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Buenas: Giving Everyone a Seat at the Study Group Table

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On-campus study group (local site) Remote student 3 site

Figure 1: *Buenas* system for hybrid study group attendance. **Local site**: students 1 and 2 attend in person, while remote students 3 and 4 are projected onto cardboard screens at empty seats. **Remote student site**: student 3 uses an XR headset in passthrough mode to view students 1, 2, and 4 integrated into their physical space, along with their laptop and virtual lecture slides.

Abstract

Study groups are crucial in education to foster collaboration and motivation. Remote students, at greater risk of isolation, often miss this peer-driven environment. This paper presents *Buenas*, an Extended Reality (XR) system enabling remote students to participate in on-campus study groups seamlessly. Local students interact with projected representations of remote peers seated at a conference table, while remote students use XR headsets to integrate the group into their physical surroundings. A user study comparing Buenas to conventional videoconferencing showed significant improvements in engagement, presence, connectedness, and rapport through both objective and subjective measures.

Index Terms: Remote education, Hybrid remote + local education, Hybrid study groups, Extended reality.

1 Introduction

Variants of distance learning (DL) have become crucial to provide flexibility in education. For instance, asynchronous DL provides self-pacing and convenience to access learning materials, while synchronous DL fosters real-time engagement and interaction. Hybrid DL, which combines local and remote participants, is becoming more prevalent to benefit from the advantages of both synchronous and asynchronous DL. Nonetheless, they present unique challenges in maintaining engagement and a sense of co-presence, where both groups feel equally included and connected [2].

Most hybrid DL systems have focused on remote lecture attendance. Albeit relevant, research has shown that other learning approaches such as study groups are essential to foster collaboration, motivation, critical thinking, and peer-driven problem-solving [7]. However, replicating the benefits of in-person study groups in hybrid DL settings remains challenging [8]. Video conferencing tools like Zoom enable remote participation but often fall short in capturing non-verbal cues, spontaneous discussions, and spatial awareness [5]. Alternatively, XR technologies have shown promise in addressing these limitations by enhancing engagement, sociability, and spatial alignment in hybrid group settings [4, 6].

This paper introduces *Buenas*, an XR system designed to seamlessly integrate remote students into in-person study groups. Utilizing XR headsets, mini-projectors, and web cameras, *Buenas* enhances eye contact, spatial alignment, and natural communication cues. Building on advancements in XR conferencing [3, 5], our system offers significant improvements over traditional video conferencing tools, as shown in a controlled user study evaluating *Buenas*' effectiveness in enhancing hybrid study group experiences.

2 Methodology

2.1 System Architecture and Implementation

Buenas is a hybrid DL system for synchronous interaction and communication between local and remote students during study group sessions. As depicted in Fig. 1, Laptop A at the local site connects to Webcam C and Projector C. Webcam C captures a single live video feed of Local A and Local B, which is then sent over the Internet and displayed onto Headset C at the remote site. Conversely, Laptop A receives the video feed of Remote C, which was acquired by Laptop C, and then projected onto Panel C at the local site. This bidirectional video feed setup is replicated for Local B and Remote D using Laptop B, Webcam D, and Projector D. Each site within our system, whether local or remote, accommodates two students.

The system was developed using Unity Game Engine [9], along

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with Agora SDK [1], which provides real-time audio/video connectivity between the components. At the local site, both students have their own laptop connected to a projector, a webcam, and two cardboard panels positioned where the remote participants would be seated. The remote students appear to be seated at their corresponding position at the table after projecting their video feeds, captured through their webcams and after background subtraction routines, over the cardboard panels. At the remote site, each remote participant uses a laptop and a Meta Quest 3 XR headset. The webcams of their laptops capture a frontal view video, which is streamed to the local site for projection and to the other remote participant for display in XR. The headset operates in passthrough mode, allowing remote participants to see their surroundings, laptop screen and study materials. In the XR environment, the remote participant sees the other three participants—Local A, Local B, Remote C—in their correct positions as if they were at the Local site.

