A VIRTUAL REALITY ASSISTED LANGUAGE AND CULTURE LEARNING APPLICATION

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I certify that in my opinion the thesis submitted by Mert CRUMPTON titled "A VIRTUAL REALITY ASSISTED LANGUAGE AND CULTURE LEARNING APPLICATION" is fully adequate in scope and in quality as a thesis for the degree of Master of Science.

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Mert CRUMPTON

ABSTRACT

Master Thesis

A VIRTUAL REALITY ASSISTED LANGUAGE AND CULTURE LEARNING APPLICATION

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Institute of Engineering
Department of Computer Engineering

Thesis Advisor:
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In this study, a virtual reality (VR) application is created, using the unique advantages of virtual reality technology, such as immersive experiences and interactive object manipulation, to create an innovative language and culture learning environment focused to Turkish language, using Experiential Learning Method. A flashcard game is designed for vocabulary practice, along with a Generative Conversational AI based realistic Metahuman, to enhance the VR experience. A virtual classroom environment is designed to mimic the ambiance of a real classroom, providing learners with a familiar and conducive learning space, enhancing their focus and engagement with the learning material. The AI based Metahuman that resembles a Turkish teacher is designed with high realism and can interact with users in a natural and lifelike manner. The use of a Metahuman adds a personal touch to the learning experience, simulating the presence of an actual instructor and thereby enriching the educational interaction. Generative conversational AI enables the Metahuman teacher to engage in dynamic and responsive dialogues with learners. This AI-driven interaction allows for a more personalized learning experience, as the virtual teacher can adapt conversations and feedback to the individual needs and responses of each user. The generative AI aspect ensures that the conversations are not just scripted interactions but are instead evolving and contextually relevant, closely mimicking a real-life language learning scenario. An experiment was conducted among 12 foreign users, comparing the same settings in both VR and classical desktop setup and users preferred VR over desktop. Citing that flash card game was more memorable and interactable than desktop setup, and the classroom environment with a virtual assistant helped to increase their motivation.

Key Word : Virtual Reality, Virtual Reality Assisted Language Education, Human-Computer Interaction.

Science Code : 92425

ÖZET

Yüksek Lisans Tezi

SANAL GERÇEKLİK DESTEKLİ DİL VE KÜLTÜR ÖĞRENİMİ UYGULAMASI

Mert CRUMPTON

Karabük Üniversitesi
Lisansüstü Eğitim Enstitüsü
Bilgisayar Mühendisliği Anabilim Dalı

Tez Danışmanı:
Dr. Öğr. Üyesi Kasım ÖZACAR
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Bu çalışmada, sanal gerçeklik teknolojisinin tam dalış sürükleyiciliği ve etkileşimli nesne manipülasyonu gibi özelliklerinden yararlanılarak bir sanal gerçeklik uygulaması geliştirilmiştir. Uygulamada Deneyimsel Öğrenme Yöntemi (Experiential Learning Theory) kullanılarak Türkçe diline ve kültürüne odaklı bir öğrenme ortamı oluşturulmuştur. Nesne manipülasyonu için bir flaş kart oyunu, tam dalış sürükleyiciliğini arttırmak için ise bir sınıf ortamı ve Üretken Konuşkan Yapay Zeka'ya (Generative Conversaitonal AI) sahip bir sanal asistan eklenmiştir. Sanal sınıf ortamı, gerçek sınıfın ortamını taklit etmek, öğrencilere tanıdık ve elverişli bir öğrenme alanı sağlamak, odaklarını ve öğrenme materyaliyle etkileşimlerini geliştirmek için tasarlanmıştır. Türkçe öğretmeni şeklinde eğitilmiş yapay zeka tabanlı Metahuman (Gerçekçi İnsan Modeli), gerçekçi grafiklere sahiptir ve kullanıcılarla doğal ve gerçekçi bir şekilde etkileşime girebilir. Kelime öğrenimi odaklı flaş kart oyununda ise nesne manipülasyonu ile kartların masaüstü uygulamaların aksine 3 boyutlu şekilde tutulup döndürülebilmesi sağlanarak sanal gerçekliğin avantajlarından faydalanılmıştır. Uygulama, 12 yabancı kullanıcı ile test edilmiştir. Sonuçlar kullanıcıların sanal gerçekliği masaüstü uygulamalarına tercih ettiğini, flaş kart kelime oyununun sanal gerçeklik versiyonunun masaüstü versiyonuna göre daha akılda kalıcı ve ilgi çekici olduğunu, oluşturulan ortamın ve akıllı asistanın öğrenme motivasyonlarını arttırdığını belirtmiştir.

Anahtar Sözcükler : Sanal Gerçeklik, Sanal Gerçeklik Destekli Dil Öğrenimi, İnsan-Bilgisayar Etkileşimleri

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ABBREVIATION SECTION

VR	: Virtual Reality (Sanal Gerçeklik)
AR	: Augmented Reality (Arttırılmış Gerçeklik)
HMD	: Head Mounted Display (Başa Takılan Ekran, Sanal Gerçeklik Gözlüğü)
2D	: 2 Dimensional (2 Boyutlu)
3D	: 3 Dimensional (3 Boyutlu)

PART 1

INTRODUCTION

With the COVID-19 global pandemic, the use of online educational applications has increased. Remote teaching has become more popular, along with new approaches and technologies. One of this technology is Virtual Reality. With virtual reality, users not only reach online access to classes, but also reach an interactive object manipulation.

In this thesis, a virtual reality (VR) application is created, using the unique advantages of virtual reality technology, such as immersive experiences and interactive object manipulation, to create an innovative language and culture learning environment focused to Turkish language, using Experiential Learning Method. A flashcard game is designed for vocabulary practice, along with a Generative Conversational AI backed realistic Metahuman, to enhance the VR experience. The flashcard game is selected based on an interview with an expert and a second language teacher, Alkiviadis [1].

A virtual classroom environment is designed to mimic the ambiance of a real classroom, providing learners with a familiar and conducive learning space, enhancing their focus and engagement with the learning material. The AI based Metahuman that resembles a Turkish teacher is designed with high realism and can interact with users in a natural and lifelike manner. The use of a Metahuman adds a personal touch to the learning experience, simulating the presence of an actual instructor and thereby enriching the educational interaction. Generative conversational AI is enabling the Metahuman teacher to engage in dynamic and responsive dialogues with learners. This AI-driven interaction allows for a more personalized learning experience, as the virtual teacher can adapt conversations and feedback to the individual needs and responses of each user. The generative AI aspect ensures that the conversations are not just scripted interactions but are instead evolving and contextually relevant, closely mimicking a real-life language learning scenario. An experiment was conducted among 12 foreign users, comparing the same settings in both VR and classical desktop setup, and mostly the VR setup preferred over desktop setup.

To sum up, this thesis represents a novel approach to Turkish language and culture learning, combining advanced technologies like VR, Metahumans, and conversational AI to create an immersive, interactive, and personalized educational experience. Using the key elements of VR for vocabulary practice through a flashcard game within a virtual classroom, guided by an AI-powered teacher, demonstrates the potential of technology to transform traditional learning methods and offer more engaging and effective educational tools.

1.1. RESEARCH QUESTIONS

This study investigates the use of VR in Turkish language and culture learning by using Experiential Learning Theory in an immersive and interactive environment with a support of an AI assistant and compares the VR setup with a desktop setup.

Research Question 1: What impact Virtual Reality have for a Turkish Language Learning application?

Research Question 2: What is the user experience differences between VR and a desktop setup for Turkish Language Learning?

