is assessing the learners' individual needs and different starting points in language learning. The language skill level of the target group varies according to the European Framework of Reference for Languages (CEFR) from the elementary level (A1-A2) to the basic level (B1). The foreign language courses offered at the participating universities are concise and involve a limited number of contact hours, which is usually insufficient to develop the language skills needed in working life or to communicate in social situations. It is, therefore, necessary to complement classroom teaching with parallel or supporting activities that allow the students to improve their speaking and listening comprehension skills. Almost all university students of the two languages are not in regular contact with native speakers they could practice with. Therefore, the game's focus was language comprehension and production skills in as authentic situations as possible.

We wanted our students to be able to practice their target language in a safe VR environment and gain some of the necessary skills for work and socializing in Finnish/Swedish. For the scripted VR game, we selected three CEFR A2-level communicative situations: providing and understanding directions from A to place B, applying for a job, and discussing health and wellbeing. We chose the themes and communicative functions based on informal discussions with previous students in Sweden and with students and teachers in Finland. The teachers suggested communicative situations not specific to a particular profession, small talk skills, and applying for a job. In addition to these topics and functions, students hoped to practice colloquial Finnish in the game and have an opportunity to improve their language skills at different levels. For us, the tasks and scenarios need to be placed in a context that motivates the learner and contains elements that are emotionally engaging and identifiable (cf. Lappalainen et al. 2015, p. 113). For this reason,

in our VR game, the learner meets a non-Finnish friend on a trip to a summer cottage, and they discuss topics that are relevant for a young adult in the target language. Our test day surveys showed that we had selected scenarios the students would encounter in real life: 100 % of the respondents indicated this was the case for the Swedish game, and 85 % for the Finnish game (see Table 2). One person who tested the Finnish game mentioned they did not know any Finns.

As previous studies show, with a VR game, it is possible to complement gaps in the learning materials and provide opportunities for practicing things like colloquial language or general listening comprehension (e.g. Lan et al. 2018). Our students perceive phone conversations as incredibly challenging, so the directions are given on the phone in the game's scenario 1. Moreover, based on our previous VR project experience and research (Partanen et al., 2022), we knew that the game dialogues must be brief as long lines and conversations are stressful and tiring for the player. The immersive experience can be compromised if the player feels unwell while standing and wearing a heavy VR headset for too long. Our prior knowledge of user experience significantly impacted how we designed the scenarios in the game script. For example, game scenes were short and included a phone conversation.

To summarise, the VR environment offers a safe place to practice in real life. The learner-player can model different near-authentic communicative situations and develop critical skills that are otherwise hard to practice (Lappalainen et al., 2015, pp. 112-113). We approach the design of the scripted communicative situations to help the students pass their courses and provide an opportunity to practice everyday conversations and the associated listening comprehension in a safe environment with a VR game character.

Step 2 - Design the linguistic content: What is the linguistic content of the game like (e.g., grammar and vocabulary, pragmatic functions, audio)?

In scenario 1, the player aims to guide a friend to a summer house on the phone. The player is already at the summer house, but the friend is on their way there and needs driving instructions. The friend calls the player to ask for help, and they have a phone conversation. In the game, as in real life, the player only hears the lines of the interlocutor but cannot see them or the lines in writing. The player's task is to react to the lines using the target language. They are sometimes provided with visual cues.

As language teachers, we pitched the three scenarios' vocabulary, grammar, and communicative functions at the A2 level. Two team members produced drafts in Finnish in a shared file once the three general themes had been chosen. All four teacher-designers then met to discuss the details of each script and create suitable tasks. At some of our meetings, the engineers were present to demonstrate what the VR world would look like and answer our questions about task types and how they would work in practice. Once again, some team members' prior experience in VR game creation (Partanen et al., 2022) was crucial for smooth and efficient script writing and task development. The Swedish teacher translated the scripts, and the team met again to review the Swedish versions.

