

Telepresence Robots: A Phenomenological Study of Perceptions of Graduate Students and Professors

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The purpose of this phenomenological case study was to capture the perceptions of telepresence learning from three different perspectives: the graduate student using the telepresence robot, the graduate students in the physical learning environment with one of their peers utilizing the telepresence robot, and the instructor teaching in the learning environment where a telepresence robot is being utilized. This study was analyzed through the lens of Whiteside's 2015 Social Presence Model, which synchronizes interactions between the instructor/professor, students, content, and technologies being utilized. While some challenges exist, the telepresence robots established a social and physical presence from a remote location.

Keywords: telepresence robots, social presence, physical presence, recruitment, retention

INTRODUCTION

Telepresence robots are being used in education to provide access to students who available yet cannot be physically present in the room with their peers (Herring et al., 2016; Zhang et al., 2018). While face-to-face interactions may always be the gold standard, there are situations where students are prevented from learning with their peers in synchronous, face-to-face settings. Telepresence robots may be a solution to these situations as telepresence robots allow students to use their laptop, phone, or other computing device from a remote location in order to learn synchronously with their peers (Herring et al., 2016; Zhang et al., 2018).

Telepresence robots are similar to internet-based webcasting platforms, such as Zoom, Webex, Microsoft Teams, or GoToMeeting in that users in different locations can talk to each other and see each other in real time. However, telepresence robots are different than Zoom, Webex, Microsoft Teams, or GoToMeeting in that telepresence robots are “designed specifically for remote presence and telecommunication,” which allows one user the ability to move a telepresence robot, giving it a physical and social presence (Zhang et al., 2018, p. 2).

Purpose of the Study

The purpose of this research study was to capture the perceptions of telepresence learning from three different perspectives: the graduate student using the telepresence robot, the graduate students in the physical learning environment with one of their peers utilizing the telepresence robot, and the instructor teaching in the learning environment where a telepresence robot is being utilized. This study aimed to capture the perceptions of graduate students and professors after each use of this new technology in order to identify themes or trends in perceptions as the telepresence robots were used in graduate level courses.

Understanding these themes or trends may help inform professors how to better utilize telepresence robots in their higher education courses, and, in turn, increase access to the classroom and equitable time in the classroom for educators taking graduate level courses. Moreover, when access and equity are provided for these educators, such modeling may influence them to consider using telepresence robots in their classrooms.

Research Questions

This study was guided by two research questions:

1. What are the perceptions of graduate students when telepresence robots are used in graduate level courses?
2. What are the perceptions of professors when telepresence robots are used in graduate level courses?

THEORETICAL FRAMEWORK OF SOCIAL PRESENCE

The theory of social presence was introduced by Short et al. (1976), as these researchers were interested in understanding a student's immediacy and intimacy in a classroom. This theory was further developed by Whiteside's (2015) Social Presence Model, which synchronizes interactions between the instructor/professor, students, content, and technologies being utilized. This synchronization was emphasized through connectedness and community as an important aspect of the theory of social presence (Whiteside & Dikkers, 2016). Future research should focus on the fundamental role that social presence plays in shaping a learner's educational experience through the use of new technologies (Whiteside et al., 2017). As the technologies evolve, the definition of social presence evolves as professors strive to create opportunities for high levels of social presence for learners who cannot physically be in the classroom with their peers (İzmirli, 2020; Whiteside et al., 2017).

CONTEXTUAL FRAMEWORK

Heartland University (a pseudonym for the university in this study) designed their programs for adult learners who are working full time. Their programs support a hybrid approach to instruction as the optimal method of delivery for graduate level education as it provides opportunities for accessibility and equity to educational experiences, diversity of thought, interpersonal communication skills, collaboration among districts, and relationship-building with potential dissertation committee members. However, in a large, rural state, weather conditions, proximity to the university, professional conflicts, and the personal challenges of the adult learner can prevent students from attending every on-site class. Professors in the Division of Educational Leadership were concerned that this places graduate students who are unable to attend a day long class at a disadvantage. There is an increasing need to explore the ways technology can support remote learners and professors, both the able bodied and those with mobility challenges (Herring, 2013). Most recently, the COVID-19 pandemic has created a sense of urgency to find innovative ways to effectively engage remote learners and provide an equitable educational experience. The use of a telepresence robot that allows the user to move the robot provides a more meaningful means of participation than other distance technology support services that are immobile. The student can move the robot to obtain an optimal view of the instructor and the classroom, as well as move near peers for small group interactions, which increases the sense of presence for the remote student. The user does not need additional equipment, just internet access and a connection to a computer link. For the purpose of this study, the robot is not intended to replace face-to-face attendance, but to respond to the realities of the adult learner in a large, rural state without access to public transportation. The researchers in this study only used the robot for extenuating circumstances that would prevent a graduate student from attending one class session of the semester. Professors in the Division of Educational Leadership have two telepresence robots, so use was limited to two students per class over a period of three semesters.

