

Influence of Telepresence Robot on Discussion in Hybrid Classes

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Abstract: The COVID-19 pandemic has led to widespread adoption of hybrid classes, which bridge in-person and remote learners. However, hybrid classes often result in inactive communication among the participants. Towards resolving this serious problem, it is important to share atmosphere in classes, and to enhance presence and engagement of learners. This paper focuses on how presence of remote learners could be enhanced with a telepresence robot, which is controlled by remote learners. In this paper, we report a case study where we compared group discussion consisting of in-person and remote learners under two conditions: using only Zoom and using Zoom and a telepresence robot. The results suggest that the robot could increase remote learners' presence and engagement, making them feel as if they were in the same place. It is also suggested that the robot gives all the learners in a group more equal speaking opportunities rather than only Zoom.

Keywords: Hybrid learning, Telepresence robot, Active communication

1. Introduction

Due to the COVID-19 pandemic, many higher education institutions switched from face-to-face to hybrid classes, which bridge in-person (on-campus) and remote learners. In hybrid classes, communication between in-person and remote learners often becomes inactive, which leads to fewer opportunities for knowledge and experience sharing. This paper aims to enhance communication in hybrid classes by means of a telepresence robot, which remote learners could control to interact with in-person learners as if they were physically present. There are some studies on the impact of telepresence robots on learning (Alexander, et al., 2022). However, it is not sufficient to examine the effects of robots on hybrid learning, and the differences between robots and web-based video-conferencing tools.

In this paper, we report a case study whose purpose was to evaluate the effectiveness of a telepresence robot in promoting communication by comparing group discussion among in-person and remote learners only using Zoom with the one using Zoom and the robot.

2. Promoting Communication

In a classroom, it is generally crucial to share atmosphere and tasks among the participants in promoting communication. Task sharing involves participants engaging with the same content collaboratively, which can be viewed as collaborative work (Nahomi, et al., 1999). This helps them externalize their thoughts and deepen their mutual understanding. In face-to-face classes, the participants naturally interact with each other to share atmosphere and tasks smoothly. On the other hand, such sharing is quite challenging in hybrid classes.

The keys to active communication in hybrid classes are the sense of learners' presence and their engagement. In hybrid classes, it is hard for remote learners to show their presence to in-person learners. In-person learners also have some difficulties in perceiving remote learners' presence. Due to these difficulties, communication among the participants becomes inactive in hybrid classes. In addition, they could not be engaged. In order to improve the sense of learners' presence and their engagement, we used a telepresence robot.

In this paper, we used Kubi manufactured by Xandex Inc., as a telepresence robot, which remote learners could control to promote their communication in hybrid classes. As shown in Figure 1, iPad on Kubi shows the view of a remote learner. Remote learners can talk to in-person learners through controlling Kubi on Zoom. For example, they can face to an in-person learner who they want to talk, and nod to show that they agree. Such behavior allows them to make eye contact with in-person learners and share atmosphere as if they were in the classroom. The in-person learners can also perceive the sense of remote learners' presence by seeing the robot's behavior like facing and nodding. The telepresence robot is accordingly expected to enhance the sense of presence and engagement for the participants.



Figure 1. Kubi (Left) and Controller of Kubi on Zoom (Right)

3. Case Study

We conducted group discussion among in-person and remote learners. Each group had four learners: two in-person and two remote. The participants were 16 undergraduate and graduate students in informatics and engineering. We made four groups. We also set two conditions (Figure2): discussion only with Zoom (control condition), and with Zoom and the robot (experimental condition). Each participant held discussion under each condition as within-subject design. There were two topics of discussion, which are the topic about whether elementary school students should have a smartphone, and the topic about programming language for learning. After each discussion, the participants completed a discussion questionnaire (5-point Likert scale). After both discussions, they also completed an overall questionnaire indicating their preferred condition.

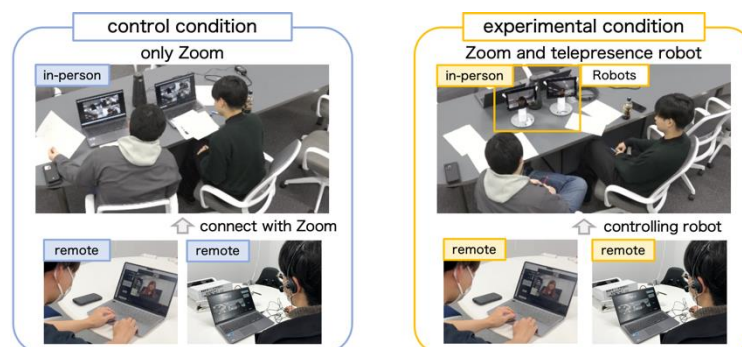


Figure 2. Two Conditions of Discussion

4. Results

4.1 Questionnaire

We analyzed the results of discussion questionnaires separately for in-person and remote learners, conducted the paired t-tests (two-tailed), and calculated Cohen's d as the effect size. Table 1 shows the results of discussion questionnaire for the 8 remote learners. There were significant differences between the two conditions on Q1, Q2, and Q4. Additionally, there were significant tendencies between the two conditions on Q5 and Q7. These results suggest that the telepresence robot can enhance participants' presence and engagement in discussion, and share atmosphere.

Table 1. *Average Scores of Discussion Questionnaire (remote learners)*

Question	Control Condition	Experimental Condition	t-value	Effectsize
Q1: I felt as if I were in the same place as the in-person learners.	1.50	3.00	3.97**	1.15
Q2: I felt as if I were in the same place as the other remote learners.	1.63	2.38	4.58**	0.63
Q3: I felt as if I were in the classroom.	1.63	2.50	1.82	0.67
Q4: How much did you feel the presence of the in-person learners?	2.5	4.00	3.24*	1.5
Q5: How much did you feel the presence of the other remote learners?	3.00	3.38	2.05†	0.41
Q6: I felt motivated to speak actively.	3.50	4.00	1.87	0.59
Q7: I was able to concentrate on the discussion.	4.13	3.13	2.0†	0.94

†p < .10, *p < .05, **p < .01

4.2 Discussion Analysis

We analyzed the number and duration of statements made by each participant in the group discussion. Table 2 and Table 3 shows the variances in the proportions of statements and speaking time each participant had to the total ones of the group. Overall, the variances in the experimental condition were lower than the one in the control group. There was a significant difference in the variances in the proportion of speaking time between the two conditions in Group D. These results show that the telepresence robot provides more balanced speaking opportunities and encourages quieter participants to contribute more actively compared to using only Zoom.

Table 2. *Variance in the Proportion of Statements*

Group	Control Condition	Experimental Condition	F-ratio
A	0.021	0.0076	2.72
B	0.025	0.0060	4.68
C	0.021	0.0029	7.23†
D	0.0013	0.00047	2.75

†p < .10

Table 3. *Variance in the Proportion of Speaking Time*

Group	Control Condition	Experimental Condition	F-ratio
A	0.036	0.015	2.37
B	0.021	0.010	2.09
C	0.0095	0.0022	4.32
D	0.012	0.00047	25.8*

*p < .05

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