Power of Telepresence Robots in Connecting Rural Communities With Pop-Up Makerspace STEAM Studios

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Abstract: This study is part of a larger project, "One Community One Challenge," which explores community Pop-Up STEAM Studios makerspaces. Through the telepresence robots, we brought together the intergenerational community members at two different libraries in the county. Two facilitators were present in both locations to navigate the robots and document the process of sharing the making of artifacts. We present the participants' experiences and challenges in implementing the telepresence robots to connect two pop-up makerspace settings at different geographic locations. The study's findings contribute to our understanding of how individuals perceive and interact with the new affordances so that we can facilitate a more strategic approach to better designing and implementing the incorporation of emerging technologies.

Introduction

Makerspaces have become a popular collaborative learning space where individuals can explore, design, test, and innovate across multiple disciplines, particularly in Science, Technology, Engineering, Arts, and Mathematics (STEAM). While making happens in various spaces, it is often restricted to museums and private spaces with a limited audience and membership fees (Buechley, 2017; Ratto, 2011). The purpose of makerspaces is to create collaborative, accessible, and democratized spaces where individuals can freely explore and tinker (Ames et al., 2014; Rosner et al., 2014). Aligned with that, our goal through the One Community One Challenge (OCOC) Pop-Up STEAM Studio project is to democratize makerspaces in such a setting that is accessible to everyone with no fees for participation. During the project's three years, we organized the Pop-Up STEAM studios in four libraries, one arts center, one resource center, three public parks, and one public botanical garden across the county. As we expanded our reach to multiple locations, we felt the need to bring together community members of different locations on a common ground of sharing the process of making and having real-time communication through telepresence robots.

Research questions

This exploratory study investigates the impact of using telepresence robots to connect two distant rural communities with pop-up makerspace STEAM studios. The following research questions guide this study:

1. What are the experiences of the participants in two distant pop-up makerspace STEAM studios in showcasing the making processes to each other through telepresence robots?
2. What challenges and barriers exist in implementing the telepresence robots to connect two pop-up makerspace settings at different geographic locations?

Theoretical perspective

This study draws upon a new affordance framework of the Perceiving and Interacting Affordances Model, which describes how people perceive and interact with affordances (Lu & Cheng, 2013). In the context of our study, this model emphasizes how participants perceive and engage with the affordances facilitated by the telepresence robots (TPR). This new affordance model elaborates three concepts closely related to our study. The first concept of perceptual probability of affordance reflects how the participants perceive the introduction of TPR. The second concept of the perceptual threshold of affordance relates to interaction with the TPR, overcoming the barriers, such as unfamiliarity with the robots, and showcasing the making processes to each other through the TPR. The third concept in the model emphasizes the significance of situational factors in shaping human-affordance interactions, which relates to the socio-economic backgrounds of the participants and infrastructure limitations of the location, which indirectly impact the adoption and usage of TPR in the makerspace studios. By understanding how individuals perceive and interact with the new affordances, we can better design and implement the integration of new technologies.

Literature Review

Previous studies explored the use of telepresence robots (TPR) in various contexts. These contexts are related to exploring the use of TPR in museums (Germak et al., 2015), engaging distant learners in the classroom (Cheung et al., 2018), studying the impact on students' autonomy, social engagement, and agency in learning (Lister, 2020; Navaie et al., 2024), and providing access to makerspaces for rural teachers (Chen et al., 2022). The Nebraska Innovation Maker Co-Laboratory project enhanced the makerspace experience for their rural community using collaborative virtual spaces and TPR (Apel, 2018). TPR has been used increasingly in makerspaces and online learning (Chen et al., 2022). However, there is limited research on the potential of

connecting two geographically distant makerspace settings through TPR that fosters the exchange of ideas and collaborative making processes. Our study aims to showcase the feasibility, challenges, and outcomes of using TPR to bridge the gap between two makerspace STEAM studios located far from each other in a rural county.

Methods

This study is a part of the larger project exploring community pop-up STEAM studios. This paper reports on the study's final implementation of pop-up sessions of the "Stories in Soil" challenge. In this challenge, community members of all ages explored soil filtration and painting with soil pigments based on the common ground theme and Oklahoma's red dirt heritage. The participants for this study were intergenerational, but this study focuses on the cases of two participants who were communicating their processes of making the artifact through telepresence robots. This study aims to uncover the potential of telepresence robots with evidence-based practices in connecting two makerspace locations situated in a rural county.

We used telepresence robots to connect two pop-up STEAM studios located at two different libraries in the county (see Figure 1). Two facilitators were present in both locations to navigate the robots and document the process of making artifacts. Intergenerational participants were present at both locations. The participants were engaged in the episodes of planning, designing, redesigning, and testing (Panwar et al., 2024) of the soil filters and painting with soil pigments. The technology facilitators navigated the robots near the participants, where they showcased their painting process and soil filtration testing process to each other.

