

Qualitative Exploration on Children's Interactions in Telepresence Robot Assisted Language Learning

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원격로봇 보조 언어교육의 아동 상호작용 질적 탐색

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Abstract The purpose of this study was to explore children and robot interaction in distant language learning environments using three different video-conferencing technologies—two traditional screen-based videoconference technologies and a telepresence robot. One American and six Korean elementary school students participated in our case study. We relied on narratives of one-on-one interviews and observation of nonverbal cues in robot assisted language learning. Our findings suggest that participants responded more positively to interactions via a telepresence robot than to two screen-based video-conferencings, with many citing a stronger sense of immediacy during robot-mediated communications.

• **Key Words** : Children and Robot Interaction, Distance Education, Video-conferencing, Telepresence Robot, Robot Assisted Language Learning

요약 이 논문은 원격언어교육으로서 2가지 형태의 비디오 영상수업과 로봇영상 수업에 따른 아이와 로봇상호작용을 연구한다. 원격지의 미국 아이와 6명의 한국 아이들로 실험수업을 진행했으며, 일대일 인터뷰를 통한 나래이션 및 관찰분석을 하였다. 실험결과 로봇영상 수업이 2가지 형태의 비디오 영상수업보다 활발한 상호작용을 보였다.

• **주제어** : 아동과 로봇 상호작용, 원격교육, 영어언어교육, 영상회의, 원격연결 로봇

1. INTRODUCTION

Mobile devices and apps are changing the way people learn English. Mobile learning (or m-learning) using N-Screen is helping self-study students and young children to learn English anywhere and at any time using the self-paced learning platform [1,2,3]. Teleconferencing technology is an educational resource

that can facilitate and broaden cultural and social exchange in the classroom. Specifically, the utilization of telepresence robots has the potential to “not only connect people together but to make them feel like they’re all collaborating together inside the same room” as members of the same learning community, “regardless of their physical location” [4]. By expanding the concept of the workplace both in time

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and space, telepresence robots have also shown significant potential in the classroom to provide opportunities for interaction with remote students, teachers or patient children[5].

Robot assisted language learning (RALL) is usually defined as learning that is mediated by robots with artificial intelligence [6,7]. In this study, we utilized a robot called Robosem, a transformed type educational service robot (see Figure 1).



[Fig. 1] Robosem in tele-operated mode

The purpose of this study was to explore how children perceive and learn differently in distance learning environments using video-conferencing technologies. To accurately capture the perspectives of children, we relied on various qualitative data. The following two research questions were explored:

- How do different video-conferencing technologies affect children's engagement and learning especially in the English as a second/foreign language classroom?
- Which technology mediation is perceived as the most interesting to students, thus motivating them to engage more actively in communication? Why?

2. THEORETICAL BACKGROUND

Bernard et al.(2009) highlighted the importance of the “affective benefits of interactivity” between learning agents, measured not by achievement but by “attitude and course satisfaction” in distance education [8]. This social aspect of interactivity is closely related

to collaboration, another type of interaction [9].

Kim et al. (2014) investigated how children interact differently when their interactions were mediated through screen-based video communication versus robot-mediated communication [10]. A key limitation of this study was that they conducted the experiments without controlling for face size, even though the size of the face is an important factor according to the media equation from Bernard et al.'s study [8]. We are expanding this study by taking into account the qualitative aspects of screen-based versus robot-mediated interactions.

In the realm of distance education, the concept of immediacy functions as “a central promise and driver of technological change”, and in the context of this study, telepresence robots operated as “an approximation to realism in representation, as an authentic feeling of being there, and as unrestricted connectivity (anytime-anywhere rhetoric)”[9].

3. METHOD

The case study method is the most appropriate approach because it is “an empirical inquiry that investigates a contemporary phenomenon (the ‘case’) in depth and within its real-world context” and explores a phenomenon of which not much is known [13]. This study followed a qualitative, exploratory case study method to compare children's perceptions of diverse learning experiences offered by three different video-conferencing technologies.

