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ORIGINAL ARTICLE

LingoVerse: virtual language learning through gamification

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Abstract
The paper explores the use of virtual reality (VR) games for enhancing motivation and effectiveness in foreign language learning through virtual environments. In addition to increasing students' motivation to study a foreign language, it also aims to explore the use of the app as a complementary tool in formal educational settings. A VR language-learning game, *LingoVerse*, was developed and tested, with a focus on gamification mechanisms. An evaluation study that included pre- and post-test proficiency tests and user feedback, provides preliminary signals that the game may support language acquisition and motivation. We also consider the technical limitations of VR devices and discuss the challenges reported in interviews by individual users. The findings suggest that the *LingoVerse* game showed a potentially positive effect on conventional test performance and language learning outcomes, and that VR may be suitable as a supplementary tool for practice in both traditional language education and individual learning.

Keywords Virtual reality · e-learning · Language learning · Virtual worlds

1 Introduction

In recent years, virtual reality (VR) and augmented reality (AR) have emerged as two promising technologies, offering new ways to interact with digital content (Jensen and Konradsen 2018; Perry 2022; Pesek et al. 2024). These technologies can be used for various purposes, such as gaming, learning, therapy, and relaxation (Emmelkamp and Meyerbröker 2021; Hartanto et al. 2014; Howard 2017). With this versatility, new opportunities arise to create more interactive and engaging learning environments, where users can immerse themselves in virtual worlds and acquire knowledge in innovative ways.

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Gamification, as defined by Deterding et al. (2011), involves incorporating game elements into non-game contexts. Traditionally, this includes tangible elements such as points, badges, and leaderboards. However, according to Luo (2022) gamification should also include underlying mechanisms such as feedback, achievement, competition, and curiosity. While game elements are often concrete features found in digital and board games, gamification mechanisms represent abstract principles rooted in human psychology, and visible elements (e.g. points and badges) serve as tools to fulfill these broader motivational mechanisms (e.g. achievement and competition). These methods have proven to be effective in various contexts, including education (Dehghanzadeh et al. 2021).

The connection between games, virtual reality, and learning represents an interesting research area, offering potential for innovation in the educational process. In language learning, these technologies enable a more interactive and immersive experience, which could lead to better learning outcomes and increased motivation. VR technology allows learners to immerse themselves in simulated environments where they can practice language in real-life situations, improving both comprehension and communication skills (Gruber and Kaplan-Rakowski 2020).

Learning a foreign language is often a challenging endeavor, requiring significant effort and time. Traditional

learning methods, such as textbooks, workbooks, and classroom-based instruction, are most commonly used. Although effective, these methods often focus on memorizing grammar and vocabulary, which could become monotonous and may not provide sufficient motivation for learners (Walia 2012).

In the past decade, more modern methods, incorporating tools such as mobile applications, have emerged, offering more interactive and flexible learning experiences. Language learning apps incorporate various learning approaches, including game elements, adaptive learning, and instant feedback, which increase user motivation and attention retention (Huu Phuc and Nghi 2023). Apps like *Duolingo* integrate game elements such as point collection, leaderboards, and rewards to encourage users to learn regularly and achieve learning goals through short tasks linked to an overarching narrative (Shortt et al. 2023).

Virtual reality has the potential to offer a more immersive learning experience compared to mobile apps or traditional learning materials. When using VR headsets, the external world is isolated, leaving only computer-generated visuals, sound, and sometimes haptic feedback. Moreover, VR enables the creation of a safe learning environment where users can learn without fear of making mistakes or being judged (Gruber and Kaplan-Rakowski 2020, 2023). This could create an experience similar to living in a country where the target language is spoken. Traveling abroad for language learning can sometimes be costly or impractical, but a VR environment provides a safe and economical alternative to experiencing another linguistic setting. Therefore, users could experience a language-rich environment at a lower cost without needing to physically travel to a foreign country, offering more accessible and flexible learning opportunities (Panagiotidis 2021). The researchers also found that virtual worlds could provide valuable support for language learners with special needs (Lin and Lan 2015).

Many language learning applications have been developed with the aim of making the learning process more engaging, interactive, and enjoyable. However, most of these applications do not utilize the latest extended reality (XR) technologies as they are not yet widely accessible. Of the few that have experimented with VR, many lack comprehensive user studies or user experience research. Furthermore, not enough research has been done on how these applications—including the most popular ones—could be integrated into formal education. They are rarely studied for their potential as complementary tools in schools, although research by Chen et al. (2022) has found evidence of the overall effectiveness of VR applications on student's language learning performance.

Therefore, our main goal is not only to develop an immersive VR experience for language learning, but also to focus on how it can be integrated into formal education. In this way, we aim to make school lessons more engaging and enjoyable and bring them in line with modern technological advances. A key question that arises is how a VR learning environment could contribute to various aspects of language acquisition.

In this paper, we focus on exploring this question by developing a VR game named *LingoVerse* for German language learning in a virtual environment and conducting an experiment involving first-year high-school students. The specific research questions we address are:

- Does the developed *LingoVerse* virtual reality game increase students' motivation to learn a foreign language?
- Does the students' foreign language proficiency improve after using the VR game?

Additionally, we gathered data on the overall user experience through questionnaires and interviews to provide insights about the effectiveness of innovative approaches to language learning using VR technologies.

2 Related work

The development of virtual reality applications for educational use is not new, as it has been researched since the 1960 s (Warschauer and Healey 1998; Panagiotidis 2021) and its use for foreign language learning has been demonstrated several times in the last two decades (Li et al. 2021). Two important features of VR are immersion and presence. Immersion in VR systems mainly depends on sensory immersion, which Kim and Biocca (1997) define as the degree to which the range of sensory channel is engaged by the virtual simulation. Within the context of virtual reality, presence is defined as one's sense of being in the virtual world (Berkman and Akan 2019). The illusion is perceptual but not cognitive, as the perceptual system identifies the events and objects, and the brain-body system automatically reacts to the changes in the environment, while cognitive system slowly responds with a conclusion of what the person experiences is an illusion (Slater 2018).

The theory on situated learning was first introduced by Lave and Wenger (1991), and suggests that learners are more likely to develop expertise when they have ample opportunity to practice in a relevant context, making learning a more natural and unintentional process. Research supports this idea and shows that situated learning environments improve language acquisition by giving learners the opportunity to practice speaking in meaningful contexts (Dhimolea et al. 2022). Immersion allows foreign language learners to combine the learning of a language with

an intercultural experience beyond many restrictions (Lan 2020). In addition, research (Lan et al. 2015; Tai et al. 2020) investigated how different contexts and environments influence foreign language learning. In both cases, the results indicated a significant improvement in language learning outcomes and showed that contextual learning in a virtual world is effective over long periods of time as it provides a rich environment that stimulates a whole-body experience (Lan et al. 2015) and enables faster learning compared to traditional learning (Tai et al. 2020). Instead of memorizing, users can associate words with objects or learn vocabulary in the context of sentences while receiving clues about meaning and pronunciation as they also experience auditory information during dialogues. This forces them to focus on the sentence structure and understand the underlying grammar, and consequently their knowledge is consolidated more deeply (Chen 2016). For these learning benefits to be fully realized, the design of the virtual environment should be intuitive and contain clear instructions (Alam et al. 2024).

2.1 Gamified apps for language learning

Game-like learning approaches enhance the overall experience of students (Prathyusha 2020), who are given even more freedom in virtual learning environments such as VR. In the field of foreign language learning, the most commonly used research methods in relation to gamification have been quantitative methods (Dehganzadeh and Dehganzadeh 2020). The researchers point out that learning a new language poses a number of challenges (Akbari 2015). For example, speaking a new language is often perceived as stressful in many countries (Dehganzadeh and Dehganzadeh 2020). In addition, the complexity of the learning methods, disengagement, negative attitude, and learner's abilities may influence the learning of a foreign language (Dehganzadeh and Dehganzadeh 2020). Therefore, the complementary and, in some cases, isolated use of gamified virtual environments is of great importance and contributes to raising the levels of education and culture. Game elements of educational games are also often highly valued by learners. According to Perry (2022), these elements were perceived as highly engaging, immersive, and useful for learning, as they encouraged user engagement. Futhermore, Wood and Reiners (2015) state that gamification is not about turning routine activities into a game, but rather about combining work processes and game mechanics to achieve a more engaging and motivating experience. This is made possible through game-based elements and mechanisms, such as badges, leaderboards, points, feedback, challenges, social features, levels, progress bars, and teams, within a non-game environment (Žnideršič et al. 2024).

