Enhancing Learning Flow: Development of an Immersive Reality Environment for Effortless Knowledge Acquisition

1, 2. Martinez Fuerte Sadya Mariana ; 1. Hernandez Ríos Edgar Rafael ; 1. Peñaloza Christian

1.Mirai Innovation Research Institute
2. Facultad de Ingeniería Mecánica y Eléctrica, UANL

RATIONALE

The neurophysiological phenomena of flow is a mental state characterized by intense absorption and optimal performance in a task, resulting in heightened intrinsic motivation and enjoyment.

We explore the development and application of a multisensory virtual reality (VR) system designed to effortlessly acquire knowledge and enhance a flow state with focus on learning Japanese Kanji.

The VR environment incorporates audio cues and binaural beats to foster this state. Key aspects of flow, such as cognitive load, attention, and auditory processing, were quantified using EEG brain patterns and compared against an initial parameter. A comprehensive questionnaire offered a qualitative perspective on the participants' experiences.

This research could not just revolutionize education technology but also redefine efficient, and engaging learning.

MATERIALS

VR system

- Unity
- Oculus quest 2

Aura biosignals monitoring

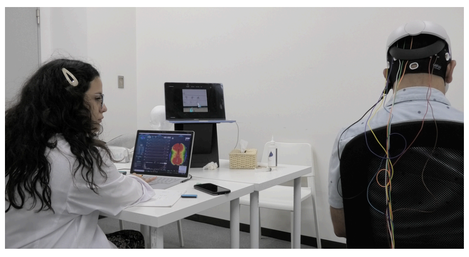

Figure 1: Subject during the practice phase, displaying the AURA EEG system in use and the "eduverse" VR environment created in Unity.

METHODOLOGY

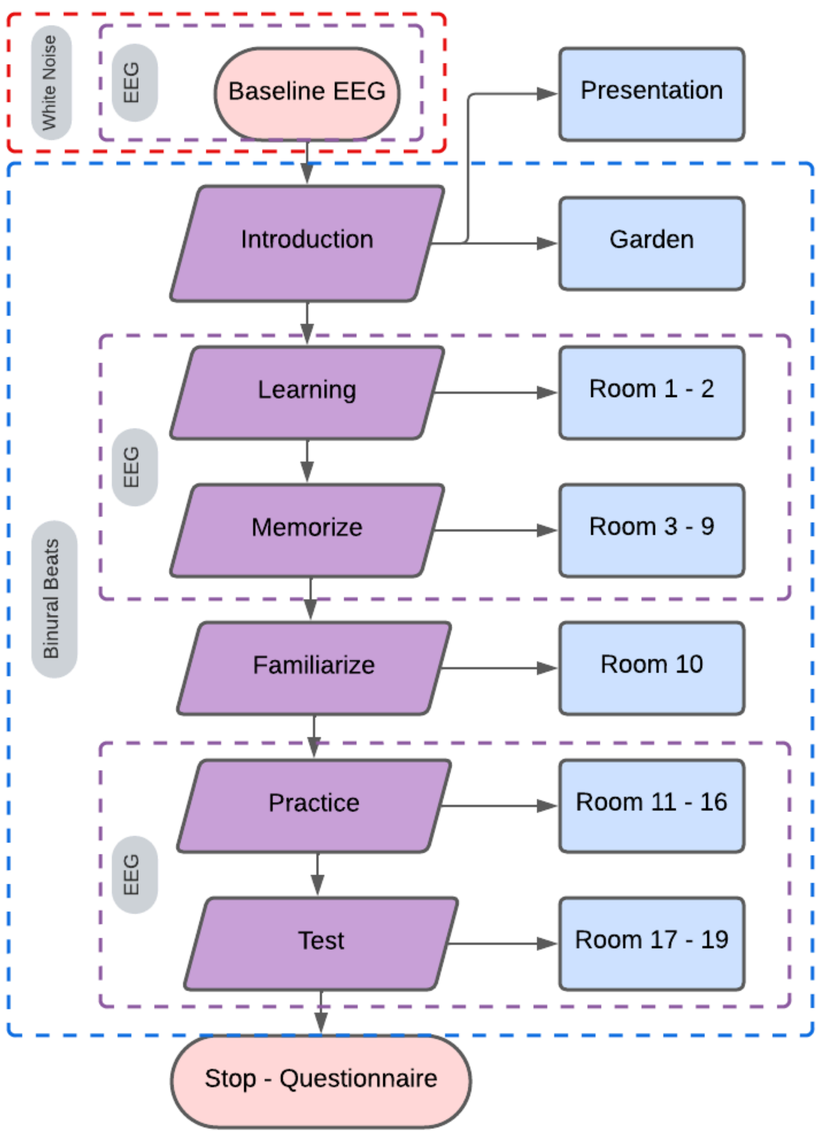

Figure 2: Steps of the VR System Design

PRELIMINARY RESULTS

The succefull development of the VR environment resulted in an ambience that enhances sense of immersion and control.

Figure 3: Sections in the VR environment with the setup used for teaching Japanese Kanji characters

Across the trials, subjects exhibited elevated Delta wave activity, which consistently signaled the Flow State during the Practice and Test phases, a trend that was consistent across all participants. The rise in Delta was evident across all trials, although the intensity varied among phases.

These physiological trends were compared against the qualitative questionnaire responses, showing alignment between subjective reports of immersion and control and the observed Delta wave patterns, a mixed-methods approach bridging computational signal analysis and subjective human experience

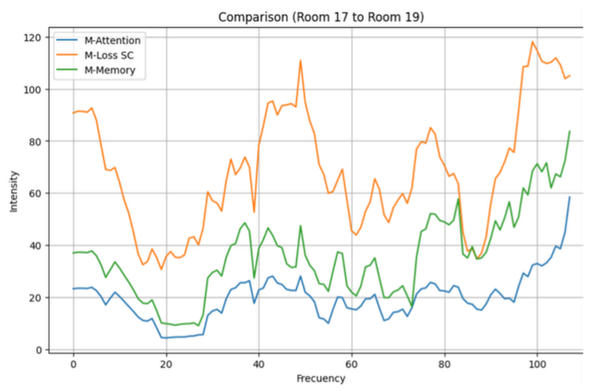

Figure 4: Increase of delta waves over gamma and alpha wave activity in the "test" phase, corresponding to average of the channels Fp1, F3, F4

FUTURE DIRECTION

The next step is to apply machine learning with rigorous statistical validation, such as cross-validation, to decode Flow State from EEG signals within the VR environment, identifying which physiological marker(s) actually explain the observed patterns. The longer-term goal is an explainable adaptive learning system, where physiological signals would induce a personalized VR environment to improve knowledge acquisition.

REFERENCES

- F. Q. Chen, Y. F. Leng, J. F. Ge, D. W. Wang, C. Li, B. Chen, and Z. L. Sun, "Effectiveness of Virtual Reality in Nursing Education: Meta-Analysis," J. Med. Internet Res., vol. 22, no. 9, 2020, Art. no. e18290. doi: 10.2196/18290..
- S. Chikhi, N. Matton, and S. Blanchet, "EEG power spectral measures of cognitive workload: A meta-analysis," Psychophysiology, vol. 59, no. 6, p. e14009, 2022. https://doi.org/10.1111/psyp.14009
- H. S. Lonczak, "How to Measure Flow with Scales and Questionnaires," Positive Psychology, 28-Aug-2019. [Online]. Available: https://positivepsychology.com/how-to- measure-flow-scales-questionnaires/.