1.2. METHODOLOGY

The study is based on 3 steps. In the first step, a VR application is developed based on Experiential Learning Theory in a specific VR setting. A flashcard game with 10 cards in a classroom environment with an AI assistant. In the second step, 12 foreign users tested the VR application in both VR and desktop settings. Users with a Turkish knowledge of less or equal than 5 out of 10 and with no health issues or fear issues are selected. Before testing, users answered a questionnaire, and an instruction were given to those first-time users in Virtual Reality. In the third step, users answered a second questionnaire about their experience of the application. These answers vary between 1 to 5 and 1 to 10, 5 and 10 being the strongest opinion.

PART 2

LITERATURE REVIEW

Virtual reality provides solutions in many areas. Overcoming fears such as the fear of hight, and other fears in the healthcare field, fear of speaking in front of crowd, fear of insects/animals such as fear of spiders, and panic situations can be supported by virtual reality technology [2, 3].

In the field of education, virtual reality remains its usefullness. There are applications that increase motivation and interaction, especially in simulation and STEM applications. [4] The use of new technologies in the field of education is a factor that increases the effectiveness of education. There is an example that is an improved version of writing as an interaction method in virtual reality [5].

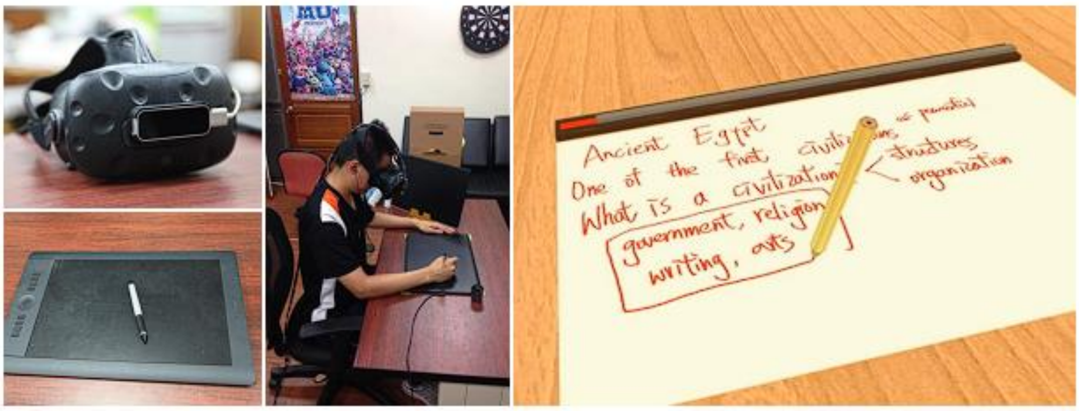

Figure 2.1. iVRNote Taking notes in VR for education [5].

This efficiency obtained when the features of the new technology are applied correctly to the educational field varies according to the style, application method and purpose of the technology, its usefulness and sustainability [6]. In an example where virtual reality technology is applied in the field of history education, 76.5% of the students stated that they understood the subject better [7].

Another solution for language education is the use of 360-degree videos and Figures in virtual reality. Since visuality and interaction are effective in language education, 360-degree videos and pictures can also provide a solution to this problem [8]. Interactive technologies are used in language education. Therefore, virtual reality technology contributes to language education [9].

The use of virtual reality is increasing among non-native users who have not learned that language before, but progress in the field is limited yet, as it is more complex to be designed by the teacher than other methods. Language learning, which takes place in authentic-real-life environments created in this virtual reality environment, can offer different solutions to the problem of language education [10].

Although many people want to learn a new foreign language, it is not always easy for them to find the necessary motivation to realize these desires. To provide these motivations, different tools, fun interactions, and techniques can usually be used. Another example of full diving language training in virtual reality is by seeing the names of objects and changing their locations with dot representation for the Spanish language, which increased the recognition of objects with a foreign name [11].

Figure 2.2. Point view learning in VR, in spanish language [11].

Along with language learning, virtual reality can also be used in culture learning. An application example for culture based virtual reality learning has been conducted, developed a full immersion application for culture and language education in virtual reality [12], they have supported language education with speech bubbles, as well as cultural movements such as expressions of respect with the physical movements of avatars.

Figure 2.3. Bowing while saying hello (konnichiha) in japanese culture [12].

Also, there are studies comparing different environments, like 2D, 3D, Virtual Reality, Desktop. In a study, participants preferred Virtual Reality simulations over 2D systems [13]. In another study in medical field held with 56 participants, virtual reality is generally better compared to desktop tasks [14]. Although, in such applications like Puzzle Games, temporal demand scores are not that noticeable [15]. A similar study using flashcards for vocabulary learning is used not in VR with HMD's, but used with AR using mobile phones as the main device, in early childhood education [16]. Also, a recent study was conducted comparing 2D videos to 3D HMD's [17].

SECTION 3

VIRTUAL REALITY IN LANGUAGE AND CULTURE LEARNING

3.1. A BRIEF INTRODUCTION TO VIRTUAL REALITY

Virtual Reality (VR) is an immersive technology that transports users into a fully digital environment, simulating a sense of presence in a virtual world. Unlike traditional desktop programs that are confined to a 2D screen, VR encompasses a 3D space, offering a 360-degree sensory experience. This is achieved through a combination of hardware and software, including VR headsets, motion tracking devices, and interactive applications or games.

Figure 3.1. A virtual reality headset by Meta, Quest 2

To use VR, a user typically wears a VR headset, which is a device equipped with a screen, lenses, and various sensors. These headsets track the user's head movements and adjust the visual display accordingly, creating a convincing illusion of being in a different space. Most VR systems also include hand controllers, which track hand movements and gestures, allowing users to interact with the virtual environment in a natural and intuitive way.

The difference between VR and desktop programs lies primarily in the level of immersion and interaction. While desktop programs are limited to keyboard, mouse, or touch input, VR allows users to physically move around and interact with the virtual environment. This makes VR uniquely suited for applications like gaming, training simulations, and virtual tours, where being "inside" the experience adds good value. In gaming, VR takes interactivity to a new level. Players can physically duck, dodge, and aim, making the experience more engaging and realistic. For example, in a VR shooting game, players can crouch behind virtual cover and peek out to aim, rather than just pressing a button.

VR also has usefull applications in training and education. Medical students can practice surgeries in a risk-free virtual environment, gaining experience without any consequences to real patients. Similarly, pilots can use VR for flight simulation training, where they can practice in various scenarios and weather conditions. Moreover, VR can be used for virtual tours, allowing users to explore places like museums, historical sites, or even distant planets without leaving their homes. This has educational benefits, making learning more interactive and accessible. Another key difference between VR and desktop programs is the level of detail and realism that can be achieved. VR environments can be incredibly detailed and realistic, making them ideal for architectural visualizations and interior design. Architects can create virtual models of buildings, allowing clients to "walk through" a structure before it's built.

VR also offers unique opportunities in the field of mental health. Therapists use VR for exposure therapy, helping patients confront and overcome phobias in a controlled, safe environment. For example, someone with a fear of heights might gradually be exposed to virtual high places. The entertainment industry has also embraced VR, using it for immersive movies and concerts. Users can feel like they're part of the action, experiencing events from different angles and perspectives that wouldn't be possible with traditional media. However, VR technology is not without its challenges. One issue is the potential for motion sickness, which can occur when there's a disconnect between what the user sees and what they feel. VR developers are continually working to reduce this problem by improving motion tracking and display technology. VR technology has been becoming more affordable and widespread, but it still requires an investment in hardware. High-quality VR experiences often need powerful computers or gaming consoles, which can be a barrier for some users.

The field of virtual reality (VR) has seen considerable advancements and diversified applications in recent years. One of the key areas in VR is collaborative learning (VRCL). In the context of collaborative learning, VR has emerged as a critical tool, especially in the wake of the COVID-19 pandemic which accelerated the adoption of remote collaboration and distance learning. VR in collaborative learning (VRCL) focuses on how VR supports and enhances learning experiences. This includes examining the skills and competences that can be trained using VRCL, the domains and disciplines it addresses, the systems developed for VRCL, and the empirical knowledge established through various methods and study designs. The research in this area aims to understand VRCL's usage in different educational fields, its affordances and benefits for education, and the characteristics that allow these benefits to be realized. This area is still developing, with a need for more comprehensive studies to fully understand VR's potential in collaborative learning.