There is a plethora of language learning environments such as mobile, web-based, and VR applications. One of the best known is the *Duolingo* app, a web-based and mobile environment for learning several foreign languages. According to Munday (2017), its main features are spaced repetition (SRS), interleaving and instant feedback. Compared to *Duolingo*, the *Babbel* app focuses more on efficiency and less on the game elements (Forsberg et al. 2018). Users can choose between different courses and the desired language efficiency, which is immediately followed by a lesson (Nushi and Eqbali 2018). Two of its key features are deductive grammar teaching and strong reliance on the source language. *Rosetta Stone* can also be found on web-based and mobile platforms. According to Nst et al. (2023), *Rosetta Stone* consists of visuals, text, and sound, with increasing levels of difficulty. It uses phrases with graphic images associated with the words, creating a natural learning context in which neither the first nor the second language is used for translation. Unlike other language learning environments, *Busuu* is not aimed at advanced learners, but at beginners. It offers a gamified environment, where the user can choose the language they want to learn and set the level of difficulty (Shibata 2020).

Memrise is an app that, according to its authors, is based on three scientific principles to help users learn new vocabulary. The first is elaborate encoding, the second is choreographed testing and the third is scheduled reminders (Zhang 2019). *Memrise* has also integrated several game elements into the learning process. When the user starts to learn a new word, the game plants a new "seed of memory" and each time a user reviews these words, their seeds turn into flowers. Similar to *Duolingo*, *Memrise* also uses spaced repetition.

There are also several VR applications for language learning. *Mondly VR* focuses on non-native language learning and has two sections: a vocabulary section and a conversation section. Users can learn new words and phrases in specific contexts, practice different language skills, such as listening or reading, and the game provides users with a feedback on their own pronunciation (Klimova 2021). *Let's date!* VR application explores the possibilities of 360° VR videos to improve language learning. Its main goal is to improve students' listening comprehension and speaking skills by situating them in a dating agency and thus immersing them in a real life situation (Berns and Reyes-Sánchez 2021).

Two further applications, *ImmerseMe* (Berti 2020) and *Immerse* (immerse.com 2025), are both designed for language learning through immersive virtual environments. *ImmerseMe* focuses on self-paced practice using 360° video scenarios with scripted dialogs and speech recognition and offers a wide range of pre-recorded content, but no live

interaction. *Immerse* offers a more dynamic and interactive experience by combining live virtual instructor-led lessons, AI-powered conversational exercises and adaptive lessons in immersive 3D environments. *Goethestr. 56* (Bartholdy et al. 2023) was developed as part of the Goethestrasse 56 project and is a VR application that allows users to learn German through an immersive learning environment. The user is placed in a family home where they engage in various everyday activities on Goethe's Street 56. Apart from the *LingoVerse* app proposed in this paper, this is the only VR application available that has been developed specifically for the German language through situational learning in VR.

2.2 Potential downsides of language learning in VR

While most researchers report that language learning through VR has positive effects (e.g. Panagiotidis 2021; Berns and Reyes-Sánchez 2021; Klimova 2021; Nicolaidou et al. 2023), some report that it may have an opposite effect, where players focus more on the gamified environment than on language learning and therefore do not develop their language skills as predicted, specifically in writing (Li et al. 2021). With regard to teachers and educators, the authors also emphasized the importance of interdisciplinary collaboration between language teachers and VR technology experts to avoid low quality VR-assisted foreign language teaching.

One of the challenges in integrating VR into education is the lack of a clearly defined pedagogical framework tailored to this technology. Luo (2022) discusses previous studies that show insufficient integration of game features into pedagogical content, a lack of adaptability in gamified education, and high entry barriers for developing effective tools. Lege and Bonner (2020) point out that VR is often "force-fitted" into existing teaching paradigms rather than being utilized for its unique capabilities, leading to ineffective implementation. Effective pedagogy for VR in education requires the utilization of its unique capabilities and not just the emulation of traditional classroom activities in VR, such as lectures or text-heavy lessons (Hu-Au and Lee 2017). Furthermore, Kaplan-Rakowski et al. (2023) emphasize that teachers' beliefs about the technology play a crucial role in the successful adoption of VR, yet many teachers lack the training or confidence to incorporate VR in a pedagogically meaningful way.

Since effective language learning requires prolonged engagement, cybersickness is also a major disadvantage. Also known as visually induced motion sickness (VIMS), cybersickness has been reviewed in detail by Caserman et al. (2021). VIMS is characterized by dizziness, nausea, eye fatigue and disorientation (Kennedy et al. 2010). It is caused by sensory mismatch, postural instability and discrepancies between visual stimuli and physical movements (Fulvio et al. 2021; Ramazan et al. 2024). Individual susceptibility depends on factors such as visual sensitivity and previous experience (Bannigan et al. 2024). In addition, hardware issues such as lag and low frame rates contribute to symptoms, driving ongoing improvements in VR design (Palmisano et al. 2024; Wang et al. 2023). The meta-analysis by Caserman et al. shows that newer HMD devices have significantly reduced cybersickness problems, though they are not eliminated entirely. They concluded, that mismatched stimuli notably increase symptoms, especially with VR flight or driving simulators and continuous locomotion techniques using joysticks. In contrast, discrete locomotion methods such as teleportation or room-based devices that allow natural walking lead to significantly lower cybersickness symptoms (Caserman et al. 2021).

3 The *LingoVerse* game

We developed *LingoVerse* as an open-world role-playing game for language learning in which the player uses VR controllers to interact with objects and move around the world. The game's goal is to enable the user to immerse themselves in a virtual environment where they can explore and learn a new language in an interactive manner with game elements. The user can move freely through diverse environments, explore objects, play mini-games, and converse with characters to gain language knowledge and skills.

LingoVerse is designed as an interactive language learning tool that employs VR concepts. It is based on the premise of linking textual elements in the foreign language with corresponding objects in the virtual world in order to support associative learning of the language (Cosper et al. 2022). The developed game includes scenarios for learning German, with the interactive interface in English. Special features of the game include interactions with non-player characters (NPCs) to learn the language through thematic dialogs, the use of objects to reinforce vocabulary, and mini-games designed to improve vocabulary through associative learning.

We have adopted the concept of short lessons and game mechanics, similar to *Duolingo* and other commonly used applications that motivate and engage users in the learning process. Similar to the *Rosetta Stone* and *Busuu* games, our game immerses the user in a world of the target language without direct translation, encouraging natural language learning and use in real-world contexts.

Following the Pimsleur method (Pimsleur 1980), the game encourages users to actively participate in dialogs, facilitating the repetition and reinforcement of phrases. This

approach is particularly important in a virtual environment where learners can converse with virtual characters, simulating real-life conversational situations.

The key to long-term retention is the spaced repetition method (SRS), which is also used in applications such as the flashcard app *Anki* (Elmes 2006) and *Memrise*. Our system allows lessons to be repeated automatically after a certain period of time, which improves the long-term retention of the learned material.

3.1 Game mechanics and design

The game is an open-world game in which the player can freely explore various locations. This exploration is closely tied to learning and simulates the experience of living in a foreign country. The player encounters new words and phrases as they discover new areas, objects, mini-games, and NPCs.

The NPC dialogs, as shown in Fig. 1, are a core element of the game. The user can engage in conversations with various NPCs scattered throughout the virtual worlds. Each NPC has a predefined set of dialogs that are used to learn specific words or phrases in the target language. The dialogs are structured to encourage the player to repeat new words frequently and use them in context to improve language retention and comprehension.

The dialogs become available again after a certain time, allowing the player to repeat them as often as necessary to master unfamiliar words. The NPC conversations consist of both text and audio components, followed by the player's responses.

Task types in the dialogs inserting the correct word into a sentence and choosing the correct verb conjugations. For each correct answer, the player receives points that contribute to progress in the game.

In addition, there are two individual game types associated with the tasks in *LingoVerse*: Matching Pairs and Interactive Objects.

3.1.1 The Matching Pairs game

In the Matching Pairs game, the player matches objects to corresponding words. Each Matching Pairs game features items related to a specific theme or environment, such as kitchen utensils or food. A screenshot of the Matching Pairs game is shown in Fig. 2.

At the start of the game, objects are randomly placed in predefined locations. The player must place the objects in the designated places where the corresponding names are written in the foreign language. Once all the objects have been placed, the player sees their score, which shows the number of correctly matched pairs and the time required to complete the game.

3.1.2 The interactive objects

The mechanic of picking up items allows the player to manipulate objects that are highlighted when picked up (Fig. 3). When the player picks up a specific object for the first time, a window will open displaying the name of the object in the target language along with an audio pronunciation. The player can manually activate this window by pressing a button on the controller while holding the object. This allows the player to associate the visual perception of objects with the corresponding names and thus improve their vocabulary and pronunciation.