Specifications of Telepresence Robots Used in This Study

The author of this study has no affiliation with Double Robotics as the following information is shared for contextual and informational purposes. The two telepresence robots used in this study were Double 2 Robots made by Double Robotics. Double 2 Robots are iPad-based telepresence robots and look similar to an iPad mounted on a Segway. Each Double 2 robot uses gyroscope and accelerometer sensors in their base, and each base is made up of one wheel which is approximately 12 inches high and 18 inches wide. A pole about one inch in diameter stems from the base and an iPad is mounted to the top. The screen of the iPad allows the user's face to be displayed at all times and is connected to the base through Bluetooth technology. The iPad must be connected to a wi-fi network. Double Robotics uses their own software, which allows users to be telepresence in a room when they are physically in a different location. At the time of this study, the cost of a Double 2 Robot is approximately \$2,499.00. Both robots were generously funded by the university's Center for Teaching and Learning.

REVIEW OF RELATED LITERATURE

Telepresence robots are a modern invention, which means more research is needed to fully understand the strengths, challenges, and other uses of telepresence robots. The researchers were unable to cite any research on the perceptions of telepresence robots as this is the first study of its kind.

Strengths

There are many identified strengths of telepresence robots including a clear purpose for the new technology, giving the user a sense of presence, and that telepresence robots are interesting.

Clear Purpose for the New Technology

One strength of telepresence robots is the clear and obvious goal, which is to provide access to students who available yet cannot be physically present in the room with their peers (Mårell-Olsson et al., 2014; Zhang et al., 2018). Telepresence robots have the opportunity to utilize a mobile platform that displays the human operator on the screen, which is the student who is available yet cannot be physically present in the room (Li, 2015). This availability to be telepresent in a room with peers helps one to feel more socially connected (Newhart et al., 2016). As education transitions from teacher-centered to student-centered, the need for telepresence robots helps students feel more socially connected in a student-centered learning environment (Rosenberg-Kima et al., 2020).

Giving the User a Sense of Presence

Users of telepresence robots for distance education report a sense of being present in the classroom even though they are not physically present in the classroom (Newhart et al., 2016; Zhang et al., 2018). A sense of presence matters because one's "physical presence plays a greater role in psychological response to an agent than physical embodiment" (Li, 2015, p. 34). Li (2015) also found that "79% of reported significant results across 12 studies showed that a physically present robot elicited more favorable responses than when the robot was displayed on a digital screen" (p. 34). Newhart et al. (2016) found that anthropomorphism occurs when students see their peers using a telepresence robot. This finding is supported by other studies in which humans subconsciously tend to treat computers or iPads as if they were humans (Luczak et al., 2003; Nass & Moon, 2000; Rosenberg-Kima et al., 2020). Put another way, the physical presence (rather than the physical embodiment) gives a user a sense of social presence, which exemplifies Whiteside's (2015) Social Presence Model.

Telepresence Robots Are Interesting

One of the strengths of telepresence robots is the novelty effect, which may cause peers who are physically present in the room to be interested in the telepresence robot, especially during one's first interaction (Rosenberg-Kima et al., 2020). One of the reasons why telepresence robots are interesting is because they combine the embodiment of intelligent systems within a physical robot and virtual agent

(Brooks, 1990; Cassell, 2000; Dautenhahn et al., 2002, Li, 2015). This embodiment is a “tighter coupling” between a robot and a human (Li, 2015, p. 24). The users of telepresence robots tend to concentrate and focus at a high level, which keeps a high interest level between peers and the user of the telepresence robot (Fels et al., 2001).

Challenges

There are many identified challenges of telepresence robots including user difficulty in continuously controlling the robot, challenges to audio and visual, difficulties for professors balancing face-to-face instruction with a with a telepresence robot in the classroom, smoothness of interactions between the user of the telepresence robot and those physically in the room, and fears of telepresence robots.

User Difficulty in Continuously Controlling the Robot

Users of telepresence robots have reported difficulties in continuously controlling telepresence robots, especially in regard to consistently keeping the teacher within the view of the user of the telepresence robot (Duan, 2019; Zhang et al., 2018). Difficulties are reported when active learning is not practiced by the user of the telepresence robot (Duan, 2019).

Challenges to Audio and Visual

The quality of audio and visual connections must be maintained in order for telepresence robots to be effective (Zhang et al., 2018). When using a new technology, professors feel a need to guarantee the technology will work or at least have immediate access to technological support specific to the telepresence robot (Mårell-Olsson et al., 2014). Rosenberg-Kima et al. (2020) reported that one of the technical functionality drawbacks is when a robot’s voice was not clear. As with any technology with hardware that connects to wi-fi, moving from wi-fi port to wi-fi port may cause issues with audio and visual (Balasubramanian et al, 2008).

Difficulties for Professors Balancing Face-to-Face Instruction With a Telepresence Robot in the Classroom

As educational technologies evolve, a reality is that professors are usually no better than students when it comes to their comfort level of using technology to enhance education (Zhang et al., 2018). While professors may be familiar with delivering high level academic content to students, adding a telepresence robot is reported as a challenge. On top of preparing for the content of the course, a professor may feel it takes too much time to prepare to teach with a telepresence robot, which may cause a professor to rely on traditional methods of teaching (Mårell-Olsson et al., 2014).

Smoothness of Interactions Between the User of the Telepresence Robot and Those Physically in the Room

The social interactions between users of telepresence robots and those physically in the room (i.e. peers and the professor) can be a challenge (Zhang et al., 2018). These challenges are magnified when the wireless network connected to the telepresence robot is weak, inconsistent, or not working properly (Mårell-Olsson et al., 2014). The smoothness of interactions usually requires a strong Wi-Fi connection, which is not always available or may be experiencing technical difficulties.

