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Introducing TreeTalky: A GenAI-Based Immersive VR Application That Gives the Forest a Voice

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Abstract. In this product demonstration paper, an immersive Virtual Reality (IVR) environment will be introduced that allows the conversation with a virtual tree in the Amazon rainforest: TreeTalky. The conversation with the virtual tree is powered by a generative artificial intelligence (GenAI)-based chatbot. The chatbot was prompted to answer from the tree's perspective and to talk about its fate suffering from forest degradation using an empathic emotional tone. The design of the application was influenced by learning objectives associated with education for sustainable development (ESD) and related pedagogical approaches such as transformative learning. In this paper, the design process is described in detail.

Keywords: Immersive VR, GenAI, Education for Sustainability, Emotional Tone.

1 Introduction

In the past, several studies have recognised the potential of immersive Virtual Reality (IVR) for education in sustainable development (ESD) [1]. Affordances of IVR, such as the feeling of presence, embodiment, or interacting with 3D environments, have been shown to provide new possibilities to address learning objectives associated with ESD [2]. Now, with the rise of generative artificial intelligence (GenAI), new technical solutions to induce a shift in mindset are possible, eventually leading to pro-environmental behaviour [3, 4]. Hence, in the following, we will describe the IVR application TreeTalky that allows the conversation with a virtual tree of the Amazon rainforest. The development of the application followed a theory-informed design approach, drawing on ESD and transformative learning theory to define learning objectives and to guide the design of perspective-taking with the goal of fostering affective learning processes (e.g., empathy, compassion, and nature connectedness). In the following, information on the technical background will be presented, and the implementation in a pilot study and a main study in institutions of higher education and secondary education in Germany will be summarised.

2 Theory-Informed Design

In its working definition, sustainability "… means prioritising the needs of all life forms and of the planet by ensuring that human activity does not exceed planetary boundaries" [5], p. 12. Subsequently, in the context of ESD, it has been discussed how to achieve this goal within educational settings. While sustainability can have different meanings in different educational contexts [5, 6], the European Sustainability Framework states that learning for environmental sustainability refers to nurturing a sustainability mindset to help humans understand that they are part of and depend on nature [5]. Learning objectives to achieve this goal address both cognitive and affective learning processes, such as enabling learners to view problems from different perspectives, inducing empathy for all forms of life, or critical reflection on the human-nature relationship. As a pedagogical approach, the transformative learning theory can serve by initiating a disruptive learning experience [7].

Against this background, an IVR environment has been designed that uses the affordances of IVR, namely the feeling of presence and embodiment [8], and the affordances of a GenAI, namely personalised human-like conversations [9]. Prior research has shown that it is perspective-taking in IVR that affects empathetic reactions [10]. Furthermore, initial results suggest that conversations with GenAI-based chatbots also may enhance empathy

[11]. However, whether talking to a tree as a non-human entity leads to similar results is still uncertain. Therefore, in the built IVR application, affordances of IVR and GenAI have been combined, and are currently tested in an experimental research study.

3 Technical Development

Narrative. Selective Logging is a method used in the Amazon rainforest in the context of deforestation. Instead of cutting down entire landscapes of trees, selective logging means cutting only selected trees instead, which are of high quality [12]. Originally, this idea was meant to safeguard the forest; however, research has shown that selective logging can negatively impact the forest's ecosystem. In the IVR, the tree will refer to this narrative and talk about its fate of suffering from selective logging in a very empathic emotional tone [13].

Mechanics. In the immersive VR application, the participants interact with a tree by using the controller, which is seen as a virtual megaphone in IVR, to ask the tree questions. Manipulating the emotional tone of the conversational AI, we prompted the tree to be empathic and to emphasise its suffering [13].

Technical Setup. The technical setup is twofold: on the one hand, we developed an IVR environment, and on the other, a conversational AI system.

VR Development. The VR application was built in Unity (version 2022.3.62f2) to run natively on the Meta Quest 3. The prototype was developed by a scientific researcher and substantially reworked by a professional game design studio (see Fig.1 and Fig 2).

Conversational AI System. A simple server-client architecture within a local network was used to serve multiple users simultaneously. The server is a PC equipped with high-end hardware. The clients are Meta Quest-3 VR headsets. To ensure low latency and data privacy, the clients were connected to the server in the same room via 5 GHz Wi-Fi, with no internet connection. The clients send recorded audio to the server. The server transcribes the audio, generates an answer using the Large Language Model (LLM), and the text-to-speech model generates an audio file based on the LLM's answer, which is sent back to the client. Google's Gemma3:12b (Q4_0 quantised) model via Ollama. Whisper (v3-Large) was used, and F5-TTS to transcribe and generate speech. The system prompt was designed and tuned as well as the parameters for role-play performance, drawing on experience gathered from earlier studies [13].

Fig. 1. Screenshot of the IVR application's prototype from the user's perspective, showing the virtual rainforest tree as a conversational partner.

Fig. 2. Screenshot of the final IVR application from the user's perspective, showing the virtual rainforest tree as a conversational partner, embedded in the Amazon rainforest.

4 Implementation

Before the conversational agent was integrated into the immersive VR environment, the GenAI system was tested as a text-to-text chatbot. In this pilot study, the chatbot was implemented in an authentic learning setting in higher education, as part of formal coursework, asking students to chat with one of two trees differing in their emotional tone [13]. In a between-subject experimental design, cognitive (knowledge, perspective-taking, reflection) and affective constructs (empathy, compassion, distress, nature connectedness) were assessed prior to and after the chatbot conversations to investigate which emotional tone induces stronger learning processes (N = 122). The results showed that, especially the empathic tree, compared to the compassionate tree, induced higher levels of self-reported empathy, distress, perspective-taking, and reflection.

Building on the first pilot study, the empathic version was implemented in IVR, as described above, and another study comparing three IVR conditions was conducted: chatting with the GenAI tree, using a scripted dialogue-system, and reading a letter from a tree as a control. This study is still ongoing to investigate differences in affective and cognitive learning processes.

5 Contribution to Immersive Learning Education and Design

With the developed IVR, two different approaches are provided for immersive learning education and design. The first approach, the LLM-based AI chatbot, can be implemented in learning settings in different subjects related to climate change, environmental education, or sustainable development. Moreover, it enables secure data conversations because it runs locally, using open-source models and software [13].

In the second approach, an IVR learning application has been developed that enables learners to converse with a tree from the Amazon rainforest using the LLM-based AI chatbot. Besides having a personalised conversation, this approach uses the affordance of IVR by letting learners actively engage with a tree in its natural environment, the forest. As prior research indicates, virtual built environments can induce similar affective processes, such as well-being or nature connectedness, compared to real nature experiences [14, 15]. Hence, learners experience the beauty of the forest while learning about the tree's fate. This scenario can be altered in many ways in the future. The tree can have a different emotional tone, or the environment can be redesigned to explore different tree scenarios, such as a tree in a local forest of one's own hometown.

Concluding, the developed IVR application, and its use in different research studies, provides new insights on combining cognitive and affective learning processes associated with ESD, leveraging high-end technology of the future.

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