3.2 Technology and development tools

The game was developed using the Unity game engine, which is one of the most popular tools for game development due

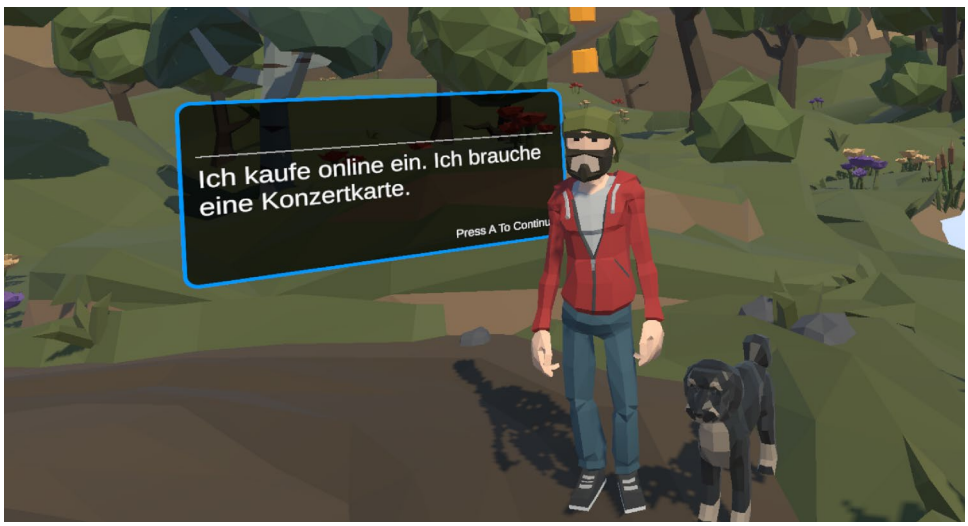


Fig. 1 Dialogue with a character in the game

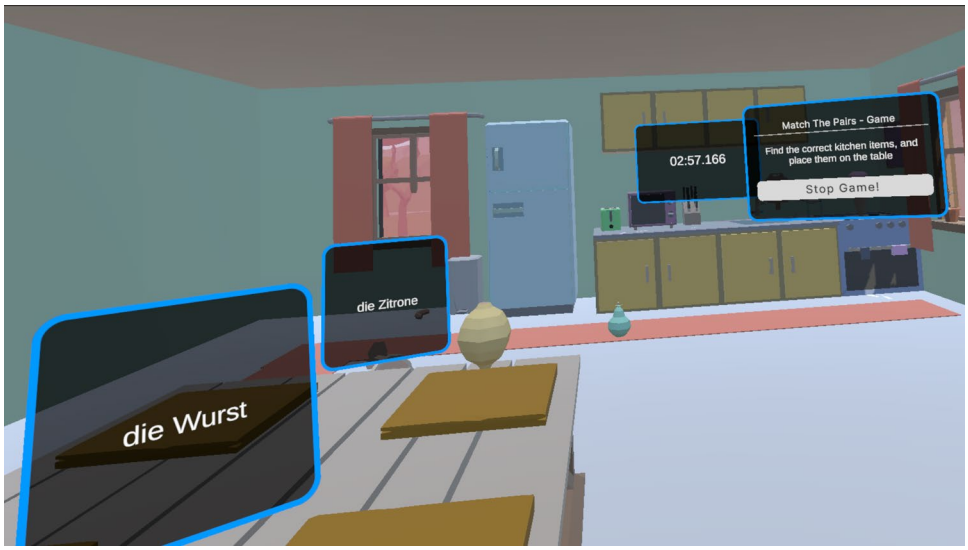


Fig. 2 Matching Pairs game

Fig. 3 Picking up an interactive object (pineapple)

to its flexibility and broad platform support. Unity enables efficient integration with various VR devices and offers a variety of functionalities for the development of interactive and visually appealing games. We used the C# programming language, the primary language for game development in Unity, as it offers a high level of control and is robust enough for complex operations.

For VR integration, we used OpenXR and the Oculus Quest SDK, which allowed us to optimize the game for performance on Oculus Quest devices. OpenXR simplifies the development of applications by enabling developers to create applications for a wide range of AR/VR devices. The Oculus Quest SDK provides tools and libraries specifically for optimizing content for Oculus Quest VR devices.

We have also implemented the *Powerful Intuitive Node/Narrative Assistant (PINA)* system for dialog systems. *PINA* enables the creation of complex dialogs with multiple choices and actions that are crucial for dynamic NPC interactions. The dialogs are designed through a visual interface, as shown in Fig. 4, making it easier to test dialog scenarios without the need for additional programming. This feature also potentially enables teachers to contribute new content to the application without the need for in-depth programming knowledge.

For the implementation of mini-games, we used Scriptable Objects, which are part of the Unity framework. With Scriptable Objects, the game data can be separated from the logic, which ensures greater modularity and reusability of code components. This approach was particularly useful when developing different types of mini-games, as game rules, parameters, and content could be easily adjusted without changing the core code.

By using these technologies and approaches, we have created a robust game environment that supports complex interactions and high-quality visuals while being flexible for future expansions and upgrades.

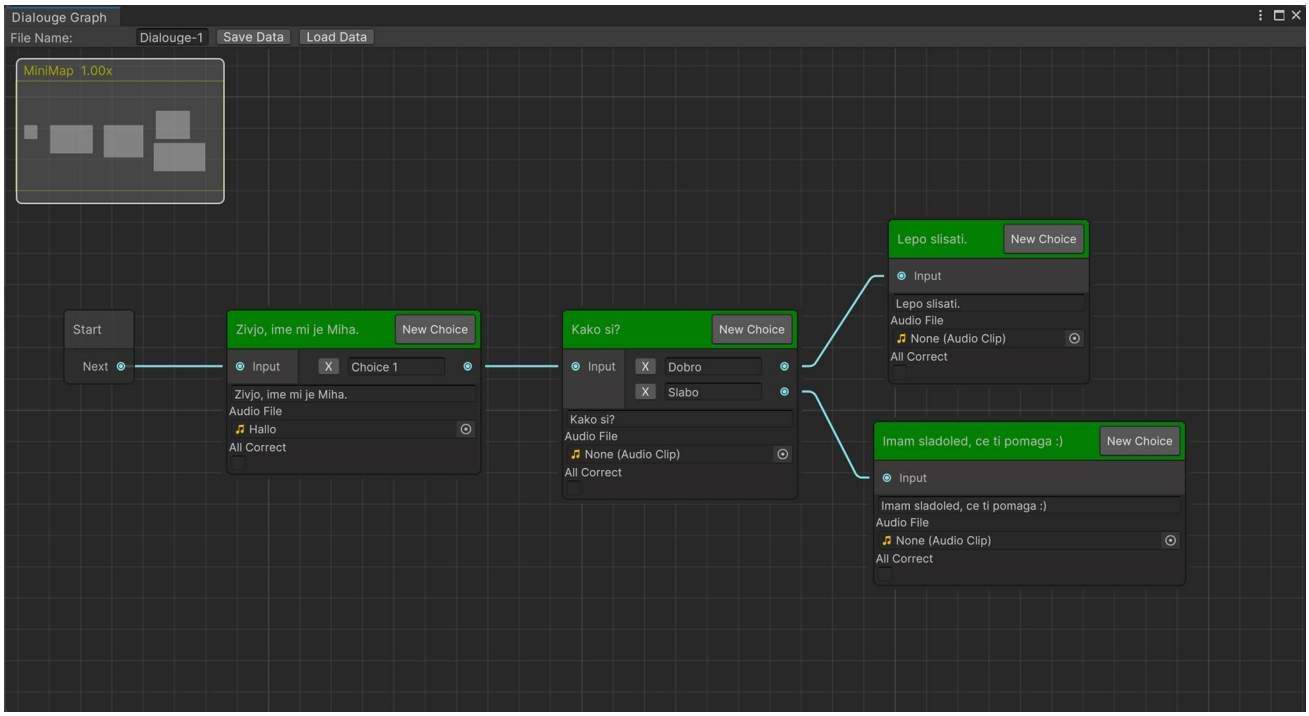


Fig. 4 *PINA* - Visual Dialogue Editor

3.3 Optimization and performance

Due to the nature of VR, where a high refresh rate is recommended to prevent motion sickness in users (Eunhee Chang and Yoo 2020), we conducted a thorough optimization of the graphical assets and code. This included reducing the graphical resolution and using occlusion culling to improve the scene rendering. Occlusion culling is a technique that improves rendering performance by not displaying objects in the world that are hidden behind other objects. This means that the GPU only processes visible elements, reducing the number of polygons and improving the frame rate.

Instead of dynamic lighting, we have implemented baked lighting, where the lighting calculations are performed in advance and stored as part of the textures. This significantly reduces the CPU load as real-time lighting calculations are unnecessary, contributing to overall performance of the game.

A loading screen was added to enhance the user experience during world transitions. It provides visual feedback and indicates to the user that a new environment is being loaded, helping maintain player engagement and reducing the feeling of interruption to the game session.

To mitigate motion sickness, we have introduced a field-of-view restriction, known as “tunneling” or “vignetting”, that blurs the edges of the field of vision during movement, reducing nausea (Wu and Suma Rosenberg 2022).

In the later stages of the game, scene management was optimized by using smaller and more focused scenes allowing for faster loading and improved game stability. This approach not only improves overall performance, but also the gameplay experience by reducing the likelihood of technical issues or lags that could interrupt gameplay.

