



Independently Supporting Learners in VR with an AI-enabled Non-Player Character (NPC)

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Abstract. The shift to computer-based Emergency Remote Teaching (ERT) and online learning during the pandemic resulted in a generally negative and an unprecedented student experience. Students were challenged by undesirable study environments, inadequate social connectedness, and increased workloads. To address these issues a Virtual Reality environment with an Artificial Intelligent non-player character acting as a supporting interlocutor is utilized to address the concerns of learner engagement, anxiety and cognitive workload when engaged in remote education.

Keywords: AI, Anxiety, Cognitive Workload, Non-Player Character, STEM, VR.

1 Introduction

In 2021 the CEO of Facebook, Mark Zuckerberg, presented his vision for the future of social media, the internet, work, and digital communication: “The next platform will be even more immersive — an embodied internet where you’re in the experience, not just looking at it. We call this the metaverse, and it will touch every product we build” [1]. To reinforce his commitment the company announced a staggering \$10 billion project to transition from social media apps to an embodied internet, along with the recruitment of 10,000 people in Europe over the next five years. He also changed the company’s name to Meta. By the end of 2022 though this initial optimism appeared to have waned as Meta scaled back operations as financial reality impacted balance sheets. Illustrative of the circumstances in the real-world, AltspaceVR, a popular social Virtual Reality (VR) platform, was shut down in early 2023.

Despite these setbacks, research in VR technologies and applications has continued unabated. A particular area of interest is the integration of Artificial Intelligence (AI) as a means to enhance the immersive experience and enable human-like intelligence of virtual agents and avatars. At the forefront of AI development is OpenAI; a non-profit company with support from technology luminaries such as Peter Thiel and Elon Musk, as well as investment from Microsoft, whose mission is to ensure that artificial general intelligence benefits all of humanity. Two of its AI applications are DALL-E, a deep learning model which generates digital images from natural language, and GPT (Generative Pre-trained Transformer), an unsupervised transformer language model; essentially an algorithm that learns patterns from untagged data, builds a subsequent representation of its world, and then generates content. This form of meta-learning has led researchers at OpenAI to experiment with AI by releasing ChatGPT, a conversational interface to the general public, allowing dialogues in natural language (www.openai.com).

Game developers are looking at ways of integrating AI to deliver a more realistic interactive gameplay. For instance, AI is used to affect the behavior of non-player characters (NPCs) resulting in a more engaging gaming experience. However, current implementations adopt essentially algorithms with limited and predetermined responses, using pathfinding and decision tree mechanisms to influence the action of the NPC. This automated computation is in

stark contrast to the reinforcement learning adopted by OpenAI. Consequently, games developers such as Modbox have begun experimenting with OpenAI's GPT to create games where players directly converse with a NPC in real-time in a remarkable human-like dialogue (<https://www.youtube.com/watch?v=nnuSQvoroJo>). The evolution of such human-AI interactions will subsequently transcend game environments and be appropriated in the metaverse space. For instance, Inworld AI is creating sophisticated NPCs that can carry out real-time, natural conversations with humans in VR, and has plans to interact with additional human modalities such as gestures, body language and emotions (www.inworld.ai).

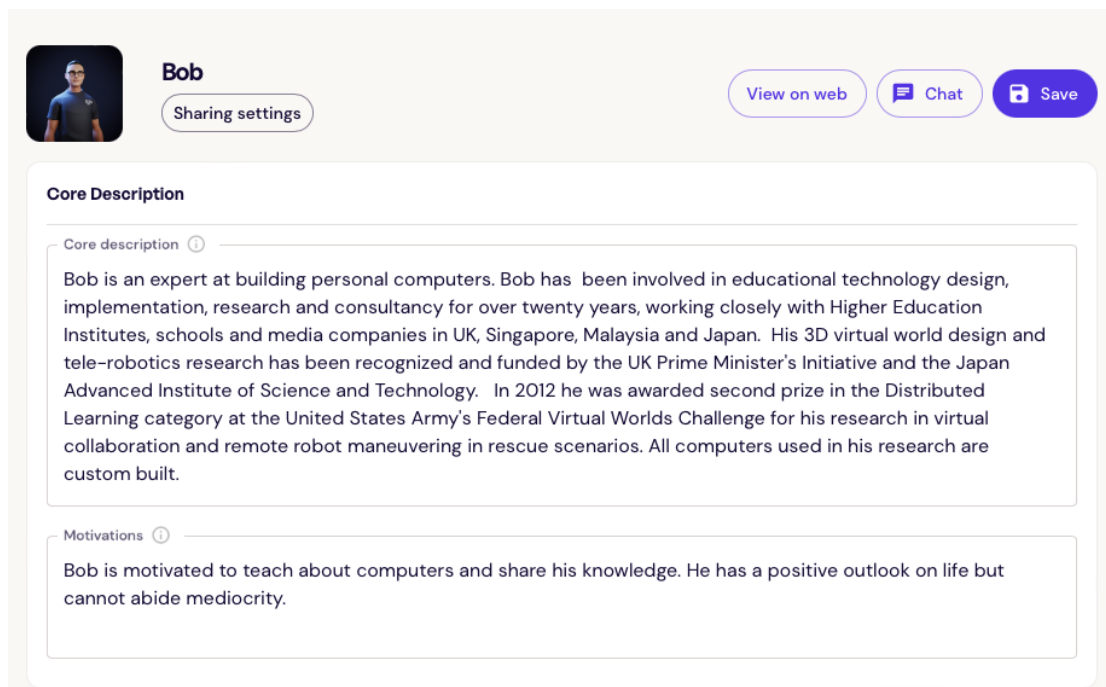
One of the goals of this practical implementation is to determine if AI-enabled interlocutor interactions with a human learner in Virtual Reality can alleviate learner anxiety and cognitive workload and subsequently engage in successful learning.

