Robotic Telepresence to Support Remote Classroom Attendance and Interactions

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Abstract—Our study explores the use of Mobile Remote Presence (MRP) in the classroom to support remote attendance and classroom interaction. The goal is to examine MRP, identify the benefits and drawbacks of using robotic telepresence in the classroom context and measure the impact of the use of MRP on engagement and interaction. Data is being collected at Indiana University Bloomington using observations, surveys, and interviews. Preliminary data show that students feel more engaged and embedded in the classroom context than when they attend via zoom, however, attending via beam is not yet equivalent to attending in-person.

Index Terms—component, formatting, style, styling, insert

I. INTRODUCTION

This document is a model and instructions for LaTeX. Please observe the conference page limits.

II. INTRODUCTION

As the world has been battling the COVID19 pandemic, we recognize the importance of remote attendance. Universities are already beginning to transition back to campus, thanks to vaccination, but some students still need to be remote, for either they have immunodeficiencies or other risk factors or they have to quarantine. In fact, even prior to the pandemic, some students needed to be remote for short-term or long-term disabilities or sickness.

Different universities have made some efforts to provide instruction for students with disabilities through home tutoring, online courses, and video conferencing. However, such solutions do not offer the social experience a student needs and gains while interacting with peers in the classroom environment [1,2].

MRP has potential as a compelling medium which affords access for marginalized populations to people and places to which they might not otherwise have access [3]. It can alleviate the problem of isolation for students with disabilities, attenuate the limitation of inaccessibility, and create a safer school environment. In particular we see MRP as critical technology for the current transitioning of universities to in-person classes and to persons with disabilities in general. MRP, for it gives the pilot agency over a remote body, may allow for a richer interaction than technologies such as video conferencing, as students can independently maneuver MRP and interact with those present in the classroom, can get a better feel for the broader social context of the classroom, and can make their own presence felt more substantially through their physical movements.

Our goal is to reveal the challenges and opportunities of supporting classroom engagement and interaction using MRP and devise design and use recommendations that can make student attendance efficient.

III. RELATED WORK

Telepresence: The concept of telepresence [4,5,6,7,8,9] has been defined as the feeling of "being there" in the mediated environment [10]. In particular, robotic telepresence interactions mimic to a great extent face-to-face interactions. Many of the face-to-face cues are available when telepresence robots are involved, such as facial expression, intonation, accent as well as movement in the remote space. Some researchers found that telepresence robots improved the interpersonal social connections between the user and interlocutor [11,12], and empowered the users [13,14]. MRP has been investigated in office work [15,11,16,12,17] and attending conferences [18]. However, they are understudied in educational settings [19,20,1,2]. The use of telepresence robots appears promising in the context of the classroom as they can be engaging.

Engagement in the classroom: Researchers have identified a correlation between the frequency of students' interaction with their school environment, and students' motivation and engagement levels [21,22,23]. Students who physically attend classes and interact with their classmates, instructors and the school environment tend to be more behaviorally, emotionally, and cognitively ready to be involved in the classroom activities and the learning process. Thus, communication tools that promote direct social interaction are more engaging for learners [24]. MRPs offer the option of mobility through the body of the robot which delivers a more realistic perception of the physical embodiment of the user within the remote space being explored. Using a MRP immerses users into navigable, real remote worlds filled with rich spatial sensorium. Thus MRP is a potentially engaging medium in the classroom context.

Embodiment: The notion of embodiment is fundamental to cognitive psychology, as embodied cognition [25], and Human Computer Interaction, as embodied interaction [26]. Embodiment can be generally defined as "having a human

body" [27]. Dourish [28,29] stresses the importance of context in embodied interaction, which emerges from the interaction, rather than being fixed by the system, such as when one is limited to interacting with a desktop computer. For Dourish, that which gives actions their meanings is the specific setting; physical, social, organizational, cultural, and so on. Thus actors understand those actions and meanings by going through experiences and activities. From cognitive psychology approach, Norman [30] and Shepard [31] emphasize the importance of the embedded relationship between people and things, and the role that manipulating physical objects has in cognition. Thus, the metaphors that shape our thinking arise from the body's experiences in our world and are hence embodied [32].