There is a close technology called Augmented Reality (AR). AR is an interactive experience that superimposes computer-generated enhancements atop an existing reality, aiming to make it more meaningful through the ability to interact with it. Unlike Virtual Reality (VR), which creates a totally artificial environment, AR uses the existing environment and overlays new information on top of it. AR can be experienced through a variety of devices including smartphones, tablets, and specialized AR glasses. It blends digital components into the real world, enhancing but not replacing reality. The difference between AR and VR is significant; while VR immerses users in a fully artificial digital environment, AR overlays virtual information onto the physical world, augmenting it rather than replacing it. In terms of use cases, AR is utilized across various sectors. In retail, for example, AR can help customers visualize how furniture might look in their home before purchasing. In education, AR can bring textbooks to life, allowing students to visualize and interact with the subject matter. In the medical field, AR can provide surgeons with real-time, inside-the-body information during procedures or training. In gaming, AR offers a more immersive experience, blending the user's environment with the game. In tourism, AR can enhance the visitor experience by providing interactive and informative overlays to historical sites. Maintenance and repair are other areas where AR can guide users through complex processes, overlaying instructions directly onto the equipment being serviced. Furthermore, AR is employed in navigation systems, providing real-time, overlaid directions on the road or within buildings. In architecture and design, it allows professionals to visualize changes and additions to existing structures. For the visually impaired, AR can augment reality with additional information to aid in navigation and understanding of their surroundings. In art and exhibitions, AR can provide additional layers of interaction and information to the audience. In advertising, it offers engaging and interactive experiences that grab the attention of potential customers. The potential of AR is vast and still largely untapped, with ongoing advancements in technology expanding its capabilities and applications. As AR devices become more prevalent and user-friendly, the integration of digital information with the real world will become more seamless, enhancing everyday experiences, and opening new possibilities in various fields. Despite its current limitations in terms of technology and adoption, the future of AR is promising, with the potential to transform how we interact with the world and each other. The blending of the digital and physical realms through AR represents a significant step in the evolution of technology and its application in our daily lives. As AR continues to evolve, it will likely become an integral part of various industries, revolutionizing the way we work, learn, shop, and interact with our surroundings.

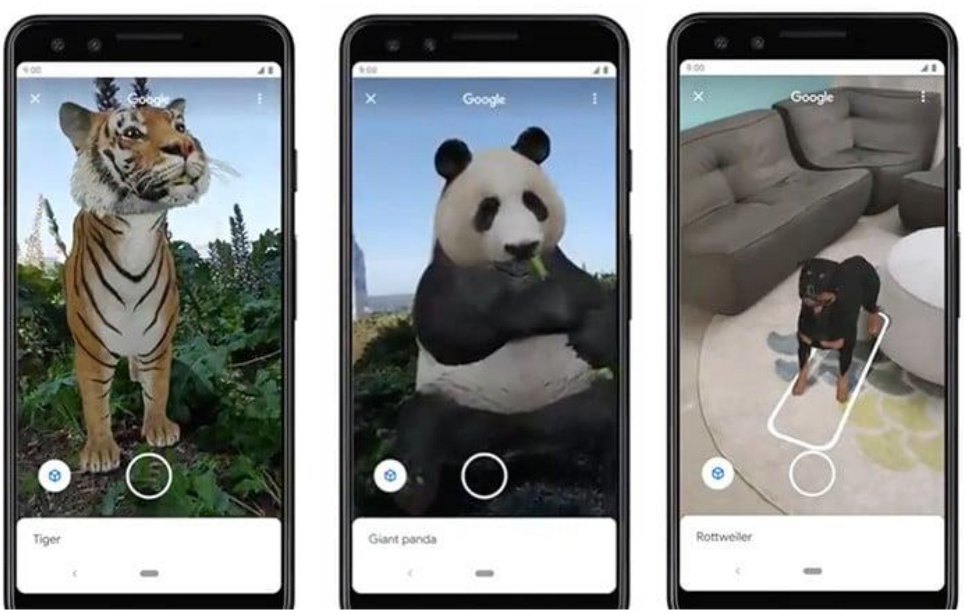

Figure 3.2. An AR example from Google

3.2. VIRTUAL REALITY APPLICATIONS IN LANGUAGE LEARNING

Virtual Reality (VR) in language learning represents a groundbreaking shift from traditional learning methods, offering immersive and contextual experiences that significantly enhance both the engagement and effectiveness of acquiring a new language. By simulating real-world environments and interactions, VR creates a sense of presence and immersion that traditional classroom settings or online platforms struggle to achieve. This immersive experience is crucial in language learning, as it closely mimics the natural way languages are learned and used in everyday life.

In a VR environment, learners can virtually visit places where the target language is spoken and engage in realistic conversations with virtual characters. This context-rich exposure is vital for understanding not just the language itself but also the cultural and social nuances that accompany it. For instance, learners can practice ordering food in a virtual café in Paris or negotiate in a simulated business meeting in Tokyo. These scenarios provide a safe space for learners to practice and build confidence, free from the fear of real-life embarrassment or consequences.

The interactive nature of VR also allows for immediate feedback, an essential component of effective learning. Learners can receive corrections and suggestions in real-time, enabling them to improve and adjust their language use on the spot. This immediate feedback loop accelerates the learning process and helps solidify the correct use of language. VR can be tailored to cater to individual learning styles and needs. Whether a learner benefit more from visual, auditory, or kinesthetic experiences, VR applications can provide suitable environments and activities. Customization extends to the pace and difficulty of the language learning experience, allowing learners to progress at their own pace and gradually build up their language proficiency. The immersive experience of VR also fosters empathy and cultural understanding. By virtually stepping into a different culture, learners gain a deeper appreciation of the context in which the language is used. This cultural immersion is a critical aspect of language learning, as understanding the cultural background and nuances of a language leads to more effective and respectful communication.

VR technology is becoming increasingly more accessible and affordable. This democratization of technology means that more language learners can benefit from these immersive experiences. Educational institutions and language learning platforms are beginning to incorporate VR into their curricula, recognizing its potential to enhance learning outcomes. However, the integration of VR into language learning also presents challenges. The development of high-quality, educational VR content requires significant resources and expertise. There's also the consideration of ensuring the content is pedagogically sound and aligns with language learning objectives. Additionally, while technology is becoming more accessible, there's still a need for widespread adoption and acceptance in educational settings.

3.3. 360 DEGREE VISUALS

360-degree videos represent a significant innovation in digital media, offering an immersive experience that vastly surpasses what traditional videos can provide. These videos capture every angle of a scene simultaneously, allowing viewers to look around in every direction as if they were physically there. This immersive capability is achieved through cameras that record all 360 degrees of the environment, capturing every perspective in one shot. Users can interact with the video by panning and rotating their view, exploring the scene from various angles, and gaining a comprehensive understanding of the content. The application of 360-degree videos is incredibly diverse, spanning entertainment, education, real estate, tourism, and more. In entertainment, they place viewers at the heart of the action, whether in a movie, a concert, or a sports game. For educational purposes, they transport students to historical sites or natural wonders, offering an experiential learning experience that enhances engagement and retention. In real estate, 360-degree videos enable potential buyers to take virtual tours of properties, examining every room and detail conveniently. Similarly, in tourism, they allow people to experience destinations and attractions virtually, an invaluable tool for those unable to travel. 360-degree videos also revolutionize storytelling, providing creators with a novel way to convey narratives and evoke emotions. They transform viewers into active participants, giving them the freedom to explore the video's environment and craft a personal and impactful experience through their choices of where to look and what to focus on. This technology is especially beneficial in professional training and simulation, such as medical training where it can simulate surgical procedures, or emergency response training where it immerses trainees in simulated crisis situations. However, the production and consumption of 360-degree videos present certain challenges. Creating high-quality content requires specialized equipment and software, along with a thoughtful approach to direction and storytelling due to the viewer's ability to look anywhere at any time. While these videos can be viewed on standard screens, the most immersive experience is through virtual reality (VR) headsets, which may not be accessible to everyone. Despite these challenges, the potential and interest in 360-degree videos continue to grow, driven by advancements in technology that make it easier and more affordable to produce and view this content. As virtual reality becomes more mainstream and the technology behind 360-degree videos improves, we can expect an expansion in their innovative and immersive applications, fundamentally changing how we consume content and perceive digital storytelling and immersive experiences.

