Platform for Comparative Study of Focus and Retention in Virtual Reality and Online Learning

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***Abstract*—Our research objective is to compare the effectiveness of standard online learning methods versus the utilization of virtual reality in education in terms of student focus and information retention. Our proposed platform will have identical lesson plans in virtual reality as our online learning methods. Eye gaze tracking and a recall test will be used on both platforms to measure focus on the screen and retention, respectively. The ultimate goal of the project is to use this data to evaluate the effectiveness of VR as a digital learning environment.**

***Index Terms*—Virtual reality, student engagement, standard online learning tools, focus, retention**

I. Introduction

THE COVID-19 pandemic has caused a rapid transition to a virtual world. In education, this resulted in students across the globe transitioning to online learning on virtual platforms such as Zoom and Google Classroom. Standard online learning methods pose challenges such as distractions from one's environment, technical issues, and limited engagement, which can result in a reduced understanding of the material. Virtual reality (VR) creates an immersive environment that can potentially revolutionize online learning. The VR market size is projected to increase to 57.55 billion USD by 2027, exhibiting a 40% growth [3]. VR has become more prevalent in recent years in video games, aid in resolving phobias, vocational training and in education [2]. However, as VR emerges as an alternative to standard online learning tools, its effectiveness should also be evaluated. In particular, there is a need for more quantitative results to objectively measure the viability of VR as a learning environment. The aim of our research, introduced in this paper is to *evaluate how the engagement of immersion in VR supports focus and retention in students compared to standard online learning tools.*

II. Related Works

There is ongoing research on utilising VR in training or educational scenarios, and how it effects retention of information. Babu et al. discusses the increase in immersive learning environments in training scenarios [4]. Their study developed evidence of the use of these immersive environments in training scenarios by directly comparing a VR training experience versus standard learning content such as a slide lecture to measure the knowledge retention of participants. After training, recall tests were used to measure the participants' retention. The experimental group exhibited an increased recall rate.

In the field of educational retention, Kuo-Ting Huang et al. conducted a study to analyze the impacts of augmented reality and VR technologies on educational outcomes [5]. Their work focuses on finding the factors that would make one platform a more effective tool than the other. Participants were given the same solar system lesson and responded to post test questionnaires about how they felt after the randomized experience. Results showed that VR users were more attentive to the educational content, described more spatial presence and immersion in the experience, and had overall greater enjoyment of the experience than users of augmented reality simulation. This paper presents a gap in the research—lack of quantitative measures—that we want to further investigate, as most of the results are qualitative and subjective surveys.

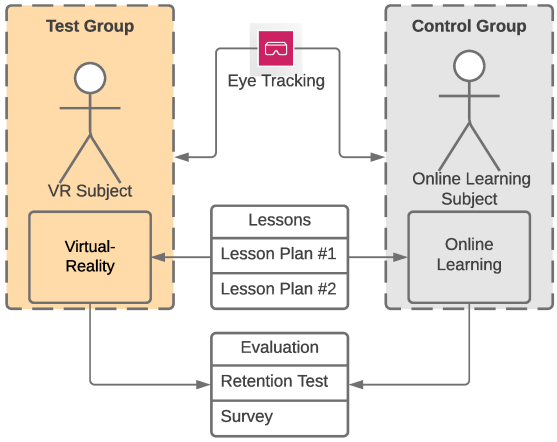

Fig. 1. System overview.

III. Proposed Research

A. Overview

To answer the research question of whether the engagement of immersion in VR supports focus and retention in students compared to standard online learning tools, we propose to compare focus and retention in students under two learning environments as seen in Fig. 1: 1) Standard online learning via a recorded zoom lecture and 2) A classroom in VR. For each environment, we are designing two lesson plans. The

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same recorded lectures will be displayed on both platforms, either on one's computer, or in the VR classroom, to ensure that participants receive identical material. Participants, who will be first year engineering and computer science students, will be randomly assigned into either the test or control group, as seen in Fig. 1, and every student will participate in a lesson in both learning environments. We will measure focus by using eye tracking to quantify the amount of time spent looking at the lecture, and retention by a recall test at the end of each lesson. After completing both lessons, participants will fill out a short survey to indicate the lesson they prefer and the lesson they found most effective.