In our study, we adopt the Learning in Embodied Activity Framework (LEAF), by Danish et al., [33], as an umbrella for our work. LEAF was developed to combine frameworks for embodied cognition, which focus on the individual learner, with Cultural-Historical Activity Theory (CHAT), which focus on collective activity. It suggests that understanding embodied cognition pre-requires accounting for "how embodied cognition is both influenced by, and helps to shape, the relationship between individuals and their social contexts." (P.51) LEAF is relevant to our project as it accounts for how the body plays a role in collaborative learning, where coordination between and across students is important to the learning process, such as when the student is attending via MRP and working collaboratively with other teammates. This framework will help us 1- make sense of our data, by attending to both dimensions of learning, and 2- suggest MRP design heuristic as well as use guidelines and activities that leverage the MRP as a remote body for learning.

We suggest MRP's embodiment feature would help immerse the student in the learning space and empower them to participate in classroom activities and discussions. While MRP has great potential in classroom use, many researchers highlighted challenges in their use [34,15,35,17]. MRPs are generally controlled by the human operators with limited or no possibility for those in proximity to provide input. Thus, it may be difficult for the human operator to respond to context. This might negatively impact the remote attendee engagement and interaction in the classroom.

Our work considers potential benefits as well as sources of friction for design and use of MRP in higher education contexts.

IV. METHOD

We are using observation, survey and interview methods to collect behavioral and attitudinal data. The study is taking place at Indiana University Bloomington where we invite students to attend an in-person class remotely using MRP. We study participants' behaviors and attitudes to measure and qualify their engagement with the classroom contents and their interactions with peers and instructors. We also survey and interview the classmates of the remote attendee.

A. Research Questions

There are three overarching questions for this project:

- What are the perceived benefits and drawbacks of MRP in the classroom with respect to both the controller of MRP and those in proximity to it? The aim is to explore how MRP as a medium supports the engagement and interaction of the remote student and what limitations does this medium impose?
- How does MRP use in the classroom differ, in terms of engagement and interaction, from other media and in-person interactions? The goal is to compare MRP with other attendance modes.
- How can the answers to the former research questions inform the design and use of MRP for the classroom? The goal is to provide guidelines for educators who consider using MRP to support their students' classroom attendance, as well as design recommendations that consider the classroom context and support classroom interaction and engagement.

This study is advertised to students through their instructors at IU's Luddy School. Students are trained prior to using the MRP. - In participatory observations, a research team member is present in the classroom to observe and take notes. This allows us to collect data about the pilots' behavior as they engage and interact with the classroom environment. - Surveys are sent to the classmates of the remote attendee to inquire about their experience and learn about their attitudes. - Interviews allow us to get in-depth information about the stakeholders' experiences (remote attendee and classmates). The remote attendees will be interviewed after attending class while their classmates will be invited after they complete the survey to be interviewed if they are interested.

Transcripts from participatory observation interviews will be analyzed in the light of LEAF using thematic analysis [36]. We will identify recurrent themes in the raw data line-by-line prior to interpretation [37]. Thematic analysis goes beyond identifying and counting occurrences of words or phrases to identify implicit ideas [38] and affinities between them; this involves iteratively looking for consistencies and differences in the data.

B. Project's significance

The project aims to contribute to knowledge at the intersection of learning and Human-Robot Interaction in the context of the post pandemic era to draw inferences about the factors (technical related to the design of the robot or social related to the users' attitudes, behaviors) that shape the use and effectiveness of MRP in supporting engagement and interaction in the classroom. In addition, it aims to enrich the literature on the use of MRP in universities and its use post the pandemic era. Last, it will problematize design aspects of MRPs and yield new insight both into their design and classroom interaction and engagement.

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