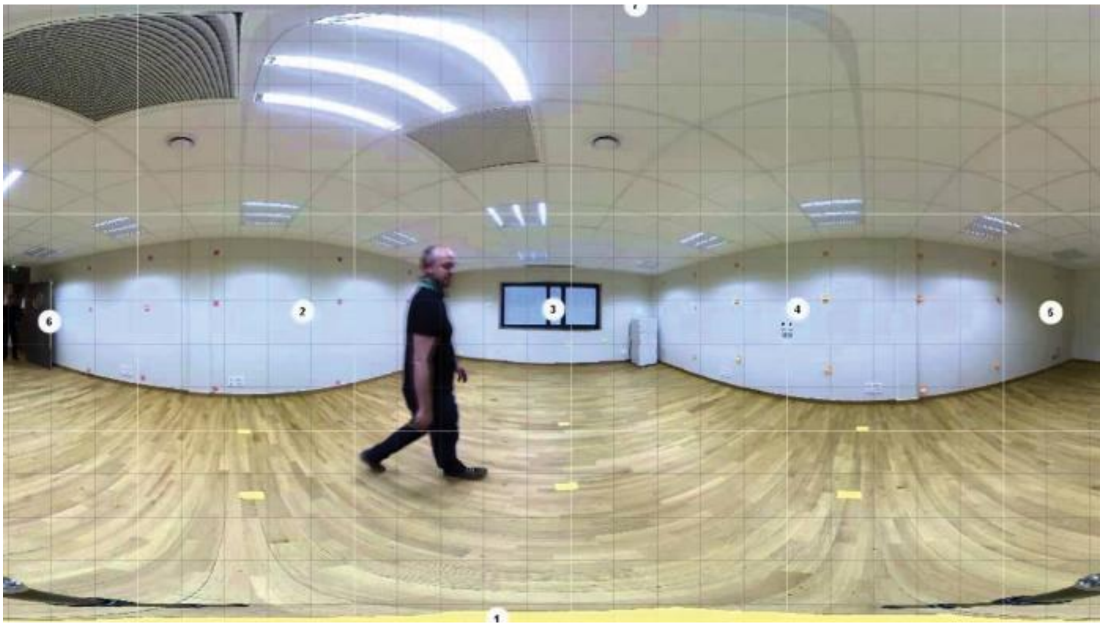

Figure 3.3. 360 Degree video example [18].

360-degree language learnings in Virtual Reality (VR) are one of the most used applications in the field of language education. These applications leverage the immersive and interactive capabilities of VR to create a learning environment that closely mimics real-world experiences, facilitating more natural and effective language acquisition. In a 360-degree VR application, learners are typically placed in a virtual environment that simulates real-life scenarios relevant to the language being learned. For example, a learner studying French might find themselves virtually transported to a café in Paris. Here, they can interact with digital avatars or pre-recorded actors, engaging in conversations, ordering food, or asking for directions. This immersive experience not only aids in understanding the language in its cultural context but also helps in developing practical conversational skills.

One of the popular 360 Degree VR language learning applications is ImmerseMe. It has conversation UI with real 360-degree videos and images.

The interactivity in these applications is a crucial element. Users can select objects, engage in dialogue with characters, and make choices that influence the course of their experience. This active participation ensures that learners are not just passive recipients of information but are actively using the language in context, which is key to language retention and fluency. 360-degree VR application can simulate real-life interactions without the logistical constraints and costs of actual travel. Learners can practice speaking and listening skills in a variety of settings – from a busy street to a business meeting – gaining exposure to different dialects, accents, and cultural nuances. Furthermore, these applications often employ speech recognition technology, allowing learners to receive immediate feedback on their pronunciation and conversational skills. This instant feedback loop is invaluable for language learning, as it helps users to quickly correct mistakes and improve their verbal communication skills [19].

Another important aspect is the emotional engagement and motivation that VR environments can provide. Learning in a dynamic, visually rich virtual world is often more engaging and less intimidating than traditional classroom settings. This can lead to increased motivation and a greater willingness to practice and experiment with the language. Additionally, VR language learning applications can be tailored to individual learning styles and proficiency levels. Adaptive learning algorithms can adjust the difficulty of conversations and tasks based on the learner's performance, ensuring that the content remains challenging yet achievable. Social interaction is also a key feature of many VR language learning applications. Learners can interact with other users in the virtual space, practicing language skills in group conversations or cooperative tasks. This social aspect not only makes learning more enjoyable but also mirrors the way languages are naturally learned and used in everyday life.

Although, access to VR technology can be a barrier for some learners, and the experience can vary greatly depending on the quality of the hardware and software. Additionally, the immersive nature of VR can be overwhelming for some users, and there are considerations around motion sickness and user comfort that need to be addressed.

3.4. FULLY IMMERSIVE APPLICATIONS

For language learning, VR also has fully immersive language learning applications. One of that is MondlyVR. Unlike ImmerseMe, MondlyVR is a fully immersive language learning application [20,21].

Figure 3.4. Mondly VR (left) and ImmerseMe(right) [22].

Mondly VR is a virtual reality application developed by the language learning platform Mondly. It's designed to immerse users in various real-life scenarios to practice and improve their language skills using virtual reality technology. By leveraging the power of VR, Mondly VR aims to provide a more interactive and engaging way to learn a new language compared to traditional learning methods.

In Mondly VR, users can engage in conversations with virtual characters, practicing their speaking and listening skills in realistic simulations. The scenarios can range from ordering food in a restaurant to checking in at a hotel, providing practical language experience that mimics real-life interactions. This hands-on approach helps learners to become more comfortable and confident in using a new language in everyday situations.

The app utilizes speech recognition technology to provide instant feedback on pronunciation, helping users to improve their speaking skills as they interact within the virtual environment. This immediate response is crucial for correcting mistakes early and reinforcing correct pronunciation. Mondly VR typically offers a variety of languages to learn, making it a versatile tool for users with different language learning goals. It's designed to be user-friendly, catering to both beginners and more advanced learners who want to refine their language skills further. The appeal of Mondly VR lies in its ability to make language learning more dynamic and engaging. By immersing learners in a VR world where they can actively use and practice the language, it seeks to accelerate learning and increase retention. The immersive experience also helps in understanding the cultural context of the language, providing learners with a more holistic approach to language learning.

As with many VR applications, the effectiveness of Mondly VR can depend on the user's access to VR hardware and their comfort with using such technology. However, for those who have access and are eager to try a new way of learning, Mondly VR offers an innovative and interactive approach to language acquisition. Fully immersive applications immerse users in the target language through various contextual and interactive scenarios, enhancing cognitive connections and practical understanding. Such immersion accelerates language acquisition by providing continuous exposure to the language in diverse contexts, ensuring that learning is not just about memorizing vocabulary but also about understanding cultural nuances and real-life usage. This method promotes active thinking in the new language, improving fluency and confidence. The use of technology in immersive applications also allows for personalized learning experiences, adapting to the user's progress and learning style, which can increase motivation and retention rates. Overall, fully immersive language learning applications offer a dynamic, effective, and engaging way to learn a new language, making the process more natural and enjoyable.