Fears of Telepresence Robots

One of the fears of telepresence technology is the fear of surveillance (Mårell-Olsson et al., 2014). Another fear of telepresence technology is the unclear understanding one’s identity or the fear of the development of humans into cyborgs (Mårell-Olsson et al., 2014). Newhart et al. (2016) found that this technology is emerging so quickly that it is being used with little to no research in regard to the impact of telepresence robot use on students.

Other Uses of Telepresence Robots

As fiberoptic internet expands, commercially available telepresence robots are becoming available (Herring et al., 2016). Telepresence robots are being used in many environments including offices, within the field of health care, in assisted living for elderly, distance monitoring, anti-terrorism efforts, spiritual companionship, restaurant industry, clothing industry, and in distance education (Duan, 2019; Zhang et al., 2018).

Homebound Students

One emerging use of telepresence robots is to serve homebound students. The use of telepresence robots for homebound students is a complex issue as it intersects with education, healthcare, and technology (Newhart et al., 2016). Newhart et al. (2016) found that

even though attending school with peers and close friends constitutes the bulk of their daily lives, when some children are diagnosed with a chronic illness (e.g., cancer, heart failure), they are suddenly removed from a social context that constitutes four to six hours of their daily lives. (p. 9)

A lack of inclusion for K-12 students may increase a sick student's feelings of anxiety (Fels et al., 2001). Telepresence robots provide virtual inclusion for homebound students, which allows for a student to interact with peers, teachers, and others in a K-12 school environment (Newhart et al., 2016). These interactions improve a student's social skills, communication skills, sense of self-confidence, motivation, and independence (Fels et al., 2001).

METHODOLOGY

This study employed a phenomenological case study approach as its aim was to capture the perceptions, feelings, and reflections of telepresence learning from graduate students and professors. Creswell (2012) conceptualizes the case study approach as "a type of design in qualitative research that may be an object of study, as well as the product of inquiry" (p. 97). A case study approach identified the boundary of the study, which in this case is the lived experiences of all graduate students and professors who learn and teach with a telepresence robot in the classroom room. This approach utilizes multiple sources of data in order to construct a multilevel analysis (Creswell, 2012). A phenomenal approach was necessary because this study describes the meaning for several individuals of their lived experiences of a concept or a phenomenon (Creswell, 2012), which in this case is the lived experience of a telepresence robot. Merriam and Tisdell (2016) encourage the combination of other methodologies with case studies whenever the study is bounded and requires a focus of inquiry, which is also supported in the literature (e.g. Fine, 2015; Goodman, 2016).

Data Collection

After the face-to-face graduate class ended, the researcher emailed a Qualtrics survey to everyone in the room who experienced the telepresence robot. Survey A was sent to the graduate student using the telepresence robot (See Appendix A). Survey B was sent to graduate students in the physical learning environment with one of their peers utilizing the telepresence robot (See Appendix B). Survey C was sent to the instructor teaching in the learning environment where a telepresence robot is being utilized (See Appendix C). The surveys were voluntary, anonymous, and took approximately 20 minutes to complete.

Population

The population of this study was limited to graduate students and professors. The graduate students and professors in this study was limited to Heartland University (a pseudonym for the university in this study), which is a public university in a rural state in the Midwest.

TABLE 1
POPULATION AND NUMBER OF RESPONDENTS

Role	Number of Respondents
Graduate Students Using the Telepresence Robot	26
Graduate Students in the Room with the Robot	115
Professor Teaching the Class with the Robot	20

This study employed survey data from three populations: graduate students using the telepresence robot, graduate students in the room with the robot, and professor teaching the class with the robot. Each survey was evaluated through a pilot study, which included graduate students and professors who taught with the telepresence robot in the classroom. The pilot study strengthened the reliability and validity of the researcher-generated survey.

Data Analysis

A phenomenological case study was employed to answer the research question of this study through survey research. Lin (2009) states the importance of have a coherent, detailed plan when analyzing survey data to ensure a thorough analysis. The data analysis of a phenomenological case study aims to make meaning for several individuals of their lived experiences of a concept or a phenomenon (Creswell, 2012).

A software program entitled NVivo 12 was utilized to analyze the voluminous responses from participants explaining their comfort level, their perception of the most beneficial aspect, their perception of the biggest challenge, suggestions for the professors who are teaching with a telepresence robot, and the value that was added because of the telepresence robot. The use of NVivo 12 was also employed to reduce the time spent on data analysis and to ensure the completeness of the data analysis.

The results of the surveys were printed and read in their entirety. The survey data was read a second time and the researcher coded the responses and documented emerging themes from the surveys (Creswell & Creswell, 2017; Rallis & Rossman, 2012). When the coded words became redundant, the researcher grouped the redundant codes together to form emergent themes (Creswell & Creswell, 2017). The specific themes became the findings within this study. Axial coding was implemented to go beyond the keywords in the data by analyzing the *why* and *how* for the initial codes (Tracy, 2019). The results from the axial coding showed a smaller number of themes around a broader theme and helped to identify written examples of the positive or negative theme. Creswell and Poth (2016) encourage researchers to complete axial coding to provide a rich description of each theme.