Our experimental design will allow us to collect both qualitative and quantitative results, unlike majority of the related work, which only provided qualitative results [5]. We aim to fill this gap through analyzing both the numerical data from the eye tracking and recall test, and our subjective data from the survey. Our hypotheses to our central research question are: H1: Students engaging in a lesson plan in a VR environment compared to a standard online learning environment with the same lesson plan will report a) higher levels of focus, and b) retention. H2: There is a positive correlation between the level of focus measured and the retention evaluation score.

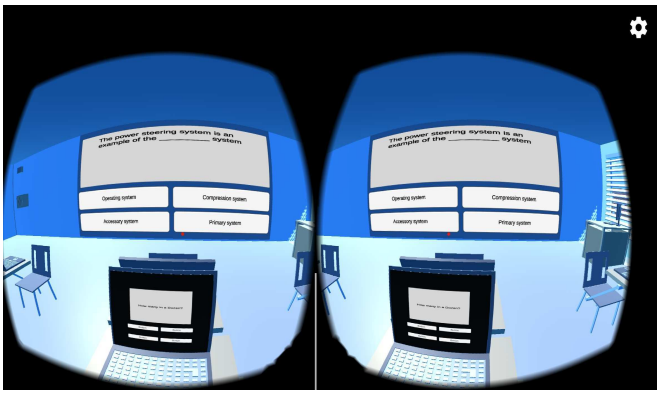

Fig. 2. Recall Test in VR environment.

The two lesson plans we are developing are on engine systems in agricultural machinery and architectural styles. We selected these topics because they are topics our target audience of first year engineering and computer science students are less likely to have prior knowledge on and thus avoid biases in the results. We plan to implement a 10 minute lesson plan due to the fact that the average attention span of a college student is between 10-15 minutes before there is a decline in attention [1]. We selected topics with memorization-based material to conduct a multiple choice recall test at the end of the lessons. The subjects of the two lesson plans are intentionally on unrelated subjects to keep participants engaged for two consecutive lessons.

B. Standard Online Learning Environment

In the standard online learning environment, we will use a webcam based eye tracking software called GazeRecorder [6] to track the user's gaze. As a browser-based software, GazeRecorder makes conducting virtual data collection easier, while also allowing per-user calibration for accurate point of gaze calculations. After the completion of the lecture, the participants will be directed to a page to complete our recall test. For each participant, a heat map will be generated to show the points of gaze throughout the lesson. The color intensity in the heat map indicates the duration of the gaze at that location on screen. Heat map data can be aggregated automatically to quantify the participants' focus level based on the percentage of time they spent looking at the screen.

C. VR Environment

We will be using Google Cardboard, a Mobile VR platform along with Unity Engine to produce our VR classroom environment. Our goal is to develop a virtual environment closely resembling the experience in a standard learning environment. We will have users arrive into a VR classroom and watch the same lecture video as the other group. We will measure the user's focus based on the percentage of time they look at the screen in the virtual classroom. We can directly compare the produced percentages in terms of how long the user looks at the screen with the data from GazeRecorder. At the end of the lesson, the participants will take the recall test in the VR environment as seen in Fig 2.

One issue with measuring focus on Mobile VR is the lack of eye tracking capabilities on the headset. We will emulate this by taking advantage of the user's lack of field of view in the headset. We can assume that the user's gaze while in VR is around the center of the screen, so we will use this to measure their gaze throughout the environment. Another hurdle in developing for Mobile VR is the lack of an input interface for instance when responding to the recall test. We will use gaze tracking for interacting with the recall test.

IV. Conclusion and Future Work

We hope to produce evidence for our hypotheses through the focus data collection of the two platforms as well as the results from the retention tests. We will also produce evidence for the correlation between the platforms and their effectiveness through the survey at the end of the testing period.

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