2 Implementation

It has been long established that people construct meaning and knowledge through experience [2]. Informed by the previous work of Checa et al [3], it was decided to create a VR experience with the goal of constructing a Personal Computer (PC). The design of the VR space considered interaction, immersion, user participation and photorealism [4]. The basic components of a PC are a motherboard, RAM, SSD, CPU, GPU, fan, and a power cable. Associated 3D models were purchased from Turbosquid (www.turbosquid.com) as they were professionally created at an affordable price. An environment in the form of an open lab was next constructed within Unity and the 3D components imported. After that, the interactive process of building the PC was programmed in a specific procedural manner.

Personalized support from a NPC was provided by an avatar created in Inworld Studio (<https://studio.inworld.ai>). The character requires a core description, motivation, identity, personality and emotions, initial facts and knowledge, a preferred voice with varied pitch and speed, and dialogue style (e.g., blunt, bubbly, formal, inquisitive). Customizing these settings result in a highly personalized NPC; for instance, a blunt NPC will simply answer a question directly whereas an inquisitive NPC will additionally attempt to engage in off-topic interactions (see Figs 1 & 2).

The Unity Project was then programmed to operate in VR using the Oculus Rift HMD and its associate controllers. Finally, the Inworld AI character – named Bob - was then integrated. Bob was designed to respond to spoken questions, specifically supporting the human interlocutor in building the PC. The interactions can also be off-topic and casual as Bob engages in an uncannily realistic conversation (see Fig 3).



The screenshot shows the Inworld Studio interface for a character named Bob. At the top left is a small 3D avatar of Bob. To its right is the name 'Bob' and a 'Sharing settings' button. Further right are three buttons: 'View on web', 'Chat', and 'Save'. Below this is a 'Core Description' section with a text area containing the following text: 'Bob is an expert at building personal computers. Bob has been involved in educational technology design, implementation, research and consultancy for over twenty years, working closely with Higher Education Institutes, schools and media companies in UK, Singapore, Malaysia and Japan. His 3D virtual world design and tele-robotics research has been recognized and funded by the UK Prime Minister's Initiative and the Japan Advanced Institute of Science and Technology. In 2012 he was awarded second prize in the Distributed Learning category at the United States Army's Federal Virtual Worlds Challenge for his research in virtual collaboration and remote robot maneuvering in rescue scenarios. All computers used in his research are custom built.' Below this is a 'Motivations' section with a text area containing: 'Bob is motivated to teach about computers and share his knowledge. He has a positive outlook on life but cannot abide mediocrity.'

Fig. 1. Non-player character core description at Inworld Studio.