This study was strengthened with separate analysis from three perspectives: graduate students using the telepresence robot, graduate students in the room with the robot, and professor teaching the class with the robot. This requires a cross-case analysis, which enhanced the conclusions and discussions. Miles and Huberman (1994) claim that a cross-case analysis strengthens the results of a study.

Reliability and Trustworthiness

Reliability and trustworthiness are important aspects to consider when a single researcher is tasked with coding voluminous survey data into themes (Creswell & Creswell, 2018, Finley, 2002). To increase reliability and trustworthiness of the data analysis, the researcher in this study asked two independent researchers to also analyze the data in order to code the results and to group the codes into emerging themes (Creswell, 2012). The goal of process was to minimize bias and to establish reliability and trustworthiness of the analysis.

FINDINGS

There were three positive themes from graduate students using the telepresence robot that emerged from this study including a retention and program completion, a sense of physical and social presence in the room, and less time spent on travel/more time for family and work obligations (see Table 1). The theme

with the highest frequency was retention and program completion. One student shared, “The ability to be here. Without it, I would not be able to finish my program with the required classes.” Another student echoed that sentiment: “Able to attend class and finish my degree.” A third student shared, “I need this class for graduation and could not commute for the face-to-face meetings.”

The second-most prominent theme was less time spent on travel/more time for family and work obligations. For example, one student wrote,

Utilizing the robot saved me 16 hours of driving and approximately \$300 (the cost of a hotel room for an overnight stay as well as two meals of eating out and the gas to get me there and back). It is difficult to put a value on the time saved and the work I was able to complete rather than spending the time in the car.

Another student shared an interesting point in that “this is five to six hours that could be better utilized for reading of studying.” This was supported by the comments of another student: In order to take this class, my options were to drive the 380 miles to class or use the robot.

A third theme was a sense of physical and social presence in the room. One student shared, “Sheldon [the name of the telepresence robot] made me feel like I was a part of the class... This experience is as close to physically being in class as I could be.” A second student wrote, “I was able to be connected even though I couldn't be there in person.” Finally, another student shared the biggest benefit for them, which was “being able to feel physically present in class.”

TABLE 2
POSITIVE THEMES FROM GRADUATE STUDENTS USING THE TELEPRESENCE ROBOT

Positive Theme	Number of Completed Surveys	Frequency of Theme	Examples of Positive Theme
Retention and program completion	26	12	<ul style="list-style-type: none"> • The ability to be here. Without it, I would not be able to finish my program with the required classes. • Able to attend class and finish my degree. • I need this class for graduation and could not commute for the face-to-face meetings. • Having access to this technology helped me stay on track for graduation. • I would have been off track on my graduation goals had I not taken this class this semester.
Less time spent on travel/more time for family and work obligations	26	8	<ul style="list-style-type: none"> • Utilizing the robot saved me 16 hours of driving and approximately \$300 (the cost of a hotel room for an overnight stay as well as two meals of eating out and the gas to get me there and back). It is difficult to put a value on the time saved and the work I was able to complete rather than spending the time in the car. • This is five to six hours that could be better utilized for reading of studying. • Ability to be in class without flying across the country to physically be there. • In order to take this class, my options were to drive the 380 miles to class or use the robot. • The value for me was financial and time. Saving the money of the drive and staying overnight for the two

			times would have cost my family close to \$400. In addition to the cost, the amount of time away my family during periods where I am the main caregiver would have caused extra stress.
A sense of physical and social presence in the room	26	6	<ul style="list-style-type: none"> • Sheldon [the name of the telepresence robot] made me feel like I was a part of the class. I could see my peers and interact with them without relying on someone else to provide the device and move me. This experience is as close to physically being in class as I could be. • I feel like I am in class. I prefer in class over online, so this is huge for me. • Being able to feel physically present in class. • I was able to be connected even though I couldn't be there in person. • Being able to experience class when I was unable to be physically present.

There was one challenging theme from graduate students using the telepresence robot that emerged from this study, which was the audio and visual issues (see Table 2). One student complained it was “hard to see the board, hard to hear classmates talk from across the room, hard to participate in class activities.” Another explained, “It's difficult to see what the instructor is projecting. It's difficult in this setting to see the whiteboard and screen.” Yet another wrote, “Sometimes it is also hard to hear classmates.”

TABLE 3
FREQUENCY OF CHALLENGING THEMES FROM GRADUATE STUDENTS USING THE TELEPRESENCE ROBOT

Challenging Theme	Total Number of Completed Surveys	Frequency of Theme	Examples of Challenging Theme
Audio and visual issues	26	9	<ul style="list-style-type: none"> • Hard to see the board, hard to hear classmates talk from across the room, hard to participate in class activities. • Sometimes it is also hard to hear classmates. • Hard to hear when my group members are far away from me and the class is noisy. • It's difficult to see what the instructor is projecting. It's difficult in this setting to see the whiteboard and screen. • The biggest challenge was seeing the screen when the presenter or instructor was using it for a game or a PowerPoint.

There were three positive themes from graduate students in the room with the robot that emerged from this study including a high level of comfort when the telepresence robot is in the room, a physical and social presence in the room, and the potential of telepresence (see Table 3). The theme with the highest frequency was a high level of comfort when the telepresence robot is in the room. One student shared, “I am absolutely comfortable with the robot.” Another student echoed this comment by sharing that I was very comfortable with one of my peers using the telepresence robot. I actually was jealous that she got to use it and I was in

class.” A third supporting statement was “Overall, I am comfortable interacting with a peer using distance technology in the classroom.”