The visual style of the game is designed in a low-poly style, characterized by the minimalist use of geometric shapes, which is very suitable for mobile and VR platforms as it ensures high performance while maintaining aesthetic appeal. We used professionally designed models from *Synty Studios*.[1] For the background music, we used royalty-free tracks.[2] The NPC dialogs and the pronunciation of the object names were recorded by native German speakers. This allows players to experience the authentic pronunciation, accent and melody of the target language.

The game’s content is directly related to the learning material and is based on the textbook series Direkt Interaktiv 1 (Černý et al. 2022a, b), which was designed for students in the first and second-year of high school and is commonly used in Slovenian learning environments. For the content of the game, we used the first five chapters that correspond to the school curriculum. The NPC dialogs and the interactions with various objects are designed to reflect the themes of the textbook. For

[1] *Synty Studios* https://www.syntystudios.com/.

[2] https://www.youtube.com/watch?v=1pGgn9rfGZU, https://www.youtube.com/watch?v=eTuvlhcdKm8, https://pixabay.com/music/traditional-jazz-the-jazz-trio-164259/.

greater depth of the storyline, additional extensions have been added to match the assumed time the user spends in the app.

4 Experimental setup

To assess the effectiveness of the developed VR game for language learning, we conducted two experimental sessions. First year high school students were recruited for the evaluation during their regular German language class at Šiška high school in Ljubljana, Slovenia.

During the introductory session, we individually asked each student about their prior knowledge of the German language. Only students with no prior knowledge were selected to ensure that the participants had the same starting point and that they were provided with equal learning conditions. The fact that all participants began with the same starting point, i.e. no prior knowledge, allowed a fair comparison of the effectiveness of the game in language learning. Written consent forms were distributed to parents, who were asked to provide informed consent for their child's participation. Only students whose parents returned a signed consent form confirming their approval were included in the study. In total, 14 students participated in the study. All were 15 years old except one, who was 14. Both genders were represented equally (7 per gender).

The students were divided into two groups, each consisting of 7 students: The first group consisted of 3 male and 4 female, while the second group consisted of 4 male and 3 female. Each group participated in three phases of the test. The first group played the game first, followed by the second group. Both groups had the same standardized knowledge tests and played the same game.

4.1 First session

The first session (Session I) took place over a 14-day period between October 23 and November 11, 2023. That is about a month and a half after participants' enrollment into first-year programme.

To facilitate the introduction to VR and *LingoVerse*, participants began with a structured onboarding process. Each participant watched a short video tutorial[3] that demonstrated how to properly wear the VR headset, adjust the headband, set the interpupillary distance, use the hand controllers and navigate a virtual environment. They were also shown how to set their play boundary and launch the *LingoVerse* application from the main menu. Once in the game, students entered an introductory world specifically designed to familiarize them with the mechanics and goals of *LingoVerse*. This included guided instructions, interactive elements, and simple example games that showcased basic interaction patterns, such as talking to non-player characters (NPCs) and completing tasks.

Beyond the onboarding and technical setup, we did not provide any additional instructional support related to the language learning itself. Students continued regular lessons at school and used *LingoVerse* at home to practice what they had learned, making any outcomes the result of self-directed gameplay.

- Introduction session (Day 0) - *Group 1 obtains the VR devices*
  - Introductory session (Groups 1 and 2)
  - Pre-test questionnaire (Group 1)
  - German proficiency test I.a (Group 1)
- In-person meeting (Day 7) - *Group 2 obtains the VR devices*
  - German proficiency test I.b (Group 1)
  - German proficiency test I.a (Group 2)
  - Post-test questionnaire (Group 1)
- In-person meeting (Day 14)
  - German proficiency test I.b (Group 2)
  - Post-test questionnaire (Group 2)

The goal of this session is to compare the exam's scores before and after the one-week use of the VR devices. Both groups were evaluated using conventional exams (see Appendix).

4.2 Second session

The second session took place between May 13 and May 27, 2024, when new content was added to the game based on the curriculum. The procedure of the second experiment was similar to the first experiment, with the steps streamlined to minimize the time we had previously spent on the introductory lessons and the pre-/ post- questionnaires in class.

- Introduction session (Day 0) - *Group 1 obtains the VR devices*
  - German proficiency test II.a (Groups 1 and 2)
- In-person meeting (Day 7) - *Group 2 obtains the VR devices*
  - German proficiency test II.b (Groups 1 and 2)

[3] Nik Jan Špruk, *Video tutorial for the game*, https://youtu.be/QzoZJ6bAfdU.

- In-person meeting (Day 14)
  - German proficiency test II.c (Groups 1 and 2)
  - Focus groups and interviews

The goal of this session was to compare the exam's scores between both groups in a cross-over experiment. First the Group 1 performs as a test group and Group 2 as a control group. The groups are then reversed. Both groups therefore completed three exams (see Appendix).

The diagram of both sessions is shown in Fig. 5.

4.3 Pre- and post-test questionnaires

To gather student feedback, we used two questionnaires (Tables 1 and 2), designed to capture a wide range of student opinions and experiences in relation to VR and the *LingoVerse* game using various question types. The questionnaires included items rated on a five-point Likert scale of agreement, representing the quantitative aspect of the data collection.

The pre-test questionnaire included questions about the frequency of playing video games, preferred gaming platforms, reasons for gaming, and weekly time spent gaming. Participants were also asked to explain their answers on the Likert scale, which were then categorized accordingly.

In the post-test we sought more detailed feedback on the game by asking students if they enjoyed it and which parts they liked the most. In addition to knowledge acquisition from the tests, the questionnaires also served to evaluate the user experience. Therefore, we included qualitative questions where students had the opportunity to express their opinions and experiences in open-ended responses. These questions provided a deeper insight into certain aspects of the game and VR technology that cannot be captured through quantitative questions.

The pre- and post-test questionnaires can be found in the Tables 1 and 2.