On the other hand, ImmerseMe is an innovative language learning platform that uses virtual reality to create immersive scenarios for users to practice and enhance their language skills. The platform places users in interactive real-world situations, such as ordering food in a restaurant, asking for directions, or engaging in a business meeting, all set within a variety of global locations. This not only allows for language practice but also offers cultural immersion. It supports multiple languages, including widely spoken ones like English, Spanish, French, German, and Chinese, catering to a diverse range of learners. What sets immerseMe apart is its use of VR technology, which provides a 360-degree environment for a fully immersive learning experience. When users use a VR headset, they are transported into scenarios that mimic being in a country where the language is spoken, enhancing the learning process by providing realistic context and encouraging quicker, more intuitive language acquisition. The platform incorporates speech recognition technology to give immediate feedback on users' pronunciation and spoken language, aiding in faster improvement. This feature is particularly beneficial as it allows learners to correct their mistakes in real time. immerseMe is not just for individual learners but is also frequently used by educational institutions to supplement traditional language learning curriculums. Its interactive nature makes learning more exciting and effective, promoting regular practice and deeper engagement.

ImmerseMe leverages the power of VR to make language learning more interactive, engaging, and contextual, aiming to boost users' confidence and proficiency in practical, everyday language use. Whether as part of an educational program or for personal enrichment, immerseMe offers a unique, immersive way to learn and practice a new language.

PART 4

DEVELOPMENT OF TURKISH LANGUAGE LEARNING APPLICATION

4.1. EXPERIENTIAL LEARNING THEORY

Experiential Learning Theory is one of the major learning theories in education. It’s based on learning by doing experience [23]. Since Virtual Reality has high-level interactivity oppurtinities, it fits Virtual Reality applications very well. In 2D systems or 3D desktop systems, interactivity is limited. For flashcard game example, in desktop settings you can only click or hold the card, but in Virtual Reality you can turn the card, this turning interactivity makes the game more realistic than 2D or 3D desktop systems.

Experiential Learning Theory (ELT) is a dynamic theoretical framework that posits learning as a process where knowledge is created through the transformation of experience. This theory emphasizes the central role that experience plays in the learning process. Effective learning is seen when a person progresses through a cycle of four stages: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). This cycle suggests that learning can begin at any one of these points and that for optimal learning, one must cycle through all stages.

Concrete Experience refers to having a direct, hands-on experience. It's about being involved in a new situation or facing a new problem. For instance, a medical student interacting with a patient for the first time is engaging in a concrete experience. Reflective Observation involves stepping back from the experience to reflect and observe. Here, the learner considers the experience from various perspectives, analyzing and reflecting on their feelings and reactions. For example, after the consultation, the medical student might reflect on the interaction, considering how it felt, what went well, and what could be improved.

Abstract Conceptualization is where the learner forms new ideas or modifies existing abstract concepts based on the reflections. They integrate their observations into logical sound theories. The medical student might learn from their reflection and readings that building rapport is crucial for effective patient communication. Finally, Active Experimentation involves the learner applying their ideas to the world around them to see what happens, thus creating new experiences. The medical student, for instance, might try different techniques in future patient interactions to establish better experience.

4.2. DEVELOPING THE APPLICATON

4.2.1. Unreal Engine and Blueprint Visual Scripting System

Unreal Engine, developed by Epic Games, is a widely used and powerful game engine that facilitates the creation of video games, simulations, and other interactive experiences. It's known for its high-fidelity graphics, robust toolset, and versatility across platforms, including PC, consoles, mobile devices, and VR/AR systems. Unreal Engine has been a game-changer in the industry, empowering developers to bring their visions to life with stunning visual quality and detailed environments.

One of the key features of Unreal Engine is its Blueprint Visual Scripting system, an innovative approach to game programming. Blueprints provide a user-friendly, node-based interface that allows developers and designers to create complex game logic without the need for traditional coding. Developers can directly program it via C++ in Visual Studio, in specific scenarios.

In practice, the Blueprint system allows developers to "drag-and-drop" various elements and define their behaviors through visual scripts. For example, a game designer could use Blueprints to create a door that opens automatically when a player approaches. They would do this by creating a "trigger volume" around the door and then defining the actions (open/close) that occur when the player enters or exits this volume. Most of this can be done visually.

Another example could be the implementation of a day-night cycle in a game. With Blueprints, a developer can set up a system where the in-game lighting and sky appearance change based on the game's internal clock, simulating the passage of time. They could further enhance this by adding environmental effects like dynamic shadows or changing weather conditions, all controlled through the Blueprint system.

Blueprints are not just limited to simple interactions; they can be used for complex gameplay mechanics as well. For instance, in a role-playing game, a developer could use Blueprints to set up a character leveling system, where players gain experience points, level up, and unlock new abilities or attributes. This could involve tracking player actions, calculating experience points, and updating the character's stats, all orchestrated within the Blueprint interface.

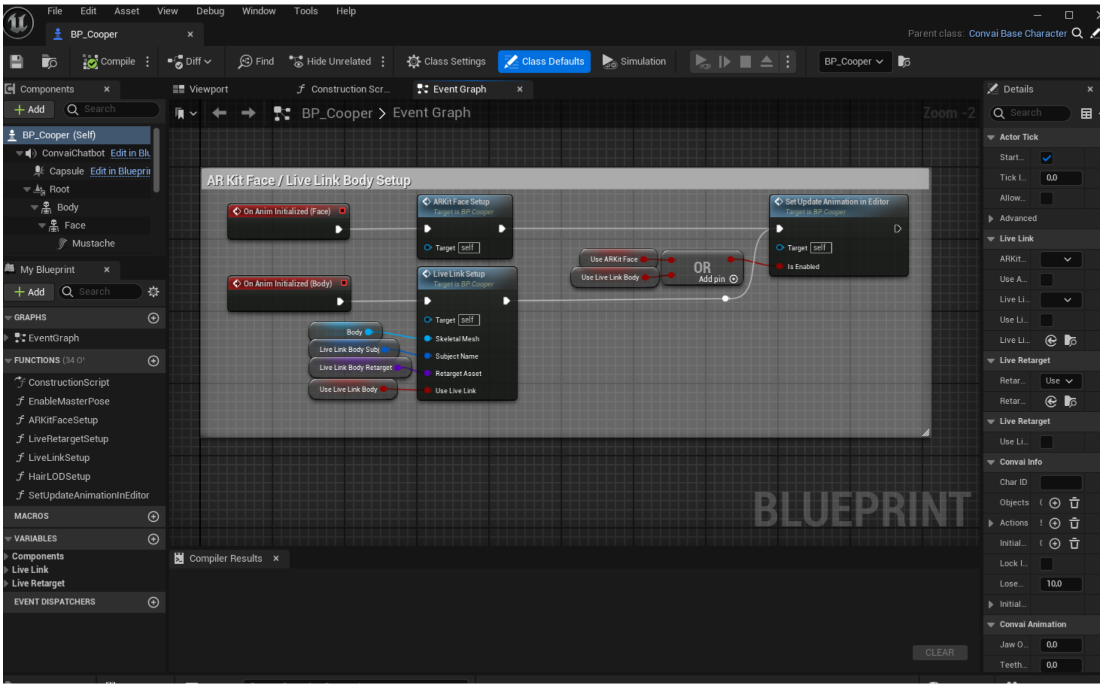

Figure 4.1. Inside a blueprint

The versatility of the Blueprint system extends to AI programming as well. Developers can use it to script the behavior of non-player characters (NPCs), from basic movements like patrolling a set path, to more complex behaviors like responding to player actions, engaging in combat, or making decisions based on the game's state.