A second positive theme from graduate students in the room with the robot was the physical and social presence in the room. Simply put, one student explained, “It felt like he was in the room physically.” Another student shared appreciation: “The most beneficial aspect was the ability to hold face-to-face conversations with a peer, even though she was not able to physically be in the classroom setting.” Finally, another supporting example is when one student stated, “It is nice to have the student that can't be here physically still participate in the class as if she was here.”

The third positive theme was that graduate students experiencing class with a telepresence robot in the room see potential of telepresence. For example, one student wrote, “The main value to me personally is the understanding that this is a potential.” This was supported when another student shared, “As an educator, I appreciate the implications for students who have long-term illnesses as they can participate in a different way with their classmates.” Yet, another summarized this theme by explaining,

It just goes to show how technology can take our school to the next step. We are no longer constricted with boundaries in regard to class attendance. If both parties are willing, the robot can substantially help ensure all students have access to class.

TABLE 4
FREQUENCY OF POSITIVE THEMES FROM GRADUATE STUDENTS IN THE ROOM WITH THE ROBOT

Positive Theme	Number of Completed Surveys	Frequency of Theme	Examples of Positive Theme
High level of comfort when the telepresence robot is in the room	115	58	<ul style="list-style-type: none"> • I am absolutely comfortable with the robot. • I am very comfortable with my classmates using the telepresence robot. • Overall, I am comfortable interacting with a peer using distance technology in the classroom. • I was very comfortable with one of my peers using the telepresence robot. I actually was jealous that she got to use it and I was in class. • It allows for a comfortable collaboration.
Physical and social presence in the room	115	43	<ul style="list-style-type: none"> • The most beneficial aspect was the ability to hold face-to-face conversations with a peer, even though she was not able to physically be in the classroom setting. • Being able to see the persons face and reactions were great. • It is nice to have the student that can't be here physically still participate in the class as if she was here. • The ability to participate in discussion, and even lead a presentation when they were not able to physically be in class. • It felt like he was in the room physically.
Potential of telepresence	115	38	<ul style="list-style-type: none"> • The main value to me personally is the understanding that this is a potential.

			<ul style="list-style-type: none"> • As a strong advocate for global learning this has shown me how possible it is to have new experiences with people across the world due to such technology. • As an educator, I appreciate the implications for students who have long-term illnesses as they can participate in a different way with their classmates. • It makes me realize how even more diverse USD is. They are catering to not only full-time, part-time, commuter, international students and etc., but also to non-traditional students. • It just goes to show how technology can take our school to the next step. We are no longer constricted with boundaries in regard to class attendance. If both parties are willing, the robot can substantially help ensure all students have access to class.
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There were three challenging themes from graduate students in the room with the robot that emerged from the study including conversing with the use of the robot, room placement of the robot, and user of the robot is forgotten (see Table 4). The challenging theme with the highest frequency was conversing with the user of the robot. One student shared, “The biggest challenge was knowing when the peer had something to say or ask. There is not a clear aspect of the device that allows the class group to see the peer wants to vocally engage.” A second example that supports this theme is a challenge that came with talking to the robot: “When talking with the robot, it sometimes did not pick up my audio completely or clearly for the student on the other end and I had to repeat myself.” Another student shared, “It was hard to have a conversation because of not being physically present with the student. Just not being here and reading the conversation and knowing when someone was done with a thought or when they could chime in.”

The challenging theme with the second most comments centered around the room placement of the robot. For example, one student shared, “I would suggest that placement of the robot be considered so that the individual utilizing the robot can see all of the information being presented.” A solution to this was as follows: “A chair might need to be removed so that the robot can be placed in a spot where she/ he can see all aspects of the classroom better.” The placement of the robot that was moving actually became a distraction for one: “The movement of the robot was distracting, like any movement is. It draws the eye and my focus away from the professor/screen.”

The third challenging theme from a student’s perspective is that the user of the robot was forgotten. The following three comments specifically used the word forgotten: “It appeared as if my peer was forgotten by the class at times” and “The biggest challenge for me was that I forget that she is a part of the class at times because she isn’t a physical body in the classroom” and “Also, I tended to forget the robot was there when scanning the room identifying classmates for activities.”

TABLE 5
FREQUENCY OF CHALLENGING THEMES FROM GRADUATE STUDENTS IN THE ROOM WITH THE ROBOT

Challenging Theme	Number of Completed Surveys	Frequency of Theme	Examples of Challenging Theme
Conversing with the user of the robot	115	19	<ul style="list-style-type: none"> • It was hard to have a conversation because of not being physically present with the student. Just not being here and reading the conversation and knowing