3.1 Experimental Setting

The classes were held in a smart classroom equipped with a large central display (a SMART Board interactive whiteboard) and a laptop operating as a video camera as shown in Figure 2.

Three different video-conferencing technologies were used for this study: two allowing traditional screen-based communications and one allowing robot-mediated communication. The traditional technologies were “a big-faced Selina (Bf Selina)”,

which zoomed in on the remote speaker's face as in most video-conferences shown in Figure 2 (a), and "a life-size-faced Selina (Lf Selina)" shown in Figure 2 (b). With these communications, we used the video chat service Google Hangouts on a large-screen display on the SMART Board. The robot-mediated communication was through Robosem, which has a camera on the top of its screen shown in Figure 2 (c).



(a) big-faced Selina



(b) life-size-faced Selina



(c) robot-faced Selina

[Fig. 2] Video conference interaction

3.2 Participants and Experimental Design

Six elementary students in Korea participated in the study (2 girls and 4 boys, all in grade 2). All participants had studied English for over 3 years and seemed to be at proficiency Level 3 - Developing according to TESOL standards. The American counterpart, Selina, was in grade 4.

Both Korean and U.S. participants were chosen 2 girls and 4 boys, second graders; one elementary student from the U.S. - Selina, a student in grade 4. All participants had studied English for over 3 years and seemed to be at proficiency Level 3 - Developing according to TESOL standards.

The field trials were conducted during two days. On the first day videoconference started with the children and Selina on the *Bf Selina* briefly introducing themselves, followed by an explanation of the content and procedures by the teacher. The next day, they interacted using the *Lf Selina* on similar tasks. Lastly, they communicated through Robosem, the telepresence robot and brought stories of their own which were made using StoryBird, a digital story-building application.

3.3 Lesson Scenario with Nonverbal Messages

The children were asked to perform simple physical activities, such as shaking hands, hugging, and handing in the storybooks that they had created to Selina through the screen-based video-conferences and Robosem. After that, the children and Selina put their arms around each other's shoulders and took a picture. Lastly, they hugged and said goodbye to each other through two different ways. With Robosem, the children performed these physical interactions as if Selina were really there as shown in Figure 3.

〈Table 1〉 Participants' Reactions after Interactions

Big faced Selina	Kyle	I could see her face and facial expressions well, so it was more fun than small-faced Selina.
	Ken	I could see Selina's face well.
	Sean	It feels like she will eat me and eat us all.아
	Clair	I like Big-faced Selina because it was easy to see Selina's face and her facial expressions.
	Matt	She looks like a giant. I felt that Selina was fake, not real.
	Sara	The different size made me feel uncomfortable. There's not much difference between small and big faces in terms of realness. Both are like people in the distance, not near me.
Life size faced Selina	Kyle	It was difficult to see Selina's facial expressions, so it felt like she was on a TV screen.
	Ken	Interacting felt fake.
	Sean	No Response
	Clair	I couldn't see Selina's face well, but I felt it was closer than Big-faced Selina because it is the same size as us.
	Matt	With the same size face and hands, Selina looks more real than Big-faced Selina.
	Sara	It had the same sized face as us and the voice sounded real, but if a robot's voice could sound the same [as a person's voice], I would like to meet friends through robots Interacting wasn't much fun because I felt like I was watching a TV screen.
Robosem	Kyle	Robosem Selina looks and feels real with a face, arms, a body, and movement. Especially because its size is similar to my height, it's as if the robot is a real friend. I feel that the robot was Selina.
	Ken	It feels real because I can touch it.
	Sean	I could kiss or touch it. It felt real when I hugged the robot, like a statue.
	Clair	The size was almost like ours. I could touch it, shake hands, and hug it.
	Matt	It looks real... like a real person with a robot body and my friend's face on the screen, moving like a person.
	Sara	I felt like the person was next to me. The robot is like a human, moving, doing activities with us, so interacting with the robot was more fun.