An extract from the Finnish version of scenario 1 giving directions includes oral gap-filling and multiple-choice tasks. We have translated the extract for the article into English. The gap-filling requires the knowledge of polar (yes/no) questions formed using a question particle *-ko/-kö* at the end of the verb—the correct versions of the missing phrase range from colloquial (*ooks* 'are you') and dialectal (*ooksie* 'are you') to standard written Finnish (*oletko* 'are you'). The multiple-choice tasks not only train vocabulary

and grammar but are multimodal, as the player has to consult an image to select the right words. The second gap-filling task tests different words that belong to the same semantic sphere of movement and travel. The player is also expected to know the correct form, an infinitive. We facilitated the choice of form by providing a parallel word in the same form earlier in the sentence (the verb *pitää* 'must, need to' takes the infinitive, and the verb *ajaa* 'to drive' earlier in the sentence is in that form). The last gap-filling exercise, a shopping list, is once again multimodal, and the player gets to engage with visual cues and complete the sentence by saying the names of items aloud. The grammatical feature in the task is the partitive case suffix (*-a/-ä, -ta/-tä, -tta/-ttä*) used to indicate an indefinite amount. The player can only proceed in the game once they have said the correct options aloud in a complete sentence.

Example 1. Scenario 1 - Giving directions

Eksynyt ystävä: (Anna tässä) Hei. Minä olen eksynyt!
A friend who is lost: (Anna speaking.) Hello. I'm lost!

Pelaaja: Ahaa, _____ (oikeat vastaukset: ootko / oletko / ooks / ooksie / ooksä) nyt tulossa mökille?
Player: I see, _____ (correct answers: are you) coming to the cottage?

Eksynyt ystävä: Kyllä, minä olen nyt huoltoasemalla Äkäslompolossa.
Friend: Yes, I'm at the petrol station in Äkäslompolo.

Pelaaja: Ahaa. Sinun pitää nyt sitten kääntyä vasemmalle.
Player: I see. You need to turn left then.

a) Ahaa. Sinun pitää nyt sitten kääntyä vasemmalle.
a) I see. You need to turn left then.
b) Ahaa. Sinun pitää nyt sitten kääntyä oikealle.
b) I see. You need to turn right then.
c) Ahaa. Sinun pitää nyt sitten ajaa suoraan.
c) I see. You need to drive straight ahead then.

Ystävä: Joo, minä käännyn tästä vasemmalle. Kuinka pitkään minun pitää ajaa sitä tietä?
Friend: Yes, I will turn left here. How long do I need to drive on that road?

Pelaaja: Sinun pitää ajaa noin 10 kilometriä ja _____ (oikeat vastaukset: kääntyä/mennä/ajaa) sitten oikealle kohti Tyynelää.
Player: You must drive around 10 kilometers and then _____ (correct answers: turn/go/drive) right toward Tyynelä.

Ystävä: Selvä. Mistä tiedän, että olen oikealla tiellä?
Friend: Okay. How do I know I'm on the right road?

Pelaaja: Olet oikealla tiellä, jos näet ison kaupan tien oikealla puolella.
Player: You are on the right road if you see a large store on the right side of the road.

2.
a) Olet oikealla tiellä, jos näet ison kaupan tien oikealla puolella.
        a) You are on the right road if you see a large store on the right side of the road.
b) Olet oikealla tiellä, jos näet metsän edessäsi.
        b) You are on the right road if you see a forest in front of you.
c) Olet oikealla tiellä, jos näet parkkipaikan tien vasemmalla puolella.
c) You are on the right road if you see a parking lot on the left hand side of the road.

Ystävä: Ok. Tarvitsetko jotain kaupasta?
Friend: Ok. Do you need something from the store?

Pelaaja: Voithan sinä tuoda _____, _____, _____ ja _____ (oikeat vastaukset: kahvia, leipää, makkaraa ja vessapaperia).
Player: You could bring _____, _____, _____ and _____ (correct answers: coffee, bread, sausages, and toilet paper).