			<p>when someone was done with a thought or when they could chime in.</p> <ul style="list-style-type: none"> • Is there was a way, perhaps a light or something, that could signal when he had a question much like we raise our hands? I wondered if the student was holding back participation due to a possible lag in the sound or if not having a physical presence felt like a barrier. • The biggest challenge was knowing when the peer had something to say or ask. There is not a clear aspect of the device that allows the class group to see the peer wants to vocally engage. • When talking with the robot, it sometimes did not pick up my audio completely or clearly for the student on the other end and I had to repeat myself. • The biggest challenge was picking up on visual and verbal cues when the individual using the telepresence had a question or something to share outside of established discussion times.
Room placement of the robot	115	17	<ul style="list-style-type: none"> • I would suggest that placement of the robot be considered so that the individual utilizing the robot can see all of the information being presented. • A chair might need to be removed so that the robot can be placed in a spot where she/ he can see all aspects of the classroom better. • I liked that she was placed at the head of the table today. She had to turn less to keep up with the conversation in class. • Have the groups come to the telepresence so that person can limit transition time. • The movement of the robot was distracting, like any movement is. It draws the eye and my focus away from the professor/screen.
User of robot is forgotten	115	14	<ul style="list-style-type: none"> • It appeared as if my peer was forgotten by the class at times. • On several occasions I forgot he was in the room. • It was easy to forget they were there. The robot is a smaller and quieter presence. • The biggest challenge for me was that I forget that she is a part of the class at times because she isn't a physical body in the classroom. • Also, I tended to forget the robot was there when scanning the room identifying classmates for activities.

There were two positive themes from the professor teaching the class with the robot that emerged from this study including the professor has a high level of comfort and the robot provides access to class (see Table 5). The first theme is that the professor has a high level of comfort. One professor wrote, “I was comfortable with the use of the telepresence robot.” Another echoed that sentiment: “I was extremely comfortable with the student using the telepresence robot for a face-to-face class that lasted seven hours.”

Another went as far to declare, “I am so comfortable using the telepresence robot that I almost cannot imagine teaching without Sheldon [the name of the telepresence robot] in the room!”

Another positive theme from professors teaching the class with the robot is that the robot provides access to class. For example, one professor shared,

The telepresence robot afforded the adult learner access to the class (he lives 8 hours from the on-site classroom), the ability to effectively participate in small group activities, the ability to control where his focus was (either the instructor, a peer, or the presentation), and the ability to interject with his own questions or respond to a discussion prompt.

Another professor wrote, “The student took this course from a different region of our country. Also, she had to work with the person next to her about 10 times, and this worked perfectly.” Upon reflection, another professor commented, “This seems like a great solution for students who can't physically be with us.”

TABLE 6
FREQUENCY OF THEMES FROM THE PROFESSOR TEACHING THE CLASS WITH THE ROBOT

Positive Theme	Number of Completed Surveys	Frequency of Theme	Examples of Positive Theme
The professor has a high level of comfort	20	16	<ul style="list-style-type: none"> • I am so comfortable using the telepresence robot that I almost cannot imagine teaching without Sheldon [the name of the telepresence robot] in the room! • I was comfortable with the use of the telepresence robot. • Very comfortable with the robot. • My comfort level was very high. • I was extremely comfortable with the student using the telepresence robot for a face-to-face class that lasted seven hours.
The robot provides access to class	20	16	<ul style="list-style-type: none"> • It provided access to a student who lives on the other side of the country. • The telepresence robot afforded the adult learner access to the class (he lives 8 hours from the on-site classroom), the ability to effectively participate in small group activities, the ability to control where his focus was (either the instructor, a peer, or the presentation), and the ability to interject with his own questions or respond to a discussion prompt. • Including a remote student was helpful to the continuity of her education and ability to remain with her original cohort. • The student took this course from a different region of our country. Also, she had to work with the person next to her about 10 times, and this worked perfectly. • This seems like a great solution for students can't physically be with us.

There were two challenging themes from the professor teaching the class with the robot that emerged from this study including technological issues with audio/visual/WiFi and a lack of social cues during

discussions (see Table 6). The theme with the highest frequency was technological issues with audio, visual, or WiFi. A frustrated professor explained, “Our biggest challenge was getting the volume set correctly so that small groups could operate but it was not overwhelming the other groups.” This was echoed by another professor: “She mentioned that she couldn't see what was projected very easily.” Finally, a third professor summarized the theme: “If logistics make it impossible to do a test run, there may be technical issues.”

A second challenging theme was a lack of social clues during discussions. For example, one professor explained, “One challenge would be the verbal and non-verbal cues in conversation. It can become awkward to know when the robot can enter conversation.” This was supported when another professor reflected, “Towards the end of the day, the school leader shared frustrations that he could not catch the social cues on when to participate in the discussion.” A third professor shared advice to overcome this theme: “Keep calling on the student using the telepresence robot. They seem to be fearful of interrupting.”

TABLE 7
FREQUENCY OF CHALLENGING THEMES FROM THE PROFESSOR TEACHING THE CLASS WITH THE ROBOT

Challenging Theme	Number of Completed Surveys	Frequency of Theme	Examples of Challenging Theme
Technological issues with audio, visual, or WiFi	20	7	<ul style="list-style-type: none"> • She mentioned that she couldn't see what was projected very easily. • Our biggest challenge was getting the volume set correctly so that small groups could operate but it was not overwhelming the other groups. • The student cannot see the information projected on the smartboard from the robot. • One of the robots cut off and kicked a student out. • If logistics make it impossible to do a test run, there may be technical issues.
Lack of social clues during discussions	20	5	<ul style="list-style-type: none"> • One challenge would be the verbal and non-verbal cues in conversation. It can become awkward to know when the robot can enter conversation. • Towards the end of the day, the school leader shared frustrations that he could not catch the social cues on when to participate in the discussion. • Keep calling on the student using the telepresence robot. They seem to be fearful of interrupting. • I tend to forget about the student who is participating via Sheldon [the name of the telepresence robot]. I'm so focused on what I'm doing. • I do accept responsibility for the challenge of maintaining awareness of the student using a telepresence robot.