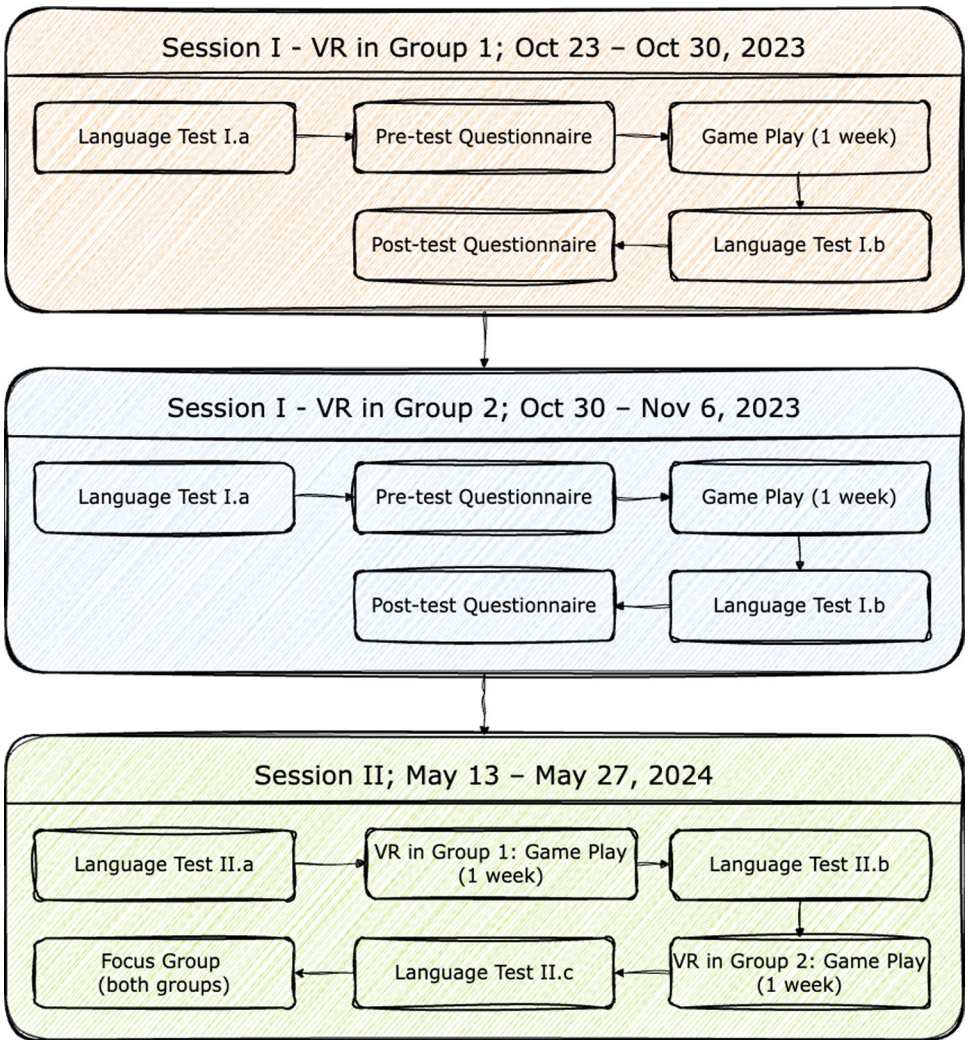


Fig. 5 Experimental design diagram for both experiments

Table 1 Pre-test questionnaire for the first experiment

Question	Options and values
Name	e.g.“John Doe”
Quest device ID	e.g. “9876543”
Gender	Male, Female, Other
Age	Expected range 14–16
How frequently do you play video games?	Every day, Once a week or more, Once a month, Almost never
How many hours per week do you play video games?	0, less than 1 h, 1–3 h, 3–7 h, more than 7 h
What is your favorite platform for video games?	Options: PC, Console (Playstation, Xbox...), Mobile or tablet device
Why do you like playing video games?	Expected responses: fun, relaxation, learning, socializing..
Are you actively learning any foreign language?	Expected responses: *languages excluding the German language*
What accessories do you use for language learning?	Books, Apps, Language courses (in-person or online), Dictionaries
How well can games aid the language learning process?	(none) 1–5 (completely)
Have you used a VR headset before?	Yes,No
If you have access to VR headset, how often do you use it?	Every day, Several times a week, Several times a month, Almost never
Why do you use VR headsets?	Playing games, Learning, Watching movies and series, Other
Would you be interested in learning a new language through a VR game?	Yes,No
Which features would you like to see in a VR game for language learning?	Vocabulary learning, Grammar learning, Pronunciation, Other
Do you think that immersion in a virtual environment would improve your language learning experience?	(completely disagree) 1–5 (completely agree)
Please explain your answer from the previous question	*Open-ended response*
How much time would you be willing to spend in one session in VR for language learning?	Less than 15 min, 15–30 min, 30–60 min, 60–90 min, More than 90 min
Would you prefer to learn a language in VR alone or in a multiplayer experience with other learners?	Alone, Mostly alone but sometimes with others, Mostly with others but sometimes alone, Always with others
Do you think a VR game would make language learning more interesting than traditional methods?	(completely disagree) 1–5 (completely agree)
Please explain your answer from the previous question	*Open-ended response*
Which aspects of traditional language learning methods do you find most challenging or boring?	Textbook, Test, Workbooks, Group work, Other
Which virtual environments or scenarios would be most appealing for language learning?	Virtual city, Historical events, Everyday scenarios, Imaginary story, Other
Would you be more motivated to speak in a VR environment than in a classroom?	(completely disagree) 1–5 (completely agree)
Please explain your answer from the previous question	*Open-ended response*

4.3.1 Focus groups

In addition to the questionnaires, we conducted focus groups in which we asked the students about their experiences with the game. With their consent, we audio-recorded the discussions and later transcribed them. The focus groups provided deeper insight into the aspects of the game that the students liked and the potential uses of the game if it were regularly included in the curriculum. This qualitative data about the game complemented the quantitative data from the questionnaires and game sessions.

4.4 Data collection

During the experiment, we collected data on various aspects of the students' interaction with the game and their progress in learning German. The primary goals of the data collection were to evaluate the effectiveness of the game as a learning tool, to understand the user experience, and to analyze the potential improvements in language skills. Each student was assigned a unique ID that they used during the tests and in the game. This allowed us to record results and gameplay time while ensuring anonymity. The collected data was divided into different categories, such as German

Table 2 Post-test questionnaire for the first experiment

Question	Options and values
Name	e.g. "John Doe"
Quest device ID	e.g. "9876543"
Why did you decide to participate in this testing?	*Open-ended response*
How many hours did you spend playing the VR language learning game in the past week?	0 h, Less than 1 h, 1–3 h, More than 3 h
Describe your first impressions when you started the game	(very poor) 1–5 (excellent)
Please explain your answer from the previous question	*Open-ended response*
Was the game intuitive and user-friendly? Did you encounter any particular challenges while navigating or playing?	(not intuitive at all) 1–5 (very intuitive)
Please explain your answer from the previous question	*Open-ended response*
Do you think you have learned or improved your German skills by using the VR game?	(completely disagree) 1–5 (completely agree)
Which parts of the game did you like the most?	Exploration, Interaction with characters, Games, Other
Were you more motivated to learn and practice German in the VR environment compared to traditional methods (workbooks, classroom learning, etc.)?	(completely disagree) 1–5 (completely agree)
Did you experience motion sickness or discomfort while playing the VR game?	Very often, Sometimes, Very rarely, Never
Did you encounter any technical errors or issues that hindered your experience?	*Open-ended response*
What functions or elements would you add or change in the VR game to improve the language learning experience (e.g., more vocabulary, more tasks, more interaction)?	*Open-ended response*
Would you recommend this VR game as a language learning tool to your peers?	Yes,No
Please explain your answer from the previous question	*Open-ended response*
Based on your experiences over the past week, do you think that VR language learning is a suitable alternative or complement to traditional methods, if the game were improved and enhanced?	(completely disagree) 1–5 (completely agree)

proficiency, gameplay time, in-game interactions, and user experience.

Collecting this data was crucial for understanding the impact of the game on German language learning. Playtime and in-game interactions provided insight into how students used the game and what aspects of the game they found engaging and useful. Feedback on user experience helped us to improve the game and adapt its features to the students' needs, while language progress data allowed us to measure the effectiveness of the game as a learning tool.

4.4.1 Assessing game engagement and motivation to learn

In evaluating game engagement and motivation to learn, we focused on several key aspects. Using questionnaires, we asked students how enjoyable and motivating the game was, how often they felt inclined to return to playing, and whether they felt an increased motivation to learn German while playing. We also asked students in a focus group about their experience, what they liked best and how useful the game could be if it were developed and integrated into the curriculum. Insight into the user experience is crucial as positive experiences could lead to better learning outcomes (Ahn and Lee 2016).

4.4.2 Assessment of German language skills

To assess German language proficiency, we used standardized tests that evaluated various skills such as vocabulary, grammar, and communication skills. These tests were created by teachers and developed in accordance with national curriculum standards. The items have been reviewed by experienced teachers to ensure content validity and the parallel forms (I.a and I.b) have been designed to be equivalent in content and difficulty. The tests are listed in the Appendix. They are listed in the Appendix. The tests were administered at the beginning and end of the experiment, allowing us to compare and evaluate the participants' progress. With these tests, we aimed to obtain precise data on whether and to what extent playing the game contributed to improving language skills.

4.4.3 Gameplay time and in-game interactions

To collect data on gameplay time and in-game interactions, we used built-in features that tracked gameplay time, moments when players interacted with NPCs, picked up objects, and played mini-games such. These features were implemented within the game and automatically recorded the following information:

- **Gameplay time**: The total amount of time a player spent in the game, from the beginning to the end of each session. We also tracked how much time the player spent in each individual scene within the game for each session (Table 3).
- **Interactions with NPCs**: The moments in which the player interacted with NPCs, including the identity of the NPCs and the number of correct answers the player provided during the interaction (Table 4).
- **Object pickup**: The moments when the player picked up a specific object in the game for the first time.

Table 3 Metrics for playtime

Attribute	Type	Value (example)
Player ID	string	Id9876543
Time within the scene	seconds	12.345678901234567
Scene name	string	MainScene_1
Session start	datetime	2024-05-23T21:15:58.000Z
Session end	datetime	2024-05-23T21:54:39.000Z

Table 4 Metrics for NPC dialogues

Attribute	Type	Value (example)
Player ID	string	Id1097872
Dialog name	string	Jens_Diag1_Start_Node
Result	number	4
Dialog start time	datetime	2023-10-28T12:22:39.000Z

Table 5 Metrics for individual games

Attribute	Type	Value (example)
Player ID	string	Id1092912
Game name	string	FlagsPairsGame
Result	number	8
Playtime	seconds	92.77576446533203
Did the player finish the game?	True/False	False
Answers (correct and chosen)	string	Pear-Pear, Apple-Banana, ..
Game start time	datetime	2023-10-29T11:03:34.000Z

- **Playing mini-games**: The time and success (correct answers) in the various mini-games (Table 5).

This data was initially stored locally on the VR device on which the students played the game. As soon as an internet connection was available, the data was sent to an external database via API (Application Programming Interface) calls.

The API server created with the Node.js runtime environment was responsible for receiving and processing the data in JSON (JavaScript Object Notation) format that is easy to read and write. API calls enabled the transfer of data from the VR device to an external database where the data was stored for further analysis.

The database was implemented using MongoDB, which stores data in JSON objects, allowing easy storage of the collected data.

4.5 Analyses

The results were analyzed using the Wilcoxon signed-rank test (for dependent samples), which was used to calculate statistically significant differences in the results between the different sessions and groups. This test was chosen because it is a robust non-parametric method that is suitable for small sample sizes and does not assume a normal distribution of the data. We report W-values, exact p-values, mean differences ($\Delta\mu$) and standard deviations (σ).