(a) video faced Selina



(c) robot-faced Selina

[Fig. 3] Nonverbal interaction with Selina

After the sessions, to make sure all of the answers and reactions to the survey questions were accurate to what the children wanted to express, we conducted open-ended interviews [14].

4. FINDINGS

Preliminary analysis based on the survey, video inquiries, and interviews revealed several themes that are significant in distance education in Table 1.

4.1 Level of Interest

Five out of six children expressed that the meeting with Selina through Robosem was the most fun and that they would recommend that their friends meet Selina through Robosem rather than other media.

Clair was the only student who chose the *Bf Selina* as the most fun, and she explained that it was because she was able to see Selina's facial expressions clearly on the big screen.

As for their second and third choices, the children were split. Those who chose the *Bf Selina* liked the fact that they could see Selina's facial expressions while the *If Selina* was chosen by the others because they could see Selina's upper body movements. The negative reactions towards the *If Selina* cited difficulty seeing expressions (Kyle and Clair) and the distance between students and Selina, which made her seem like a person on a TV screen (Kyle and Ken) and not a friend who was interacting with them. Undesirable feelings towards the *Bf Selina* included comments that

it was “unrealistic and fake” (Matt), “overwhelming” (Sara), and had an intimidatingly big face that “would eat me” (Sean).

4.2 Sense of Reality and Realness

All six children selected the Robosem-mediated meeting as the most realistic, the closest to being as if Selina were next to them in the classroom. Their reasons included the movements and actions that Selina performed via Robosem (walking around the classroom, standing next to them, handshaking, hugging, putting arms around their shoulders, and looking at their work); the feeling of Selina's physical presence in Robosem without her being actually physically present; and the human-like appearance of Robosem. The children all agreed that they felt as if the real Selina were moving around the classroom to see their work and interact with them, doing the activities together as a member of the class. They also expressed that Selina's presence felt real since they could touch Robosem and, because of Robosem's size and height, easily make eye contact with Selina.

4.3 Familiarity and Closeness

In terms of familiarity and closeness, five students chose Robosem-mediated Selina as the closest friend. Sara mentioned the *Lf Selina* felt most familiar; however, she stated in the interview that she would have chosen Robosem if the voice from the telepresence robot had not sounded “different.”

4.4 Kinesthetic Communication

Almost all of the children expressed that they liked Robosem most because they could “feel” and “touch” Selina (Clair, Kyle, Ken, Matt, and Sean). To the children, Robosem moved and acted like “a real friend” (Kyle and Sara) who was “next to us” (Clair, Sara, and Sean) and “had hands and body like us” (Matt). In contrast, they voiced that interacting with Selina through the screen-based communication felt “fake” (Kyle, Ken, Sean, and Clair), “awkward pretending”

(Matt and Sara), and distanced like “watching a TV” (Sara).

The children all agreed that Robosem was the physical embodiment of Selina—through Robosem she could see, hear, speak, and move, and the children could physically interact with her as well. Some even explicitly stated, “Robosem is Selina” (Sara and Kyle). This is why Sara was a little reluctant to hug “Robosem Selina”; Sara felt that she and Selina were not yet close enough friends to hug, especially in front of other friends. In his interview, Kyle said that he thought he would need his parents' permission to kiss Selina.

5. DISCUSSION

The children implicitly and univocally conveyed the social presence of Selina in Robosem [15]. Based on their attitudes and feelings towards Selina through verbal expressions, nonverbal cues, and implicit behaviors, we were able to see how their sense of awareness of Selina's presence differed with various technologically mediated communications.