DISCUSSIONS

This study was the first of its kind as the perceptions of telepresence robots were analyzed through the lens of Whiteside's 2015 Social Presence Model, which synchronizes interactions between the instructor/professor, students, content, and technologies being utilized. Students who used a telepresence

robot in the room reported a physical and social presence in the room. For example, one student shared they were “able to feel physically present in class.” Another explained, “Sheldon [the name of the telepresence robot] made me feel like I was a part of the class. I could see my peers and interact with them. This experience is as close to physically being in class as I could be.” The feeling of social and physical presence was corroborated by the students who were physically present in the room. Comments from students such as being able to see a person’s face and reactions allowed them to feel more comfortable participating as if they were physically present in the room. The concept of social presence was triangulated through the results of the professors teaching the class with a telepresence robot in the room. One professor shared an example of Whiteside’s (2015) Social Presence Model,

The telepresence robot afforded the adult learner access to the class (he lives 8 hours from the on-site classroom), the ability to effectively participate in small group activities, the ability to control where his focus was (either the instructor, a peer, or the presentation), and the ability to interject with his own questions or respond to a discussion prompt.

Whether the feeling of social and physical presence was because of one’s psychological response (Li, 2015), anthropomorphism (Newhart et al., 2016), or subconscious tendencies to treat technology as if it was a human (Luczak et al., 2003; Nass & Moon, 2000; Rosenberg-Kima et al., 2020), social and physical presence was experienced when a telepresence robot was in the classroom.

The use of telepresence robots should be considered by school leaders in PreK-20 education as an integral aspect of their recruitment and retention strategies. When asked to describe a benefit of using a telepresence robot, one student explained, “The ability to be here. Without it, I would not be able to finish my program with the required classes.” At the time of this study, the cost of a telepresence robot was \$2,499.00. From a purely financial perspective, one telepresence robot is the approximately the same as the cost of five graduate credits at the university in this study. Even if a telepresence robot retained one student in a 30-credit graduate program, the robot would pay for itself many times over. Other supporting comments from students included being “able to attend class and finish my degree” and “having access to this technology helped me stay on track for graduation” and “I would have been off track on my graduation goals had I not taken this class this semester.” Simply put, recruitment and retention are strengthened when students and professors in graduate school programs are able to explain that students feel supported through the use of novel technologies such as telepresence robots (Rosenberg-Kima et al., 2020).

The use of telepresence robots also opens up access for international students and diversity within a hybrid course. One student wrote, “As a strong advocate for global learning this has shown me how possible it is to have new experiences with people across the world due to such technology.” Another student shared a realization: “It makes me realize how even more diverse USD is. They are catering to not only full-time, part-time, commuter, international students and etc., but also to non-traditional students.” When the ability to be physically and socially present in a classroom is obtained through a Wi-Fi connection and telepresence robot in the room, the possibilities to recruit and retain students across the world may increase.

Both students and professors reported a high comfort level with a telepresence robot in the room. This could be explained because a telepresence robot has a novelty effect, which may cause peers who are physically present in the room to be interested in the telepresence robot, especially during one’s first interaction (Rosenberg-Kima et al., 2020). Another explanation of the high level of comfort is because a telepresence robot combines the embodiment of intelligent systems within a physical robot and virtual agent (Brooks, 1990; Cassell, 2000; Dautenhahn et al., 2002; Li, 2015). Student comments support this high level of support: “I am absolutely comfortable with the robot” and “I am very comfortable with my classmates using the telepresence robot” and “Overall, I am comfortable interacting with a peer using distance technology in the classroom.” Professors in this study corroborate this feeling when writing, “I was comfortable with the use of the telepresence robot” and “Very comfortable with the robot: and “My comfort level was very high.”

In March of 2019, the COVID-19 pandemic gripped the world and created many situations where students were sent home to learn in hopes of slowing down the spread of COVID-19. This pandemic

heightened an awareness of the importance keeping PreK-20 learners safe in all learning environments. Telepresence robots may provide an avenue to keep PreK-20 learners safe if the learner is available, yet unable to physically be in a learning environment due to safety or quarantining issues. One student wrote, “As an educator, I appreciate the implications for students who have long-term illnesses as they can participate in a different way with their classmates.” Another shared, “The main value to me personally is the understanding that this is a potential.” Yet another student summarized the potential by sharing,

It just goes to show how technology can take our school to the next step. We are no longer constricted with boundaries in regard to class attendance. If both parties are willing, the robot can substantially help ensure all students have access to class.

The professors in this study were constantly improving their implementation of teaching in front of a classroom full of students while also teaching with a telepresence robot in the room. With the input and advice from the students, a list of best practices for the user of the robot (See Appendix D) was developed and amended after each use. This includes taking time for the user of the robot to practice using the telepresence robot, establishing ways to acknowledge social cues of the remote learner, securing handouts before class begins, and optimal placement of the telepresence robot in the physical classroom.