5 Results

5.1 Pre-test questionnaire

The pre-test questionnaire results reveal diverse gaming habits among the students. Half of the participants reported playing video games daily, while the others had less frequent gaming routines, ranging from almost never to once a week or once a month. In terms of gaming platforms, mobile devices were the most popular choice, favored by eight students, followed by computers with four users and gaming consoles such as PlayStation, Xbox and Switch, used by only two students. The main motivation for gaming was fun, cited by the majority of students, while smaller groups played for relaxation, learning or to overcome boredom. Weekly gaming time varied considerably: two students did not play at all, four played for less than an hour, five played for between one and three hours, and three spent three to seven hours gaming.

5.1.1 Language learning and perception

Before engaging with the VR game, more than half of the students (8 out of 14) reported learning a foreign language in their free time, with English being the most commonly learned language, and one student learning multiple foreign languages. Mobile applications proved to be the most frequently used language learning resource, followed by books, language courses, dictionaries, and workbooks (Fig. 6).

Students generally held a positive perception of video games as a language learning tool and rated their effectiveness highly (4.2 out of 5 on average), emphasizing the engaging and interactive nature of the games. Vocabulary exercises were the most popular type of language practice in VR (86%), followed by grammar (57%) and pronunciation exercises (43%). Participants rated the potential of VR immersion to positively impact their learning with an average score of 4.3, attributing this to its novelty and interactivity. Most students preferred shorter learning sessions of 15 to 30 min and preferred to learn alone rather than in a group. Compared to traditional teaching methods, VR was rated as significantly more engaging (average score of 4.7), with its dynamic and interactive qualities increasing student motivation. Among traditional methods, textbooks and quizzes were the least preferred, while group work was the most accepted. The most popular VR scenario was practicing the language in a virtual city, chosen by eight students, with historical and fictional scenarios also appealing to some. The motivation to practice speaking in VR varied. The average score was 3.29, reflecting different views on the benefits of VR as well as students' confidence in their language skills.

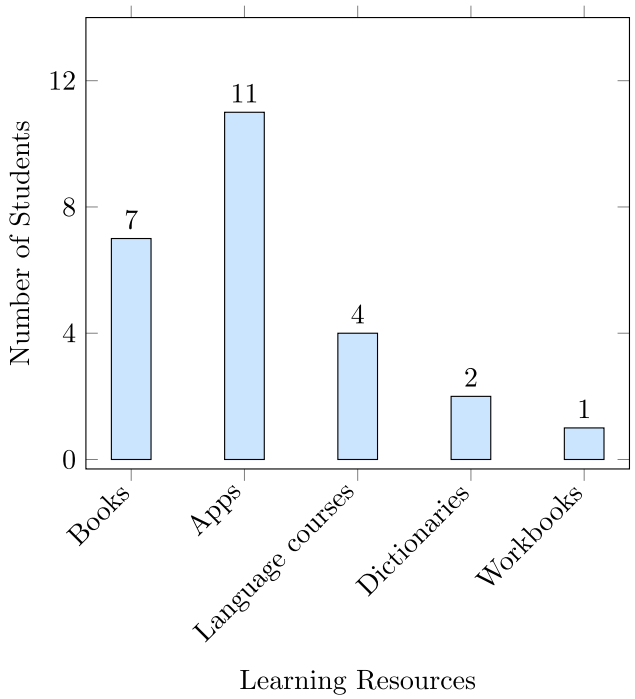


Fig. 6 Resources used by students for language learning

5.2 German language proficiency test results

This section presents the results of the German language proficiency tests conducted during the first and second sessions (see Appendix). The aim was to explore potential improvement of the students' German language skills after engaging with the VR game.

Given the small sample size, we relied primarily on the Wilcoxon W-value to assess statistical differences rather than interpreting the classic *p*-values alone. Based on the sample size (N = 14), a critical threshold of W = 3 was established. If the calculated W was below this threshold, the result was considered statistically significant (McCornack 1965). The results from the Session I, presented in Table 6, indicate observable improvements in both groups.

Table 8 Wilcoxon signed-rank test results comparing performance across three test phases in Group 2 (N = 7)

	Session II – Group 2 comparison (N=7)			
	W-value	*p*-value	$\Delta\mu$	σ
Tests II.a vs. II.b (no VR)	6	0.68	−0.43	2.94
Tests II.b vs. II.c (VR)	0*	0.016	4	0.82

No significant difference was observed between pre-test (II.a) and mid-test (II.b) without VR. A significant improvement was found between mid-test (II.b) and post-test (II.c) following the VR intervention

Although the exact *p*-values are also reported, they are provided for informational purposes only and should be interpreted with caution given the limited statistical power.

Group 1 data from Session II are presented in Table 7 for illustrative purposes, but these results do not reflect the actual situation as only two valid data sets were submitted. This shortcoming limits the reliability of comparisons between conditions and prevents clear conclusions.

Table 8 shows the comparison of the performance of group 2 in the three test phases. Between the pre-test (II.a) and the mid-test (II.b) without VR, the mean gain was −0.43 with a 95% confidence interval of [−3.15, 2.29], indicating no reliable improvement. In contrast, from the mid- test (II.b) to the post-test (II.c) with VR, the mean gain increased by 4.00 points with a 95% confidence interval of [3.24, 4.76], suggesting a more reliable improvement associated with the VR intervention.

5.3 Gameplay data results

The estimated time participants were expected to spend playing the game was around 30 min, with the game content designed to last between 20 and 30 min. While most participants stayed within this range, two students spent significantly more time than expected.

As shown in Table 9, the average playtime in Session I was around 30 min for both groups. In Session II, Group 2

Table 6 Average scores and standard deviations for the proficiency tests of the Session I and W-value, *p*-value and effect size (rank-biserial correlation) for both groups

	Test I.a		Test I.b		W-value	*p*-value	Effect size(r_{rb})
	μ	σ	μ	σ			
Group 1	13.43	2.44	16.00	2.77	1.50*	0.031	0.80
Group 2	9.43	1.72	13.14	3.53	1.00*	0.031	0.83

* Statistically significant

Table 7 Average scores and standard deviations for the proficiency tests of the Session II

	Test II.a		Test II.b		Test II.c	
	μ	σ	μ	σ	μ	σ
Group 1[+]	20.00	4.00	19.00	5.00	21.00	4.00
Group 2	23.14	2.54	22.71	1.25	26.71	1.25

[+] Results for Group 1 are missing with only two students participating in Tests II.b and II.c

maintained a similar average, while Group 1 had a much shorter session. Given the very low number of valid contributions in Group 1, this difference is likely due to insufficient participation rather than a systematic effect.

Across all participants and both sessions, recorded play times ranged from a minimum of 8.56 min to a maximum of 69.51 min, with an overall average of 29.10 min.

5.4 Opinions on the game

Following the test phase, the students completed a second questionnaire about their experiences with the VR game.

Most of the participants took part in the study to try out the VR headset or experience a VR language learning game; five students had the specific aim of improving their German language skills. When asked about their first impressions, students gave an average rating of 3.43 out of 5 (SD = 0.76), indicating a neutral to slightly positive experience. Eight students found the game enjoyable, while the most common suggestions for improvement included better navigation, additional content and improved game performance.

The participants rated the intuitiveness of the game with an average score of 3.71 (SD = 0.91), which corresponds to neutral to slightly positive usability. Two students reported minor dialog problems. Many wished for a longer game duration, more tasks and mini-games as well as an extended vocabulary. Two students suggested displaying the German names of objects when interacting with them - a function that has already been partially implemented in newer version.

In terms of favorite aspects of the game (see Table 10), interacting with the characters and exploring the virtual world were equally popular (35.7% each), with the mini-games being slightly less popular (28.6%).

Students rated the game's influence on their motivation to learn German at 4.1 on average. However, half of the participants reported occasional or frequent motion sickness during gameplay (Fig. 7). Perceptions of language improvement were mixed, with an average rating of 3.0 (SD = 0.78).

When asked whether they would recommend the VR game to others, 85.7% responded positively, citing the fun, innovative learning approach and conversational practices as reasons. Those who would not recommend it referred to personal preferences or a dislike of gaming as a learning method. The potential of the game as a supplement or alternative to traditional methods was rated at an average of 4.07 (SD = 1.07).

Since the initial questionnaire, the opinions of four students remained unchanged, while others reported that VR made learning easier and more enjoyable. In terms of preferred learning methods, most still favored language learning applications, citing their advanced features and less motion sickness. VR was liked for its interactivity and immersion, and only one student would opt for textbooks because they felt uncomfortable with VR.

Table 9 Average playtime (and standard deviations) per player in each group

	Session I		Session II	
	μ	σ	μ	σ
Group 1	30.44	16.22	8.83*	0.00
Group 2	31.06	10.04	28.13	18.93

The average values are expressed in minutes

* The number of participants in the second session is too small for any statistical analysis

Table 10 Question: Which parts of the game did you enjoy the most?