How motivated the player is to solve the scenario has to do with the credibility of the scenario. One contributing factor is the voice actors' skills, which are critical in creating realistic characters. A good voice actor can express the character's personality and emotions. Accents, speed of speech, and breaks are all elements that a voice actor can utilize to highlight the human characteristics of the character. (Partanen, Koutonen & Taikina-Aho, 2022, p. 4.) For example, in scenario 1, there were two voice actors: the friend Anna and the player. The player's lines were recorded to serve as a model in case the player had problems producing or pronouncing the required line in the target language. The player can then listen to the correct answer and try to repeat it afterward to proceed in the game. This ensures differentiation; less advanced language learners can also use the game and learn from it. Finally, we chose young native speakers of the target language as the voice actors so that the characters in the game would be credible, e.g., a trip to a summer cottage by young adults.

Previous studies show (see Jalonen, 2023) that the script plays a vital role for the voice actor. It has to be credible and highlight the character's personality so the voice actor can express the character's uniqueness. A script or speech that is too robotic can ruin the immersion and make the character feel unrealistic. (Jalonen, 2023.) As language teachers wrote the script, the voice actors suggested changes during the recording to make the lines feel natural. When spoken, words were changed, added, or removed to make the dialogue more spontaneous. For example, in the Swedish version of the script *toapapper* 'toilet paper' that the teachers based in Sweden suggested was changed to *toalettpapper* as that was what the Finland-Swedish voice actor would say, or *haloo* 'hello' in the phone conversation was removed as it sounded odd to the voice actor. A Swedish language teacher attended the recording session as the technical team did not speak Swedish as their mother tongue.

In the recording session, we consciously chose to keep the voice actor's speed of speech regular. We included some colloquial expressions and constructions that the player would not be exposed to in a classroom environment but would encounter in an authentic communicative situation. Previous studies have shown that this type of incidental vocabulary learning and learning communication are some of the

advantages of a VR environment (cf. Yamazaki 2018). For example, the Swedish voice actor suggested changing *uppfattat* 'understood' to the more colloquial *fattar* 'get it,' and she suggested changing *värktabletter* 'painkillers' to an alternative, more widely used term *smärstillande.* In the Finnish script, the voice actors pronounced words more colloquially, e.g., the standard written Finnish *ei ole ollut* 'hasn't been' was changed to the colloquial *ei oo ollu* during the recording session as they felt it was odd for anyone to speak the standard written language.

The voice actors recorded three variants of each line of the interlocutor so that there would be variation in the game and the player would hear as many target-language structures as possible when playing the game several times. The varying lines from the interlocutor bring an element of surprise to the game, keep up the player's interest, and teach different types of vocabulary and structures each time. In this way, we created an authentic yet safe environment with spontaneous yet repetitive elements, which previous studies have indicated as one of the key advantages of VR language learning (e.g. Dooly et al., 2023). The types of alternations are illustrated in example 2. Note that the translations are approximate and demonstrate the type of variation we built in. As you can see, the variation ranges from alternative ways of saying the same thing (yes, yeah, okay) to synonyms (petrol station, service station, service area) and colloquialisms (cheerio, wellies). Elsewhere in the game, we also had multiple-choice alternatives that focused on appropriate emotional reactions, such as commiserating or expressing compassion as appropriate to the communicative context (e.g., 1) *Voi ei!* 'oh no', 2) *Kuulostaa hyvältä!* 'sounds good', 3) *No niin!* 'very well then').

Example 2. Scenario 1 - Alternative versions of the VR friend's lines

Variant 1	Variant 2	Variant 3
Anna tässä hei. Minä olen eksynyt! It's Anna here, hello. I'm lost.	Anna tässä, terve. Olen hukassa! It's Anna here, howdy. I've lost my way.	Anna tässä moi, minulla on ongelma, en löydä sinne. It's Anna here, hi. I have a problem, I can't find the way
Kyllä, minä olen nyt huoltoasemalla Äkäslompolossa. Yes, I'm now at a service station in Äkäslompolo.	Joo, minä olen nyt bensa-asemalla Äkäslompolossa. Yeah, I'm not a petrol station in Äkäslompolo.	Juu, minä olen nyt huoltamolla Äkäslompolossa. That's right, I'm now at a service area in Äkäslompolo.
Joo, minä käännyn tästä vasemmalle. Kuinka pitkään minun pitää ajaa sitä tietä? Yes, I will turn left here. How long do I need to drive on that road?	Okei, ajan siis vasemmalle. Kuinka kauan sitä tietä pitää sitten ajaa? Okay, I will drive left in that case. How far do I need to drive on that road?	Kyllä, käännyn vasemmalle. Pitääkö tätä tietä ajaa pitkä matka? Alright, I will turn left. Do I need to stay on this road for long?
Selvä. Mistä tiedän, että olen oikealla tiellä?	Joo. Miten voin tietää, olenko oikealla tiellä?	Okei. Tiedänkö jotenkin, että olen oikealla tiellä?