2.2 System Evaluation

The study evaluates the *Buenas* system through a controlled, between-subjects user study involving 60 participants from three universities. Participants were assigned to either the *Buenas* (experimental) or Zoom (control) condition, with each session lasting 60 minutes. The goal was to compare engagement, presence, connectedness, and rapport across the two systems. Participants were divided into 15 groups (8 experimental, 7 control), each consisting of four students: two local and two remote. Remote participants in the *Buenas* condition interacted in a shared virtual space via XR headsets, while control participants used Zoom's gallery view. The session included a demographics questionnaire, guided study activities (e.g., quiz, discussion, scheduling), and post-session surveys. Ethical approval was granted by the Institutional Review Board (IRB).

The study acquired metrics for **presence & engagement** (speech diarization, gaze tracking, iGroup Presence Questionnaire), **connectedness** (eye contact analysis, Networked Minds Social Presence, Temple Presence Inventory), **rapport** (affective coding and social presence measures), and **workload and usability** (NASA Task Load Index). The differences between conditions were analyzed using the non-parametric Mann-Whitney U test.

3 Results

Buenas showed significant improvements in engagement, presence, connectedness, and rapport when compared to conventional videoconferencing. Results are shown as median ± interquartile range.

Perceived workload: NASA Task Load Index (TLX) results indicated that participants in the control condition experienced significantly higher perceived workload, particularly in terms of time pressure (3.00 ± 2.00 vs. 2.00 ± 2.00; $p = 0.044$) and emotional strain (2.00 ± 3.00 vs. 1.00 ± 1.00; $p = 0.017$). In contrast, *Buenas* users reported a more relaxed and secure learning environment, with lower workload scores.

Social presence: Participants in the *Buenas* condition reported significantly higher social presence as measured by the Temple Presence Inventory (TPI), with stronger perceptions of body language observation (4.00 ± 3.00 vs. 5.00 ± 1.50; $p = 0.017$), changes in tone of voice (5.00 ± 2.25 vs. 6.00 ± 2.00; $p = 0.006$), and overall engagement (5.00 ± 2.25 vs. 6.00 ± 2.00; $p = 0.006$). Participants in the *Buenas* condition also rated their study sessions as more lively, responsive, emotional, and immediate compared to videoconferencing (*p-values* between 0.006 to 0.045). The iGroup Presence Questionnaire revealed a higher sense of "being there" and a stronger sense of consistency between virtual and real environments in the *Buenas* condition (0.00 ± 2.00 vs. 1.00 ± 2.00; $p = 0.024$ and 1.00 ± 2.25 vs. 1.00 ± 1.00; $p < 0.001$).

Connectedness: The Networked Minds Social Presence Inventory showed *Buenas* facilitated better co-presence (2.50 ± 1.25 vs. 4.00 ± 1.00; $p = 0.003$) and improved communication comprehension, for sending ($p = 0.005$) and receiving messages ($p < 0.001$).

Objective metrics: Significant differences were observed in eye contact rates ($p = 0.019$ for sustained gaze duration; $p = 0.008$ for frequency of mutual gaze) and speech patterns ($p = 0.043$ for turn-taking frequency; $p = 0.001$ for speaking duration), indicating enhanced engagement and visual attention in the *Buenas* condition. The statistical significance underscores *Buenas'* effectiveness in promoting behaviors of active participation and attention.

These findings suggest that *Buenas* offers a more immersive and collaborative experience for virtual study group sessions, with participants reporting better emotional and non-verbal communication.

4 Conclusions, Limitations, and Future work

We introduced *Buenas*, an XR system designed to enhance hybrid study groups by bridging the gap between local and remote participants. A user study (N=60) compared *Buenas* with traditional videoconferencing tools across engagement, presence, connectedness, and rapport. Results showed stronger social interactions, improved emotional connection, heightened body language awareness, and reduced stress, with no reported cybersickness. These findings highlight XR systems like *Buenas* as effective tool for enhancing hybrid DL study groups.

In terms of limitations, XR headsets obscure facial expressions, reducing perceived social presence. Manual alignment of video feeds adds setup complexity, and the current seating layout may limit remote-local interaction. Future work should address these with facial inpainting, automated spatial positioning, and flexible seating arrangements. Longitudinal studies are also needed to assess the sustained impact of *Buenas* on group cohesion and academic outcomes. These improvements will be key for scaling *Buenas* as a robust hybrid education tool.

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