	Frequency (f)	Percentage (%)
Interacting with characters	5	35.7
Exploring	5	35.7
Mini-games	4	28.6
Total	14	100.0

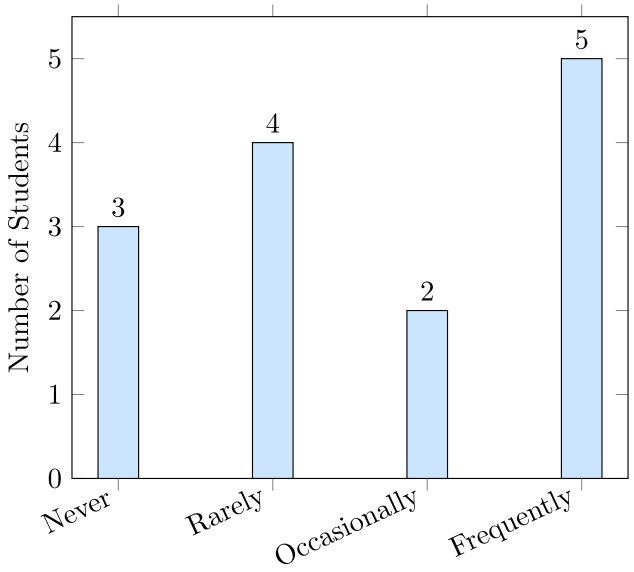


Fig. 7 Frequency of motion sickness during gameplay

5.5 Focus group

In a discussion-based focus group students were able to further elaborate on certain aspects and opinions about the game.

The participants highlighted short mini-games and interactions with NPCs as their favorite aspects. These elements were praised for their interactivity and linking words to objects (all participants agreed), facilitating visual, associative and hands-on learning. All participants found the VR gameplay more fun and effective than traditional methods because it helped them visualize and retain information better. All agreed that the mini-games were the most useful in

reinforcing language learning through repetition and active engagement with the VR environment.

Among the most important suggestions for improvement was the addition of a storyline that guides the player through specific missions. Participants also emphasized the value of verbal interaction with NPCs and recommended voice recognition features to train German pronunciation and conversation skills. They also wanted more varied mini-games, such as memory games, to enrich the learning experience.

Students described the learning process as intuitive and natural. They appreciated the introductory world, which helped them get started with the game mechanics and concepts, and the map feature, which helped them navigate and find tasks. Participants cited several advantages of VR-based language learning over traditional approaches, such as active learning through movement and interaction, strong visual support, and increased motivation. Many noted that using VR headsets felt more engaging than desk-based learning. However, some disadvantages were also reported, including headaches, dizziness during prolonged use, the weight of the headset and the need for optimization for longer sessions. The unique ability of VR to move freely in the virtual world and physically interact with objects was seen as a major advantage. For example, picking up objects in the VR environment helped learners to associate words with their correct pronunciation. Overall, participants felt that VR had a positive impact on their motivation to learn. Most stated that they would use the game regularly during a school semester and would recommend it as a supplement to traditional learning methods. Compared to language learning apps like *Duolingo* or textbook study, the focus group felt that VR provided a more immersive, focused and engaging experience, with fewer distractions and more interaction.

6 Discussion and conclusion

In this paper, we explored the potential of VR games as tools to support language learning, with an emphasis on motivation and knowledge consolidation. Our findings align with earlier research that demonstrated how VR can enhance learning environments, foster engagement, and improve performance in language acquisition (Chen et al. 2021, 2022). Utilizing a combination of data from device metrics, user experience questionnaires, and language proficiency assessments, we found preliminary evidence that VR applications like *LingoVerse* may offer benefits in language learning contexts.

Our results indicated observable improvements in conventional German language exam scores post-interaction with the VR game, with an average increase that suggest potential benefits through , though the precise magnitude requires further validation. This observation correlates with previous that found immersive VR environments can significantly bolster vocabulary acquisition and overall language performance among learners (Chen et al. 2021). The interactive nature of VR has been demonstrated to heighten learners' motivation and engagement levels, which coincides with previous studies that highlight how such immersive experiences improve overall knowledge retention and satisfaction among students (Pramasta and Wibowo 2023). Feedback from our participants echoed these sentiments, as they expressed appreciation for the engaging and novel learning approach that VR provides compared to traditional methodologies.

Furthermore, the *LingoVerse* game appears to enhance motivation as well as aspects language comprehension, particularly in vocabulary and grammatical applications. Participants in our study reported greater enjoyment and engagement throughout their language learning, which aligns with findings by Yu and Duan (2024) indicating that VR learning environments significantly influence learner motivation and performance outcomes. Our data suggest that continued exposure to the VR framework may yield further proficiency gains. This conclusion needs to be confirmed in larger controlled studies, but is supported to some extent by previous meta-analysis (Chen et al. 2022), which advocates for leveraging VR technologies in diverse language learning settings.

The VR game not only increased motivation to learn, but also proved to be a promising educational tool in schools. The language proficiency tests indicated potential effects on language learning and motivation, although the results should be interpreted as signals of feasibility rather than clear evidence of effectiveness.

In this study, we posed two research questions about the impact of the *LingoVerse* VR game on students' motivation and language proficiency. Based on the results of the post-test questionnaire, the students generally reported increased motivation. The collected students' feedback suggests the majority of students found the VR game engaging and motivating, with some reporting that it offered a novel and interactive way of learning compared to traditional methods. In the first session, the proficiency tests also indicated improvements in both groups' German language skills, especially in vocabulary and grammar, areas they interacted with most frequently in the game. Furthermore, in the second experiment, Group 2's proficiency scores significantly improved on the third proficiency test, indicating that continued interaction with the game could yield further language improvement.

6.1 Remaining challenges and limitations of the study

Despite promising results, our research also encountered some limitations. First, the sample size was limited by the availability of equipment, students, and teachers, which is a methodological limitation that affects the statistical power and generalizability of the results. To address this, we used Wilcoxon signed-rank tests, which are well suited for small samples and do not require the assumption of normality. In line with best practices, we report W-values, p-values, mean differences and standard deviations. Although p-values are provided for reference, given the limited sample size, they are primarily for informational purposes and should be interpreted with caution. Instead, statistical significance was determined based on critical W-value thresholds appropriate for our sample size. In addition, due to the very limited number of valid datasets in Group 1 during Session II, these crossover results should be used for illustrative purposes only and should not be interpreted as evidence of systematic effects. Despite these limitations, the observed improvement between Test II.b and II.c ($W = 0$, $p = .016$, $\Delta\mu = 4$, $\sigma = 0.82$) indicates a potentially meaningful effect and supports the feasibility of the approach. Further studies with larger samples and randomized designs are needed to validate and extend these results.

Second, the experimental duration was limited to a one-week lesson, restricting the ability to assess long-term effects. While the findings indicate an improvement in students' academic performance and motivation, they should not be generalized to the entire population or all aspects of language learning. Nevertheless, VR-based interventions integrated into school curricula remain rare, and this study aimed to provide initial feasibility evidence of VR for language learning before considering a semester-long evaluation. Future research is warranted to explore longer-term impacts and adjust for existing limitations found in previous studies on immersive language learning contexts (Dooly et al. 2023; Dobrova et al. 2018).

In addition, several challenges arose during the development of the game. From a technical point of view, the development of a stable prototype that could be used by several non-technical participants at the same time proved to be demanding. The design of the content was also constrained by the students' limited prior knowledge, as their limited vocabulary and grammar made it difficult to include enough material. This was further complicated by the fact that the game has a non-linear structure, requiring more content than is usual in a textbook-based lesson.

To reduce motion sickness in the *LingoVerse* VR game, standard preventive measures were implemented. These included the use of occlusion and a stable horizon to reduce visual disorientation, along with a relatively short total playtime duration of approximately 30 min on average. This aligns with existing research emphasizing the importance of user acclimatization to mitigate discomfort associated with extended VR use (Wu and Suma Rosenberg 2022). Despite these efforts, the presence of motion sickness in some participants suggests that these measures may not have been fully effective. Possible reasons include individual variability in VR tolerance, limited prior exposure to VR environments, and the novelty of the experience for some students, which may have heightened physiological responses. Additionally, the lack of acclimatization sessions beyond the brief introductory session and the tutorial included in the game might have contributed to insufficient adaptation, particularly for those with little gaming experience.

6.2 Future work

To extend this research in the future, it would be useful to involve higher year students as this would allow the use of a wider range of verbs, words and tenses, which would enrich the game and allow testing over an entire semester without the game becoming monotonous. We will also investigate whether the observed effects are due to either the specific VR application, the stimulating environment and gamification, or the increased language practice in general (due to VR use in these experiments), and whether VR learning games have the same effect on people with different levels of prior linguistic knowledge.