Okay. How do I know I'm on the right road?	Yes. How can I tell whether I'm on the right road?	OK. Is there a way of knowing I'm on the right road?
Ok. Tarvitsetko jotain kaupasta? Ok. Do you need something from the store?	Joo. Ostanko sulle jotain kaupasta? Yeah. Shall I buy something for you in the store?	Hyvä. Toisinko sulle jotain kaupasta? That's good. Would you like me to bring you something from the store?
Joo. Minun pitää ostaa myös kumisaappaat ja sadetakki itselle. Yes. I also have to buy rubber boots and a raincoat for myself.	Juu. Aion ostaa itselle kumisaappaat ja sadetakin. Yeah. I'm going to buy rubber boots and a raincoat for me.	Okei. Ostan itselle myös sadetakin ja kumpparit. Okay. I will also buy a raincoat and wellies for myself.
Ei, minulla ei ole päänsärkylääkettä. Minäpä ostan sitä myös. Onko mökki kaupan lähellä? No, I don't have painkillers. I will buy that too. Is the cottage near a store?	Mulla ei kyllä ole päänsärkylääkettä. Pitääpä ostaa sitä myös. Onko se kauppa mökin lähellä? I actually don't have painkillers. We need to buy that too. Is the store near the cottage?	Päänsärkylääkettä ei kyllä ole. Ostan sitä samalla. Onko kauppa lähellä? There are no painkillers here. I'll buy that too. Is the store nearby?
Selvä. Okay	Joo. Yeah.	Aivan. Exactly.
Okei. Okay.	Kyllä. Yes.	Sopii. That's fine.
Kiitos. Olen tosi väsynyt, olen jo ajanut yli viisi tuntia. Onneksi sinä vastasit heti puhelimeen. Thank you. I'm exhausted; I've been driving for five hours already. I'm glad you answered the phone straight away.	Kiitti. Väsyttää kyllä kauheesti, tässä on ajettu jo viis tuntia. Onneksi vastasit puhelimeen. Thanks. I feel so tired. I've been on the road for five hours. I'm glad you picked up the phone.	Kiitos paljon. Huh huh, kylläpä väsyttää. Olen ajanut jo useamman tunnin. Hyvä, että vastasit heti puhelimeen. Thanks a lot. My goodness, I feel tired. I've already been driving for several hours. It's good that you picked up the phone.
Kuulostaa hyvältä. Kiitos vielä avusta. That sounds good. Thank you again for your help.	Kuulostaa mainiolta. Kiitti vielä kerran. That sounds excellent. Thanks once again.	Aivan loistavaa. Kiitos paljon avusta. Brilliant. Thank you so much for your help.
Heippa! Bye.	Morjens! Cheerio.	Heihei! Bye-bye.

When we translated the game script from Finnish to Swedish, we changed the gap-filling tasks to be meaningful and fit for purpose. In the Swedish version, the target level was B1, which is why the vocabulary and structures could be more challenging than in the Finnish version. For example, in Finnish, a case ending was tested (*apteekista* 'from the pharmacy'). However, in the Swedish version the tested form was a verb tense and vocabulary item as these were deemed to be more relevant, for example, *jag _____ (köper/hämtar/skaffar dig/skaffar) medicin mot förkylning och C-vitamin på apoteket*. 'I will (buy /go and get / get you / get) flu medicine and vitamin C at the pharmacy.'