4.2.2. Realistic Avatars: Metahumans

"Metahuman" is a term often used in the context of digital technology and artificial intelligence to describe highly realistic, digitally created human characters. These characters are typically generated through advanced computer graphics, AI, and motion capture technologies. They are increasingly popular in various fields such as gaming, film production, virtual reality (VR), and augmented reality (AR). They are designed to look and move like real humans, with detailed facial features and naturalistic body movements. This realism is achieved through sophisticated rendering techniques, detailed texturing, and advanced animation algorithms.

These digital humans can be customized to a high degree, allowing creators to alter their appearance, clothing, and even facial expressions. This versatility makes them suitable for a wide range of applications, from storytelling in movies and video games to virtual assistants in customer service. Also, Metahumans often utilize motion capture technology, where the movements of real actors are captured and translated onto the digital character. This process ensures that the movements and expressions of the Metahuman are lifelike and believable.

In VR and AR experiences, Metahumans can be programmed to interact with users in real-time, responding to user input with natural movements and dialogue. This enhances the immersive experience of virtual environments. Metahumans can represent a diverse range of human appearances and abilities, promoting inclusivity in media representation. They can be designed to embody any age, race, gender, or physical condition, allowing for stories and experiences that are more reflective of the real world.

In educational settings, Metahumans can be used for interactive learning experiences, simulating real-life scenarios for training purposes in fields like medicine, law enforcement, or customer service. In the entertainment industry, particularly in gaming, Metahumans provide a way to create deeply engaging and emotionally resonant characters, elevating the storytelling and player immersion. The use of Metahumans also raises important ethical questions, particularly around the authenticity of digital representations and the potential for misuse in creating deceptive or manipulative content.

Unreal Engine is supporting Metahumans via Quixel Bridge, which is a plugin that comes with Unreal Engine. It has several ready to use metahumans, along with its clothes, apperiances etc.

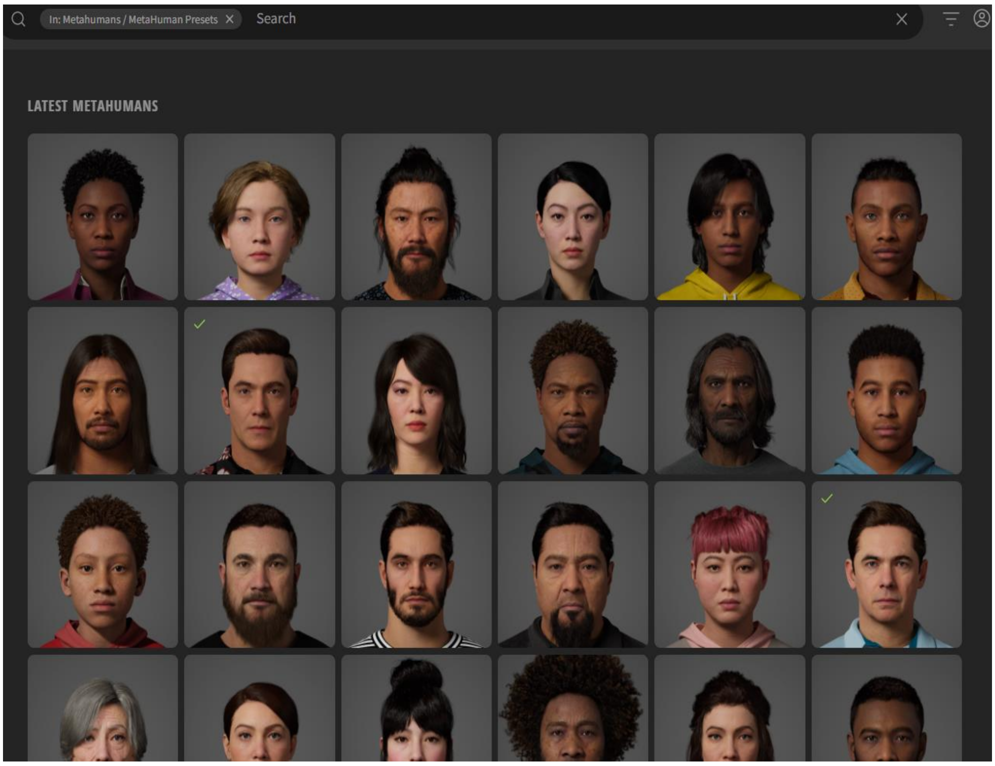

Figure 4.2. Some metahuman profiles in Unreal Engine

4.2.3. Implementing Metahumans

In QuixelBridge plugin, we implemented Metahumans. We have selected a Metahuman called Cooper from the given list in Figure 4.2.2.1.

Figure 4.3. The metahuman Cooper

Metahumans come with a skeleton inside, every skeleton is animatable by hand. It has the support for blueprint system as well, see in Figure 4.2.3.2.