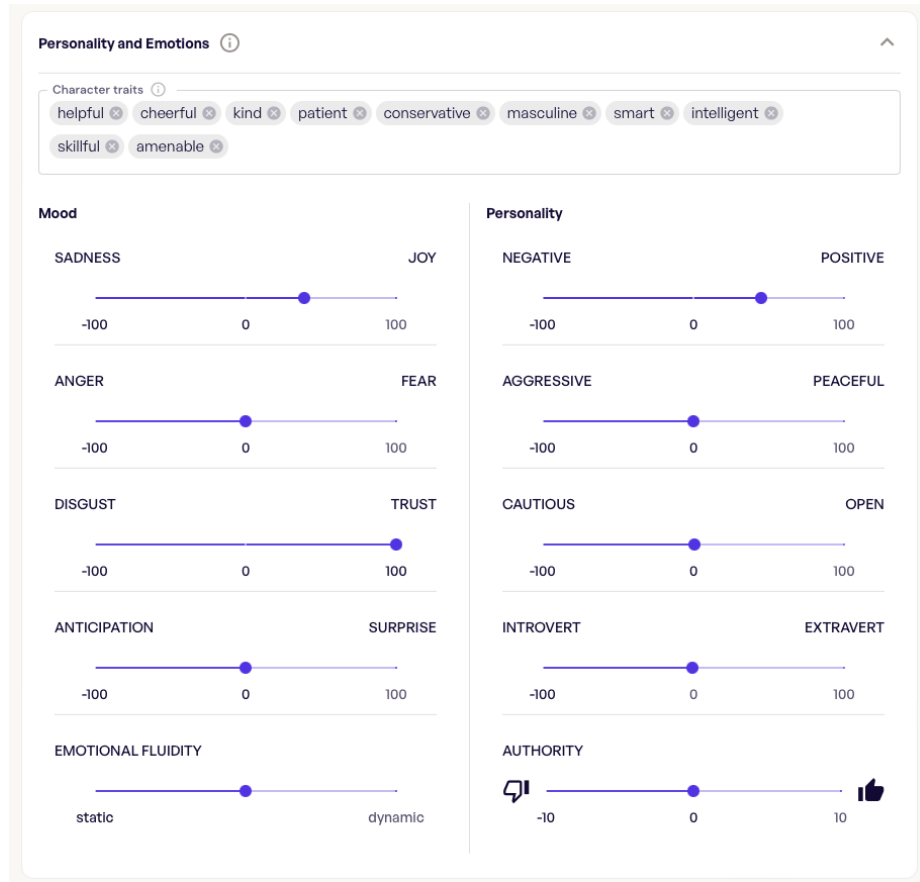


Fig. 2. Non-player personality settings at Inworld Studio.

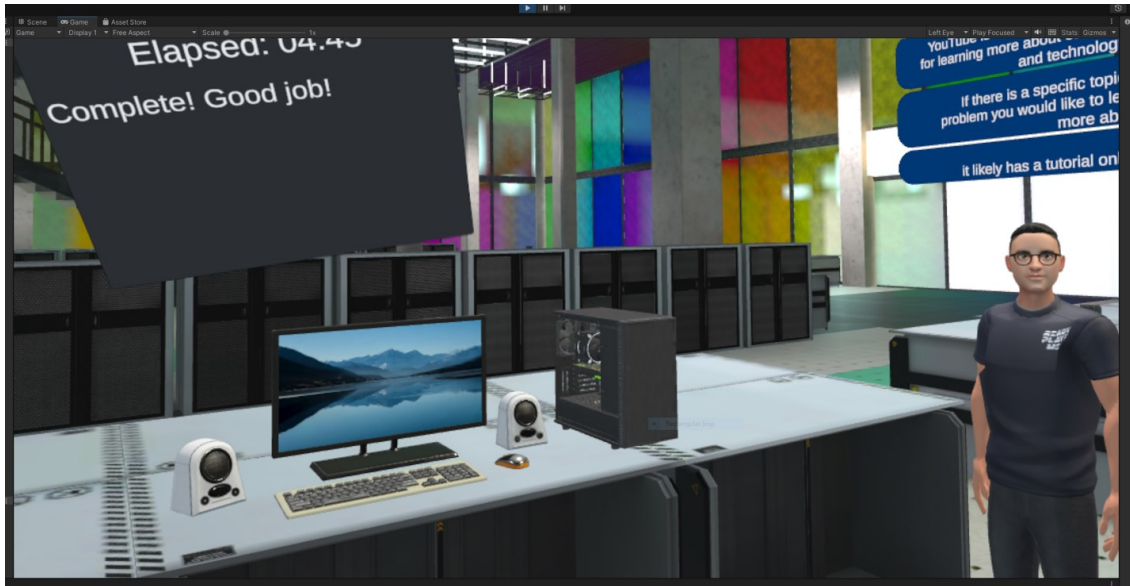


Fig. 3. Non-player character support in VR.

3 Anticipated Outcomes

Given the increased stress reported by learners during the period of online education imposed by supposed pandemic-alleviating lockdowns, measures of cognitive workload and anxiety are captured alongside task completion success and NPC interactions. Each participant will have four measures; (1) time to complete task; (2) interactions with the NPC; (3) EDA score; (4) a NASA-TLX cognitive workload score.

Task success will be determined when the PC is fully built and started. The lower the time for completion then the assumption is the more skilled the participant.

The interactions with the avatar will indicate the amount of support the participant is requesting.

Anxiety will be measured using a peak EDA score captured from a wearable biodata device. Electrodermal activity (EDA) is the variation in the electrical characteristics of the skin, often referred to as skin conductance or sweat, and is an indication of physiological or psychological arousal or anxiety [5].

Workload represents the cost incurred by a person to achieve a particular level of performance. A person's subjective experience of workload is influenced by the requirements of the task, the circumstances, skills, behaviors and perception. Workload is operationalized using six dimensions: Mental, Physical, Temporal Demands, Frustration, Effort and Performance. The NASA-TLX App combines fifteen pairs of the six dimensions for the participant to select. Then the participant rates each of the six dimensions from Low to High on a sliding scale. The raw score is then multiplied by the weight from the first step to generate an overall workload score. It has been determined that NASA-TLX workload scores below 70 are acceptable enough to not impact cognition [6].

4 Conclusion

It is expected the result will reveal that more successful students will have reduced cognitive workload and anxiety. The content of the interactions will need to be considered though; for example, the participant may enjoy interacting with the NPC and engage in general conversation as human-virtual realism occurs. It is the data from these participants that may prove interesting as an indicator of their developing procedural knowledge, and acceptance of a virtual experience enhanced with AI for offsite learning, and thereby answering the hypothesis that AI-enabled interlocutor interactions with a human learner in Virtual Reality support the acquisition of procedural knowledge.

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