Our test day surveys support our findings: 82 % of the testers of the Swedish game and 85 % of the testers of the Finnish game found the game characters helpful in their learning (see Table 2). The former learned vocabulary and pronunciation and gained confidence in language use, while the latter found it most useful for vocabulary, phrase learning, and pronunciation. Some participants, who perhaps learned less language, mentioned that they learned to use a VR headset or appreciated the voice recognition model.

We had pitched the difficulty level reasonably well: 94 % of the testers of the Swedish game felt it matched their level, compared to 62 % for the Finnish game (see Table 2). The latter group found some of the sentences too hard to understand. It's worth noting here that the test subjects had been learning Swedish longer than those who tested the Finnish game, who had been learning for a shorter time.

Step 3—Design the audio-visual content and the game world: What is the nature of the visual and interactive game world (e.g., environment, characters, equipment)?

Our game aimed to increase student motivation and engagement through a credible and authentic communicative situation and immersion, in line with previous studies (cf. Lappalainen, 2015, p. 113; Kuorikoski, 2018, p. 282). More specifically, in our VR game, while wearing a VR headset, the player sees a map in the directions scenario and, in other scenarios, a Nordic summer house and sauna setting. They will also see additional images, such as items on a shopping list. The player gets to interact with high-fidelity VR game characters whose voices the player also hears.

The player can progress in our game after uttering or pronouncing the right/correct phrase or alternative in the target language (see previous section). This function was achieved in the game using a speech-to-text AI model. By comparing the target sentence to the player's output, the game determines whether a reply by the player is correct, wrong, or unclear using Levenshtein distance. Levenshtein distance is a way to measure the "distance" or difference between two words, sentences, or pieces of text. The output is then converted into a percentage score. The game accepted answers matching the target sentence by 70-80% based on the length and difficulty of the sentence, which can be adjusted by language and scenario after the game testing days. Weaker players can hear the correct answers rather than creating them from scratch. As an additional aid, we provided written options versions (see previous section) for all players to see and say aloud. The written data supported the player's skills development. Later, a reward system with stars was added to the game: three stars if you get the answer 100 % right the first time, two stars if the answer is not entirely correct, and one star if it is poor, i.e., when it matches the expected answer weakly through speech recognition.

The technical team at FrostBit can model landscapes, houses, and details to a high standard. Thus, when wearing the VR headset, the player will experience an immersive feeling of being in this environment with

a VR friend. FrostBit was the one who suggested that the visual world would be based on a summer house setting, including a forest, the main summer house, and a sauna (see Figure 1). The reason was that they already had a substantial number of assets available for this setting, and we would have required a greater budget for FrostBit to create other scenes from scratch. They first suggested a cruise on a Sweden-Finland ferry, but the summer house trip was an excellent second option and soon became the choice preferred by the team. FrostBit did model some additional assets (e.g., a garden table) using the 3D modeling program Blender.

Figure 1: Sauna as the visual background of our VR language learning game

The VR friend, the game character that functions as the interlocutor, looks like an authentic human being, which can increase the player's desire to perform as well as possible in the target-language interactive situation. In addition to an authentic voice (see previous section), an essential feature of a VR character is facial expression animation. Usually, when we interact with another human, our gaze automatically focuses on their face, and we use this first impression to base our attitudes and social behavior toward the individual (Xiadong et al. 2022, 1-4). In addition to the general facial appearance, humans focus subconsciously on fine, small, quick movements that convey emotion and messages. (Costantini, Pianesi & Prete 2005, 5-6.) For this reason, it was essential for us to focus on the details of the facial features of the characters' 3D models.