5.1 Immediacy

The children used expressions that were closely connected to their perceptions of Robosem as an extension of Selina: “real,” “realistic,” “natural,” “like my friend,” “as if she were here with us,” “We shook hands,” “tangible,” and so on. Furthermore, the children were not hesitant to ask Selina questions on her personal life, initiating the communication by telling their stories first. The use of positive words and inclusive pronouns illustrates their feelings of connectedness with Selina through Robosem.

Nonverbal immediacy behaviors were more evident. The children not only expressed feelings and moods but also conveyed messages by nodding and smiling a lot more and leaning forward toward Robosem, as if they wanted to shorten the physical and psychological distance between Selina and themselves. They jumped

up and down, stomped their feet, clapped their hands, and grinned in excitement when waiting to interact with Selina via Robosem. In addition, the children's eyes were fixed on Robosem Selina's face, even when it was interacting with other students. In contrast, they tended to become distracted easily when *Bf Selina* or *Lf Selina* was interacting with other students.

All children were very attentive to the responses of their classmates and Selina, bending their bodies to see Selina's face and turning to make eye contact with the teacher. They also maintained closer positions to Robosem Selina than to screen-based Selina. The physical and psychological proximity they showed through nonverbal implicit behaviors clearly communicated their positive feelings and attitudes toward Robosem-mediated communication.

5.2 Individual Differences

Study participants Sara and Matt seemed shy and very quiet at first, but they both smiled a lot whenever their classmates were shouting answers or asking silly questions. Video analysis of the classes revealed that Sara seemed especially excited about interactions with Robosem Selina and her classmates' responses. Her excitement was evident based on her body movements and facial expressions: wide sparkling eyes, big smiles, forward lean, and changing body orientation to make eye contact with Selina and the teacher.

Matt, in a similar manner, used several immediacy cues to convey his preference and liking. For example, he eagerly asked Ken about how and what he did during the interaction with Robosem-mediated Selina. Other children also went over the steps verbally with the friends next to them, making sure they understood the instructions before their turns. Like Matt, most boys shared their feelings of excitement and adventure with their friends when they successfully accomplished the tasks. Throughout the task, the children exhibited learner - learner interaction and collaborative behavior.

In contrast to Sara and Matt, Ken was very chatty and outgoing. When he was referred to our study, he

was described as a distractible, hyperactive kid who did not care much about learning outcomes. However, during class he exhibited a drastically different attitude, asking questions and being very attentive. After the children shared their stories online, Ken articulated to his mother his dissatisfaction with his story, comparing it to the other students' work. His mother informed us that she was really surprised to hear Ken expressing frustration over not being a better student, since it was the first time he had talked about his academic abilities and shown positive determination.

Together, these reactions and various verbal and nonverbal cues indicate how much the children were engaged and motivated by the telepresence robot, how the interactions created feelings of closeness and connectedness, and how strongly they felt the social presence of Selina [15,16]. These are the "affective benefits of interactivity" that can be measured by attitudes according to Bernard et al.'s study [8]. The children clearly showed through various explicit and implicit behaviors that they considered Robosem Selina to be a classmate of theirs, pursuing the same goals as they were.

6. CONCLUSION

The subtle quality of nonverbal cues and implicit communicative behaviors add more interesting dimensions to their experiences, ones that could have gone unremarked if only rating scales were employed in RALL.

In addition, with a human-like physical form and corporeal interactions, the telepresence robot Robosem enabled the children to see Robosem as an embodiment of Selina, an avatar that brought her social presence to the classroom. Even though some of the children did not overtly express their positive feelings and attitudes towards Robosem Selina, their nonverbal cues and implicit behaviors indicated that their interactions with Robosem Selina had created feelings of closeness and connectedness. This sense of immediacy is what

fosters a sense of community in distance education.

Future studies should investigate the impact of extended engagement, the role of mediator/accommodator, verbal and nonverbal teacher immediacy, and the effectiveness of blended learning. This additional research would add to our understanding of telepresence robot-mediated communication in the classroom and help meet the intended education and motivational end goal.

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