Finally, several starting points for further research were uncovered in the course of this study. One of the most desired enhancements was the opportunity to practice speaking. While the version of *LingoVerse* used in this study did not include any AI-based features, the currently released version includes an offline speech-to-text model that works entirely on device and does not transmit any user data externally. It would be valuable to investigate the impact of speech recognition technology on language learning and user experience. By implementing this modality, we could not only track progress in grammar and comprehension, but also improvements in pronunciation and structure. There was also a desire to include a narrative. Therefore, it would be useful to investigate the long-term effects of using VR games for language learning and their sustained effectiveness with the addition of a story in the game. Improvements are also needed in terms of the validity of the results, particularly by increasing the sample size, which would allow for more representative results and better generalization of results across different school years and proficiency levels. In addition, it would be useful to develop and test different didactic methods in VR environments to determine the most effective approaches and to investigate the effects of regular VR use on reducing motion sickness and increasing user comfort. Nevertheless, our research on the use of the developed VR *LingoVerse* game for language learning shows the promising potential of this technology to contribute to learning motivation and increased practice of the target language.

Appendix A German proficiency test I.a

1. Ergänze die richtige Form von *lesen*, *fahren* und *sprechen*.

1. Ich _____ das Buch.
2. Wer _____ heute nach Berlin?
3. Frau Hoffmann, _____ Sie Französisch?
4. Der Lehrer _____ die Essays.
5. _____ ihr mit dem Auto.

2. Ergänze die richtige Form von *haben* oder *sein*.

1. Wer _____ ihr? – Wir _____ Zala und Klemen.
2. Wer _____ er? – Er _____ Dominik.
3. Wir _____ Hunger.
4. Meine Mutter _____ einen neuen Job.
5. Wie _____ das Wetter (=vreme) heute?

3. Ergänze das richtige Fragewort.

1. _____ bist du? – Ich bin Tine.
2. _____ du gerne? – Ich lese gerne.
3. _____ kommst du? – Ich komme aus Slowenien.
4. _____ wohnst du? – Ich wohne in Ljubljana.
5. _____ alt bist du? – Ich bin 18 Jahre alt.

4. Schreibe die Länder.

1. Paris ist die Hauptstadt_____.
2. Madrid ist _____.
3. Moskau ist _____.

5. Rechne und schreibe *die Nummer*.

1. Drei mal dreißig ist ? _____
2. Fünfzehn minus sieben ist? _____
3. Sechzehn mal null ist? _____
4. Neun und acht ist? _____
5. Vierzig durch zwei ist? _____

Appendix B German proficiency test I.b

1. **Ergänze die richtige Form von *lesen*, *fahren* und *sprechen*.**
   1. Wir _____ jeden Tag mit dem Fahrrad zur Schule.
   2. Die Schülerin _____ drei Sprachen.
   3. Die Kinder _____ gerne Kinderbücher.
   4. Wer _____ heute den Text?
   5. _____ ihr auch manchmal mit dem Bus?

2. **Ergänze die richtige Form von *haben* oder *sein*.**
   1. Wer _____ du? – Ich _____ Tina.
   2. Er _____ eine Tochter.
   3. Wer _____ Sie? – Ich bin Frau Müller.
   4. Wer _____ sie? – Sie _____ Petra und Tomaž.
   5. Unser Haus _____ einen Balkon.

3. **Ergänze das richtige Fragewort.**
   1. _____ geht es dir? – Gut, danke. Und dir?
   2. _____ kommt zur Party?
   3. _____ alt ist dein Bruder?
   4. _____ wohnt deine Familie?
   5. _____ kommt deine Tante?

4. **Schreibe die Länder.**

1. Ankara ist die Hauptstadt von _____.
2. Wien ist _____.
3. Berlin ist _____.

5. **Rechne und schreibe *die Nummer*.**
   1. Vier mal fünfzig ist? _____
   2. Siebzehn minus neun ist? _____
   3. Sechzehn mal drei ist? _____
   4. Zweiundvierzig und acht ist? _____
   5. Achtig durch zwei ist? _____

Appendix C German proficiency test II.a

1. Wer ist das? Identifiziere.

1. Der Vater von meinem Vater	
2. Der Mann von meiner Mutter	
3. Die Mutter von meiner Mutter	
4. Der Sohn von meinem Onkel.	
5. Der Bruder von meiner Mutter	
6. Die Frau von meinem Onkel	
7. Die Schwester von meinem Cousin	
8. Die Tochter von meiner Oma.	

2. Ergänze *kein/keine* oder *nicht*.

1. Er hat _____ Haus.
2. Das ist _____ Haus, das ist ein Restaurant.
3. Meine Mutter ist _____ Köchin, aber sie macht guten Kuchen.
4. Heute besuchen wir die Oma _____.
5. Meine Freundin hat _____ Geschwister.
6. Er hat _____ Idee.
7. Das sind _____ meine Freunde. Das sind die Freunde von Eva.

3. Benenne die Haustiere. Schreibe ganze Sätze. z. B. *»Das ist ein/eine…«*



4. Benenne die Schulsachen. Schreibe ganze Sätze. z. B. *»Das ist ein/eine…«.*





5. Konjugiere das Verb »*essen*«.

1. Was _____ du gern zum Frühstück? – Ich _____ gern Brot mit Marmelade.
2. Was _____ sie gern zu Mittag? – Wir _____ normalerweise Schnitzel.
3. Was _____ ihr gern zu Abend? Maja _____ sicher gerne Salat.

Appendix D German proficiency test II.b

1. Wer ist das? Identifiziere.

1. Die Mutter von meinem Vater.	
2. Die Frau von meinem Vater.	
3. Der Vater von meinem Vater.	
4. Die Tochter von meinem Onkel.	
5. Die Schwester von meiner Mutter.	
6. Der Mann von meiner Tante.	
7. Der Bruder von meinem Cousin.	
8. Der Sohn von meiner Oma.	

2. Ergänze *kein/keine* oder *nicht*.

1. Wir machen _____ Vorbereitung.
2. Er tanzt _____.
3. Sie haben _____ Ahnung.
4. Das ist doch _____ Party.
5. Das ist _____ Familienfeier.
6. Die Party dauert _____ so lange.
7. Den Kuchen haben wir _____.

3. Benenne die Haustiere. Schreibe ganze Sätze z. B. *»Das ist ein/eine…«*



4. Benenne die Schulsachen. Schreibe ganze Sätze. z. B. *»Das ist ein/eine…«.*





5. Konjugiere das Verb »*essen*«.

1. Was _____ dein Vater gern? – Er _____ gern vegetarisch.
2. Was _____ deine Kinder gern? – Sie _____ gern Schokolade.
3. Was _____ Sie gerne Brot, Frau Müller? – Nein, Brot _____ ich nicht gern.

Appendix E German proficiency test II.c

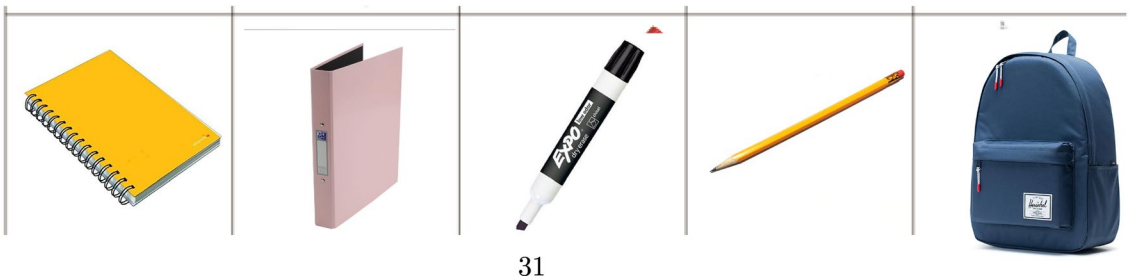
1. **Wer ist das? Identifiziere.**

1. Der Sohn von meinem Opa.	
2. Die Tante von meinem Cousin.	
3. Der Opa von meinem Bruder.	
4. Die Tochter von meiner Tante.	
5. Die Schwester von meiner Mutter.	
6. Der Mann von meiner Oma.	
7. Der Bruder von meinem Onkel.	
8. Die Tochter von meiner Mutter.	

2. **Ergänze *kein/keine* oder *nicht*.**
   1. Wir gehen _____ ins Kino.
   2. Er schwimmt _____.
   3. Ihr seid _____ Lehrer.
   4. Das ist wirklich _____ Stuhl.
   5. Das ist _____ Katze.
   6. Er kommt _____ nach slowenien
   7. Morgen trifft er den Opa _____.
3. **Benenne die Haustiere. Schreibe ganze Sätze z. B. *»Das ist ein/eine…«***



4. **Benenne die Schulsachen. Schreibe ganze Sätze. z. B. *»Das ist ein/eine…«.***



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5. **Konjugiere das Verb »*essen*«.**
   1. Was _____ er gern zum Abendessen? – Er _____ gern Obst.
   2. Was _____ deine Tocther gern? – Sie _____ gern Schokolade.
   3. Was _____ Sie montags? – Wir _____ Kekse.

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Declarations

Conflict of interest The authors declare no Conflict of interest.

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