FrostBit used Unreal Engine's MetaHuman technology to create high-fidelity human characters (Figure 2). According to research, virtual people who are designed with top technology, like MetaHuman, no longer exhibit uncanny valley characteristics, and they are seen as more appealing, human, and less ghost-like than before (Higgins et al. 2022, 2). Unreal Engine and MetaHuman technology also streamline many other processes that would otherwise be time-consuming, such as the frame, level of detail, and materials. As our budget did not include funds for purchasing a gaming computer, a requirement was that the game could run

using only a VR headset, affecting the quality of visuals. For a long time, the FrostBit team was still determining whether the MetaHumans software would work with only a VR headset. Fortunately, it does.
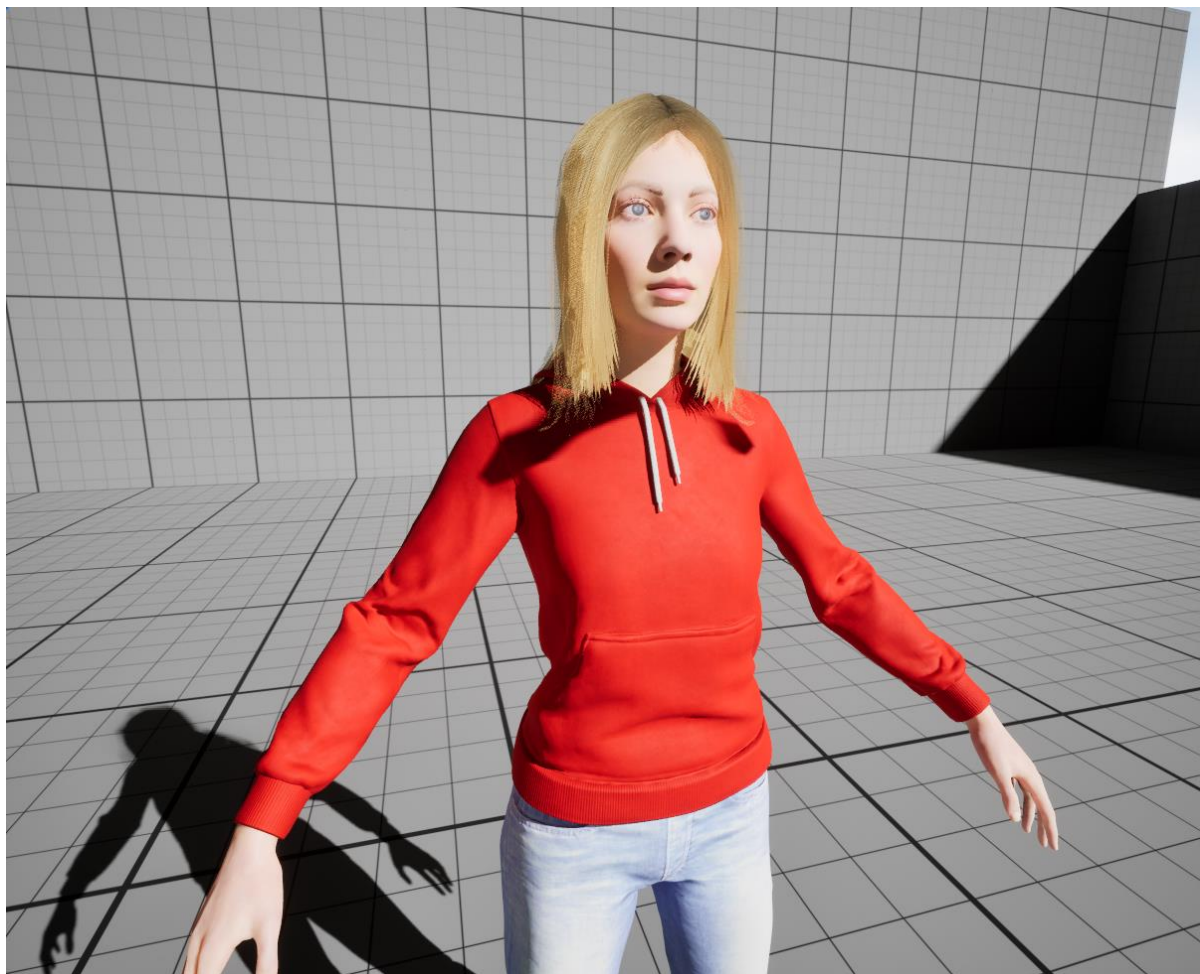

Figure 2: The interlocutor Nordic friend Anna of our language learning game

FrostBut has been using a combination of ready-made animations and animations recorded during the project to create the animations. We are currently in the process of fine-tuning these using motion capture, a method that records people's movements and turns them into computer animation. It is made using motion detectors or markers attached to the actor's body and high-quality, high-definition cameras that record the actor's movement. (Sharma et al. 2019, 2.) We used motion capture to record facial expressions during the voice recording sessions. In February 2024, we organized a separate recording session to capture the other characters' movements, which will be added to each game character later.