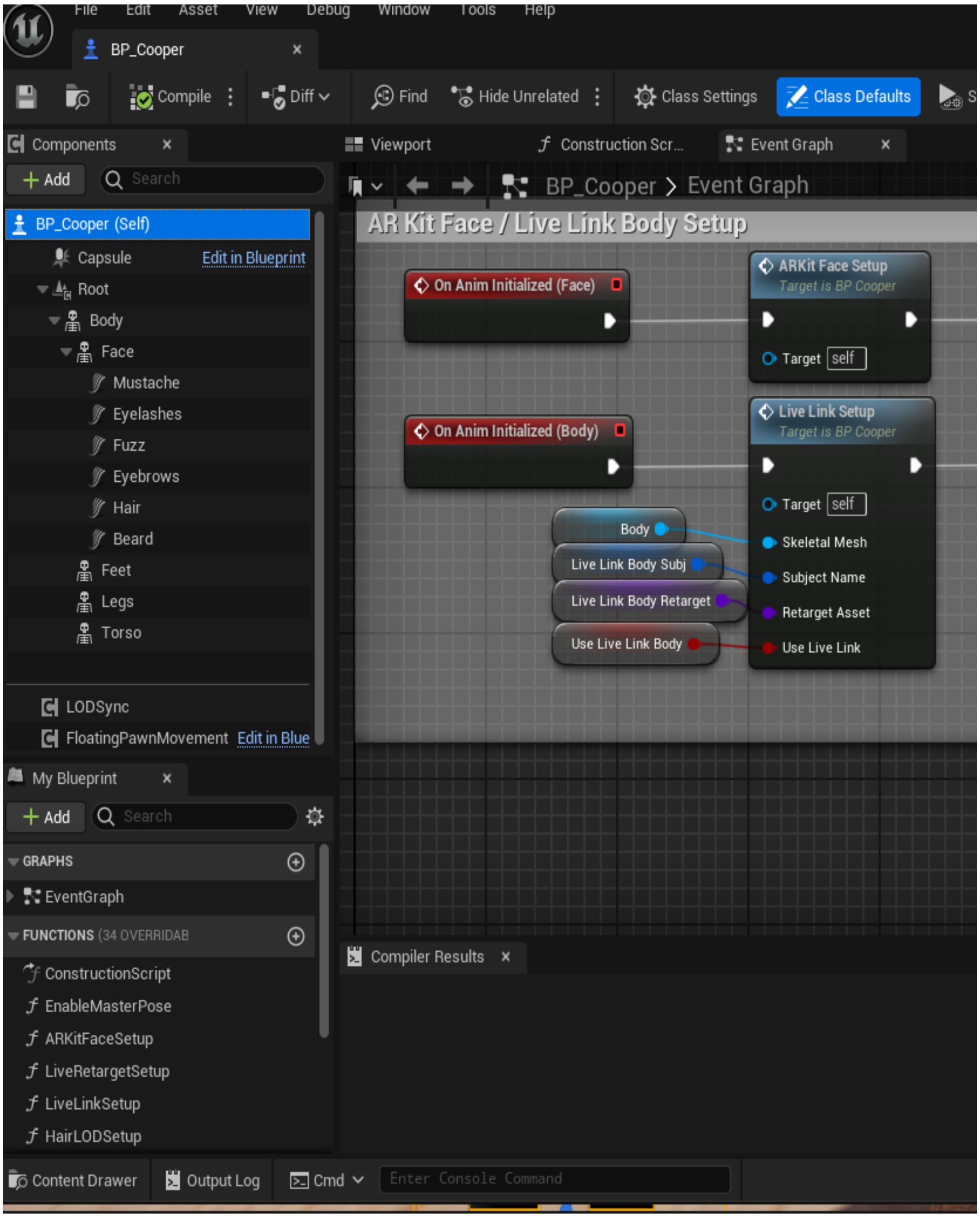

Figure 4.4. Inside the blueprint of Cooper, the metahuman

4.2.4. VR Pawn System

The VR Pawn system in Unreal Engine is an essential component for creating immersive virtual reality experiences. In Unreal Engine, a "Pawn" is an actor that can be controlled by the player or the game's AI. In the context of VR, a VR Pawn is specifically designed to represent the player in the virtual environment, providing a crucial link between the player's physical actions in the real world and their movements and interactions in the virtual world. It is essentially the player's avatar in the VR world. It is a 3D model that can include a body, hands, or other elements, depending on the level of immersion desired. The Pawn is what the player sees when they look down at themselves in VR, providing a sense of presence within the virtual environment. It has support for blueprint system too, see Figure 4.2.4.1.

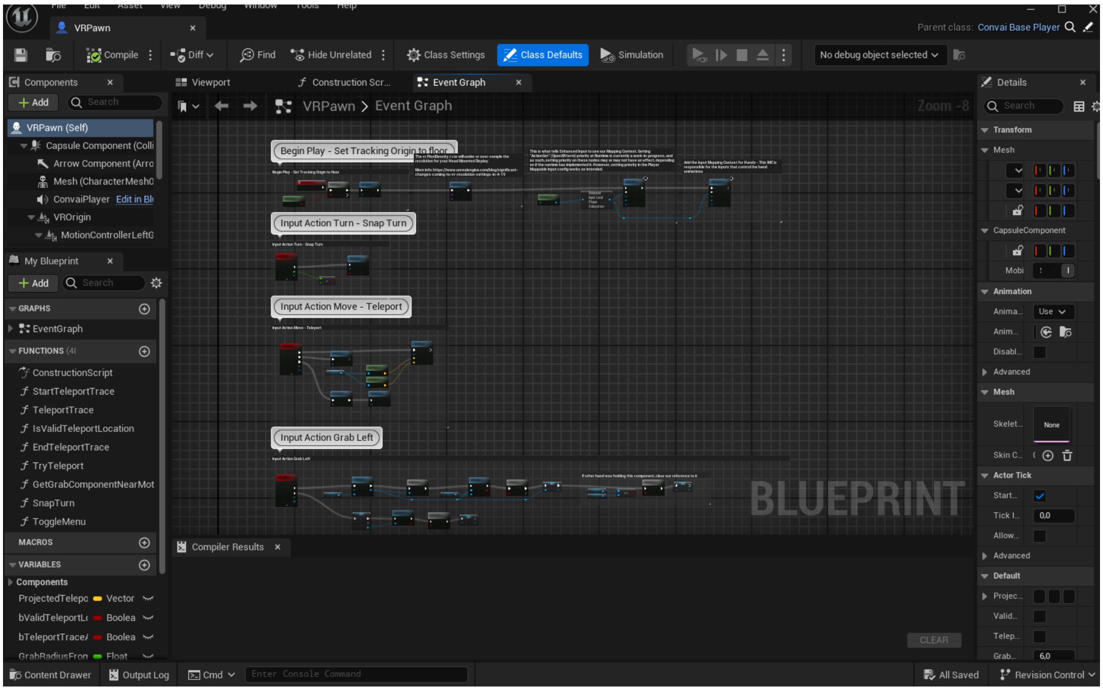

Figure 4.5. VR pawn blueprint

VR Pawns are designed to respond to player inputs for movement. This can be achieved through various mechanisms, such as teleportation, where the player points to a location and teleports there, or more direct forms of movement like walking or running, which can be simulated through controllers or treadmills. In VR, it is crucial that the Pawn's movements correspond accurately to the player's real-world movements. This is achieved through head and hand tracking. The VR Pawn is programmed to follow the movements of the VR headset and controllers. When the player turns their head or moves their hands, the Pawn's head and hands move correspondingly in the virtual space. VR Pawn can interact with objects in the virtual environment. This can include picking up, holding, or throwing objects, pressing buttons, or using tools. These interactions are made possible through the Pawn's hands or other appendages, which are controlled by the player's movements using the VR controllers. The VR Pawn includes a camera system that represents the player’s point of view. The camera's position and orientation are linked to the VR headset, ensuring that the visual perspective in the VR environment matches the player's head movements in the real world.

VR Pawns also handle collisions and physics interactions within the VR environment. They have collision components that prevent them from walking through walls or other solid objects and can interact physically with objects in a way that feels natural and realistic. Unreal Engine allows developers to customize their VR Pawns extensively. This includes adjusting the scale, appearance, and capabilities of the Pawn to fit the specific needs of the VR experience they are creating. To enhance immersion, VR Pawns can also be integrated with spatial audio and haptic feedback systems. This means that the Pawn not only navigates and interacts with the virtual world visually but can also hear sounds from specific directions and feel haptic feedback from interactions.

4.2.5. Generative Conversational AI

Generative Conversational AI refers to artificial intelligence systems that can generate natural language responses in a conversation. Unlike traditional rule-based systems that rely on pre-defined responses, generative conversational AI uses sophisticated algorithms to produce responses that are not pre-scripted, enabling more flexible, dynamic, and human-like interactions. Generative conversational AI usually uses machine learning, particularly deep learning techniques such as neural networks. These AI models are trained on vast datasets of human language, learning patterns, and structures of conversation. The training can involve understanding the context, intent, and the nuances of language, including slang, idioms, and cultural references [24].

One of th aspects of generative conversational AI is its ability to understand and generate contextually relevant and coherent responses. This capability is crucial because conversations are inherently contextual, and maintaining the thread of conversation requires understanding not just the current input but also the history of the conversation. Generative conversational AI systems often employ techniques like sequence-to-sequence models. These models take a sequence of words (like a question) as input and produce another sequence of words (like an answer) as output. This process often involves encoding the input sequence into a fixed-dimensional space and then decoding it to produce the output sequence. Advanced versions of these models use attention mechanisms to focus on different parts of the input sequence when generating each word of the output sequence, allowing the model to produce more relevant and accurate responses. Natural language understanding (NLU) is also important. NLU enables the AI to interpret the user's intent, even when the phrasing or grammar is unconventional or complex. This understanding is then coupled with natural language generation (NLG), which is the process of converting the AI's response from a structured form into a natural-sounding human language.

An example of a generative conversational AI application is "ConvAI," a platform used in the Conversational Intelligence Challenge. ConvAI is designed to evaluate AI systems based on their ability to maintain a meaningful, coherent, and engaging conversation with humans. These systems are assessed on various criteria, including the relevance of their responses, their ability to maintain context, and their overall fluency and human-likeness in conversation. In practical applications, generative conversational AI is used in chatbots, virtual assistants, and customer service agents. These AI systems can handle a wide range of queries, provide personalized recommendations, and even engage in small talk, making them highly effective in customer engagement and support.

4.2.6. Implementing Generative Conversaitional AI

To implement a generative conversational AI to a metahuman, we first needed to create one with attributes. Since it is a language learning application, the assistant AI should have a Turkish language and culture knowledge and database. We used ConvAI model for that because of it’s support to Unreal Engine. We changed the parameters and created a character named Ali. In the backstory description part, we set Ali’s background to a Turkish Teacher.