Figure 1

Telepresence robots connecting two pop-up STEAM studio makerspaces

Findings

The primary sources of data collection were visual images, observations, and interview transcripts. The research team transcribed the participants' interview videos and examined the visual and observational data through digital stories for better data analysis (Panwar & Vasinda, 2023). This section presents the participants' experiences and challenges in integrating telepresence robots (TPR) in a makerspace setting.

Based on the thematic analysis of the data collected, we found curiosity among the younger participants about operating the TPR to drive. The participants were curious to see what was happening on the other side of the pop-up studio at the other location. As soon as the telepresence robot entered the room, all the kids of different age groups ran towards it and started peeking at the screen to see who was on the other side and where they were from. After a while, everyone settled into their own places and were engaged in making their artifact. Interestingly, two young female participants were engaged in the conversation while creating their artifacts and showed each other their soil filtration testing process. They also become creative in their work while looking at each other's making process. Below is an excerpt of the interview transcript for the two young female participants and their interactions using TPR (see Figure 2).

> *Participant A - Ohh Look at yours! Mine is pinkish brownish. It is so fun (Looking at other participants' colors)*
> *Participant B - we have different colors*
> *Participant A - I don't know why we have different colors*
> *Facilitator - what did you add?*
> *Participant B: I did some of each (added all the different kinds of soil present there). I also added a little bit of char*

and this really cool dirt.
Participant A - I put pot soil and sand, gravel, sandy loam and topsoil.

Figure 2

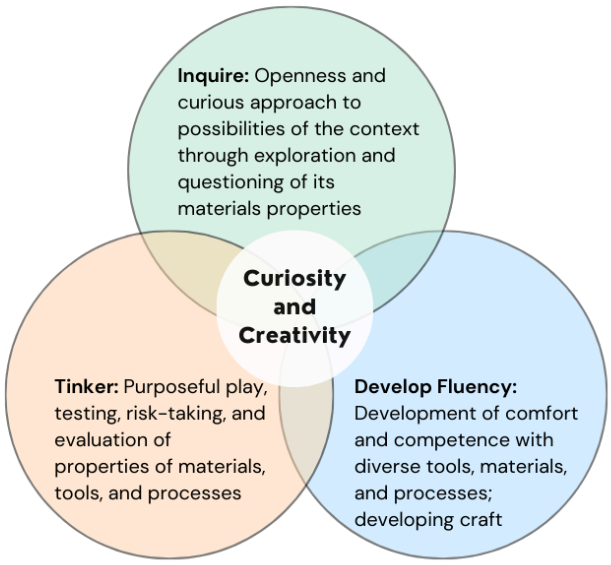
Interaction of the participants through Telepresence robots

Their interview transcript was analyzed using the seven learning practices of making: Inquire, Tinker, Seek & Share Resources, Hack & Repurpose, Express Intention, Develop Fluency, and Simplify to Complexify (Wardrip & Brahms, 2015).

The emerging themes of curiosity and creativity overlap with the learning practices of making: Inquire, Tinker, and Develop Fluency (Wardrip & Brahms, 2015), adding to the theme of "satisfaction" that the OCOC team uncovered in the previous study (Vasinda et al., 2023, p. 1596). Inquire showcases a curious approach towards exploration. Tinker involves purposeful play, which relates to the creativity of the participants. Developing Fluency is about developing comfort and competence with diverse processes. As the makers gain fluency, their curiosity and creativity are empowered (see Figure 3).

Figure 3

Emerging Themes with Learning Practices of Making (adapted from Wardrip & Brahms, 2015)



With the introduction of a creative learning environment, there come challenges with the technology. Some of the challenges were related to internet connectivity issues and mobility, as maneuvering the robots was challenging with heavy iPads. The facilitators switched to using their mobile phones to navigate the robots instead of iPads. We experienced different levels of engagement in different age groups. A teenage male participant was not very interested in interacting with the other participants at different locations through TPR. There was a misperception of TPR as a toy rather than something that facilitates real-time communication with the participants from other locations.

Discussion

Our study showcases the potential of telepresence robots (TPR) as a transformative community-building tool for connecting distant makerspaces in rural communities. The research team gained valuable insights from the participants' responses regarding the feasibility, challenges, and outcomes of using TPR to facilitate collaboration and communication between geographically distant makerspaces. Future research could explore the long-term impacts of integrating TPR on community

engagement and connecting makerspace communities, particularly those without access to physical makerspaces. Future studies can also benefit from integrating AI features into the telepresence robots.

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