The testing days demonstrated that the volume of the game was appropriate: 94 % of those who tested the Swedish game thought it was good, while the figure for testers of the Finnish game was 62 % (see Table 2). The main challenges for the latter were surrounding noise and hearing oneself. The font size was suitable for 81 % of Swedish and 100 % of Finnish game testers (see Table 2). Issues were usually caused by not being able to wear glasses under the headset.

94 % of Swedish and 92 % of Finnish testers liked the visual appearance, while 100 % and 77 % found the game easy to use (see Table 2). Overlapping audio caused problems for those who played the Finnish game, and some wanted more on-screen guidance, a glossary, correct answers after several attempts, and help with linguistic content before the game. Some of those who played the Swedish game mentioned that external help was needed when there were several correct options or complicated words.

Step 4—Reflect on the game's pedagogical features: How does the game world's linguistic and audiovisual content support learning?

The vital pedagogical approaches we embraced were in addition to the general framework of computer-assisted language learning (CALL), Applied Linguistics and previous research on VR pedagogies, contextualized multimodal learning (Liaw & Chen, 2023), and guided independent learning (e.g., Niño 2020). Our game's most significant contribution to language learning lies in speaking and listening practice.

Speech is the most crucial form of interpersonal communication (Ylinen & Kurimo, 2017). Yet, an accent or non-fluent speech often makes a learner shy about speaking and avoids real-life communication in the target language (Ylinen & Kurimo, 2017, p. 58). The solution can be a VR simulation's calm and pressure-free language learning environment. For example, the VR simulation friend, Anna, could be described as an ideal interlocutor for speaking: she accepts and doesn't care about linguistic errors, doesn't switch to English, and is prepared to repeat the same communicative situation until the learner's communication is automated. Repetition is needed for fluent speech in a foreign language as it automates speech production, such as cognitive processes, and trains the function of speech organs (see also Ylinen & Kurimo, 2017, pp. 59, 67; Martin, 2008). By playing the simulation many times, the player can learn their lines by heart, and the lines become automated. In an ideal situation, the player will later be able to apply the sentences in the game in real life, in spontaneous informal situations without the written aids. The same applies to the listening comprehension component. By being able to repeat the line by the interlocutor and experience the effects of a correct oral answer on the interaction, the learner can become more confident in their listening skills.

Autonomy and independence stem from the essence of gaming: the teacher is not present in virtual reality (see also Blin & Jalkanen, 2014, p. 166). In a successful scripted learning game, support and guidance are built into the game, which promotes and facilitates self-study (Lakkala et al., 2015, p. 90). This was achieved with the visual cues and by allowing weaker students to hear and repeat the missing parts. The scripted VR game works best if the student is taught relevant vocabulary before the gaming event, followed by oral or written post-game reflections. This is what we mean by *guided* independent learning.

Contextualized language learning implies that learning happens through active engagement with meaningful real-world tasks that involve problem-solving. At the same time, multimodality embraces the multimodal nature of situated learning practices (Liaw and Chen, 2023, p. 3). Currently, multimodality is often digital or computer-assisted (Dressman, 2020). In practice, through the audiovisual interaction in our game, the player becomes part of the simulation game world and develops an affective attachment to the VR friend and interactive situation using several modes of learning and meaning-making (see also Kuorikoski, 2018, pp. 280–281; Vesisenaho et al., 2019).