Turkish culture is a specific topic, and AI like answers are less enjoyable and make it an unrealistic experience, hence we trained AI with special Turkish culture information from Republic of Türkiye Ministry of Culture and Tourism. After configuring the AI, we have implemented it to VR pawn system and to our character Cooper, in game name Ali. We have set the communication to Voice Enabled, so that it can respond to our voice in VR.

4.3. FLASHCARD VOCABULARY GAME IN VR

Vocabulary learning is one of the key parts of the language learning. In VR it is possible to create visual materials, which is suitable for vocabulary learning. One of the games/methods of vocabulary learning is the Flaschards. These cards are two sided, on one side you have English part of an object, and on the other part you have the other targeted language [25].

The biggest reason why we choose the flashcard example for our study is that these cards are highly interactable. In 2D or 3D desktop setups you can flip them by clicking but in Virtual Reality, you can hold and turn them, which highly increases immersiveness and interactivity.

In our application, we have designed and implemented 10 flashcards that includes Turkish vocabulary and culture information. On the culture side, we focused the hand gestures inherited by Turkish culture.

Figure 4.6. Inside the app flashcard example

In Turkish Culture there are specific hand gestures that resembles a specific Turkish meaning. There are a lot of hand signs and gestures that means something, but a foreigner could not know without an explanation [26].

Figure 4.7. Inside the app with flascards

PART 5

EXPERIMENT

5.1. DESING OF EXPERIMENT

The study involves 12 foreign participants. For VR HMD device we used Oculus Meta Quest 2. Each participant tried the application in both desktop settings and VR settings, and they answered two questionnaire one before the test and one after. Specific introduction is given to those first time VR users. Participants selected among those who have less then 5 out of 10 knowledge about Turkish language and culture, asked before the test.

Participants have been instructed to first look at the classroom environment, then look at the flashcards and interact with them, then see the AI Teacher Assistant Ali, and talk with him. No time limit applied.

Figure 5.1. During the experiment, flipping interaction part

Figure 5.2. Flashcard example: glasses

Figure 5.3. Instruction part of VR

Pre-Experiment Questionniare:

1. Do you have any VR Experience?
2. Do you have any health issue?
3. Your Turkish level out of 10?
4. Your English level out of 10?
5. Advantage of VR over Desktop out of 5?
6. Advantage of interaction of holding and flipping the flashcard in VR over clicking in desktop out of 5?
7. Did you like classroom environment, or would you prefer more public environments like a café?
8. Any health problems after using VR?
9. Was the AI teacher assistant helpful and increased your motivation?
10. Which type of textures would you prefer: Realistic or Cartoon?

5.2. QUESTIONNIARE RESULTS

Table 5.1. Questionniare Results

Questions	**Mean Value (Standard Deviation)**	**Variables**
Do you have any VR Experience?	0,583 (0,515)	Yes=1, No=0
Do you have any health issue?	0 (0)	Yes=1, No=0
Your Turkish level out of 10?	4,25 (0,965)	1 to 10, 10 being the highest
Your English level out of 10?	7,91 (1,443)	
Advantage of VR over Desktop out of 5?	4,33 (1,23)	1 to 5, 5 being the highest
Advantage of interaction of holding and flipping the flashcard in VR over clicking in desktop out of 5?	4,83 (0,577)	
Did you like classroom environment, or would you prefer more public environments like a café?	1 (0)	Classroom=1, Café=0

Any health problems after using VR?	0,166 (0,389)	Yes=1, No=0
Was the AI teacher assistant helpful and increased your motivation?	4,666 (0,492)	1 to 5, 5 being the highest
Which type of textures would you prefer: Realistic or Cartoon?	1 (0)	Realistic=1, Cartoon=0

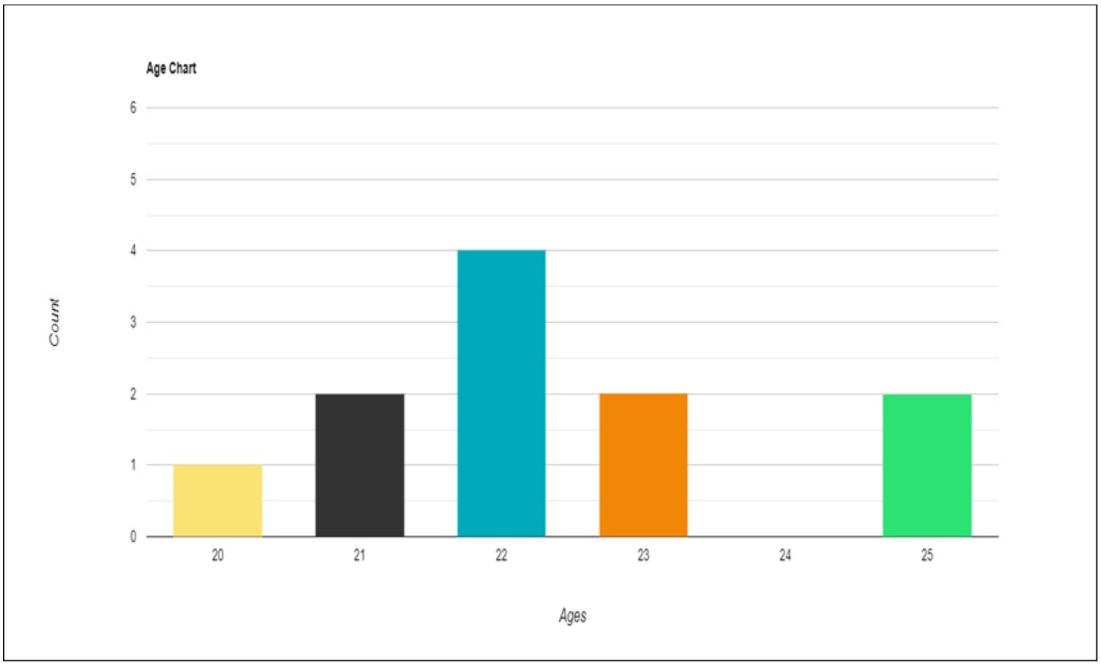

Figure 5.4. Age chart

Using the data, for hyphothesis of the advantage of VR over Desktop question, for significant level of 0.05, Null Hyphothesis is rejected since P is between 0.025 and 0.05. T test is conducted because we have 12 participants, less than 30. In this case, we can say it is true.

PART 6

RESULTS, DISCUSSIONS AND LIMITATIONS

6.1. RESULTS AND DISCUSSIONS

In this study, we found that VR has unique features that can be use in language education. The AI we used in the environment improved participants motivation, and they preferred more classical environments like classrooms over public environments. Object interaction is a big advantage in VR over desktop setups, making the experience more realistic. %86.6 of the participants favored VR over desktop setups, but %96.4 of the participants said the interaction in VR, being able to interact and flip-hold the flashcards, is better than desktop setups. For environment settings, all the participants selected the classroom environment over public environments like caffes.

The metahuman virtual AI assistant positively affected students and encouraged them to ask any questions if needed. It also helped the environment look better, since it has realistic graphics.

For hypotheses of the advantage of VR over Desktop question, for significant level of 0.05, Null Hyphothesis is rejected since P is between 0.025 and 0.05. In this group, we can say VR has more advantages over Desktop settings.

6.2. LIMITATIONS AND FUTURE WORK

The experiment was conducted once, not repeated. To see the fade of novelty effect of VR, more repeated experiments are needed. Participants were another limitation. In this study we worked with foreign users particularly, making it harder to increase the sample size of 12. Also, the AI assistant was helpful, but it can be improved by training it with things like sample lessons or assessments.

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RESUME

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