In the spirit of CALL, our goal is to make the game widely available. For a learner to be able to find a freely available online game intended for study use, its distribution and marketing must be carefully planned so that it can be found by both potential students and teachers in the field (Lakkala et al., 2015, p. 95). Our VR game is intended to be part of the foreign language teaching at the project universities. Anyone interested can also download it from the website. In addition, after its completion, the game will be promoted, especially in teachers' networks and in the VR pedagogy seminar held after the end of the project, to achieve its active use in Nordic higher education. With the help of the game, anyone can train in peace and at their own pace at any time, as long as they have the appropriate VR glasses.

5. Conclusion

The first step in our design-based study showed the importance of identifying one's target audience and their needs. Specifically, higher education learners of Finnish and Swedish required more speaking and listening practice in a safe environment to complement classroom and teacher-led study. We developed a fully immersive voice-controlled VR speaking game to support this target group and learning context. In this study, we provided examples of the thematic and linguistic choices made by the team (step 2). We also discussed the technological solutions developed using the available tools and the audio-visual environment and the game world (step 3). Our pedagogical framework has been embedded in multimodality and independent learning throughout this design project, as shown in step 4 - reflection.. We see the game being used at universities and secondary schools, either as part of a course at the right level guided by a teacher or in a computer room for the students to use independently outside classroom time. If a student has a set of 3D glasses at home, they could use the game online once it is made available after the end of the project.

VR technology facilitates studying independent of time and place and encourages cooperation between higher education institutions. In this Nordic project, teachers of different languages combine their experience and expertise to support their students' foreign language learning process in a world characterized by rapidly changing demands for knowledge and communicative skills. The teachers got to know each other during the project, and the tone of the discussions was always constructive, considering the requirements of teaching different languages. Indeed, the development work and implementation of teaching technology require close and transparent communication throughout the university community, increasing the legitimacy of the technologies and reducing possible resistance to change not only among staff but also students (National Union of University Students in Finland, 2023, pp. 10-11). Furthermore, when introducing digital tools, their effects on the accessibility of studies must be considered (National Union of University Students in Finland, 2023, p. 13). In this Nordplus project, the goal was that, with the help of the game, learners from different backgrounds would get new opportunities to practice the language they are learning using the latest technology. We partly achieved this goal: 41 % of the testers of the Swedish game and 50 % of the testers of the Finnish game said they might use the game in the future in their free time (see Table 2). At the project's next stage, we will continue organizing test days, collecting user feedback, and developing the game using the input.

What is the game's benefit for an adult student studying at a university? The teacher can differentiate the students with the help of VR games and worlds. The educational use of VR games allows students to practice their speaking and listening skills independently and through authentic interactions and environments during ordinary lessons. Using virtual worlds and games does not free the teacher from planning his or her work but allows the classroom teaching to expand to spaces and situations that students would not necessarily otherwise have access to. Virtual worlds and games bring variety to class teaching and can be used to repeat, deepen, and expand the things learned in language class.

Adult language learners do not have many opportunities for spontaneous interaction with native Finnish speakers in everyday life. Therefore, VR language environments can now and in the future be an opportunity for international experts and cross-cultural and professional learning. They also access the discourses and variations of the written and spoken language learned (Finnish or Swedish). Attaching VR simulations to the curricula of higher education institutions would be a new language and culture-aware solution justified in terms of education policy, which aims to support the development of adult students' language and vocational skills.

Artificial intelligence and virtual worlds may cause fear of unemployment in the education sector. Teachers will not become unemployed, as VR language learning pedagogy must be continuously piloted and developed as part or support of teaching (Godwyn-Jones, 2013), which offers the learner genuinely meaningful learning opportunities. When new teaching materials are produced, developing and sharing good pedagogical usage ideas is vital to promote their innovative use in the Nordic higher education field more widely (Lappalainen et al., 2015, p. 116). This is why our team will organize an online VR pedagogy seminar at the project's next stage.

6. Limitations and Suggestions for Further Research

Our design-based study suggested both thematic and linguistic options as well as technical and visual solutions. The main limitation of our study was that it focused on the beta version of the game, but this was in line with our design approach: the results are necessary to improve the game during the design process. Future research could collect data from a larger group of testers or examine students' language acquisition when playing the game compared to a control group that uses a different method.

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