The use of telepresence robots in this study had a clear and obvious goal, which was to provide access to students who available yet cannot be physically present in the room with their peers (Mårell-Olsso et al., 2014; Zhang et al., 2018). The triangulation of the perceptions from the user of the telepresence robot, to the perceptions of the students who were physically present in the classroom, to the professors teaching with students and a telepresence robot show promise for this new method of learning. While some challenges exist, there is great potential for telepresence robots to provide access to educational opportunities while establishing a social and physical presence from a remote location. As the technologies evolve, the incorporation of new technologies and their impact on the definition of social presence will also evolve (Izmirli, 2020; Whiteside et al., 2017), thus creating new opportunities to study the future of the intersection of telepresence robots and education.

CONCLUSIONS

The graduate students using the telepresence robot identified positive themes and challenging themes for using a telepresence robot during class. The primary positive theme was a perception that the professors were going out of their way to retain the graduate students in their programs and to help them towards graduation. As professionals in higher education are looking for creative methods of retaining students, the incorporation of telepresence robots is one way to help students complete their program. However, the audio and visual issues of using a telepresence robot was well-documented as a challenging theme in the surveys from students. Students reported issues with seeing the board, hearing classmates, and experiencing difficulties participating in classroom activities to the same degree they would if they were physically in the room. As telepresence technology improves, these issues should be addressed by the manufacturers.

The graduate students in the physical learning environment with one of their peers utilizing the telepresence robot also reported positive themes and challenging themes. The primary positive theme was a high level of comfort when the telepresence robot was in the room. Students described their interactions with the user of the telepresence robot as a “comfortable collaboration.” One student even mentioned that they were jealous that their peer was able to use the robot while they had to be in class. Another positive theme was the perception that their peer was physically and socially present in the classroom with them. One student explained that their peer had the ability to participate in the discussions and even lead a presentation when they were not able to physically be in class. The results of these surveys provide evidence that graduate students are very comfortable when one of their peers is joining them in the classroom through a telepresence robot. Students reported challenges of their peers using a telepresence robot, yet even the theme with the highest frequency was only 16% (19 times out of 115 completed surveys).

The professor teaching in the learning environment where a telepresence robot is being utilized reported positive themes and challenging themes as well. One positive theme is a professor's high level of comfort when teaching with a telepresence robot in the room. One professor explained that they could not imagine teaching *without* a telepresence robot in the room. Another positive theme was providing student access to class. According to the grant application to obtain the first telepresence robot, the original intent of incorporating telepresence robots was to provide access to students who available yet cannot be physically present in the room with their peers. The results of the study showed that professors reported that telepresence robots provided student access to class, which also aids in the retention of students in the programs. Professors reported challenging themes, but not at a high frequency. It should be noted that even though the frequency of responses was not high, it may be a challenge for professors to teach face-to-face, face-to-technology, and troubleshoot at times.

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APPENDICES

Appendix A

Questionnaire for Graduate Student Using the Robot

1. How many times have you been the graduate student using the telepresence robot?
 - a. This is my first time.
 - b. This is my second time.
 - c. This is my third time.
 - d. This is my fourth time.
 - e. This is my fifth time or more.
2. How many miles were you from the physical classroom when you used the telepresence robot?
 - a. 0-10
 - b. 10+
3. Please provide a brief narrative of yourself including the following (your role as a graduate student, the current graduate program that you are in, why you chose the University of South Dakota, etc.).
4. Provide a specific example of what you found to be the most beneficial aspect of using the telepresence robot.
5. Provide a specific example of what you found to be the biggest challenge of using the telepresence robot.
6. What suggestions would you have for the instructor on how to improve how the instructor utilizes this telepresence robot in future classes?
7. What was the value of this experience for you personally?

Appendix B

Questionnaire for Graduate Students in the Physical Learning Environment with One of Their Peers Utilizing the Telepresence Robot

1. How many times have you been the graduate student in the physical learning environment with one of your peers utilizing the telepresence robot?
 - a. This is my first time.
 - b. This is my second time.
 - c. This is my third time.
 - d. This is my fourth time.
 - e. This is my fifth time or more.
2. Please provide a brief narrative of yourself including the following (your role as a graduate student, the current graduate program that you are in, why you chose the University of South Dakota, etc.).
3. How would you describe your comfort level with one of your peers using the telepresence robot?
4. Provide a specific example of what you found to be the most beneficial aspect of one of your peers using the telepresence robot.
5. Provide a specific example of what you found to be the biggest challenge of one of your peers using the telepresence robot.
6. What suggestions would you have for the instructor on how to improve how the instructor utilizes this telepresence robot in future classes?
7. What was the value of this experience for you personally?

Appendix C

Questionnaire for Professor Who Taught When a Graduate Student Used the Robot

1. How many times have you been the instructor in the physical learning environment with a graduate student utilizing the telepresence robot?
 - a. This is my first time.
 - b. This is my second time.
 - c. This is my third time.

- d. This is my fourth time.
 - e. This is my fifth time or more.
2. Please provide a brief narrative of yourself including the following (your role as an instructor, the current graduate program that you are teaching in, etc.)
 3. How would you describe your comfort level with one of your graduate students using the telepresence robot?
 4. Provide a specific example of what you found to be the most beneficial aspect of one of your graduate students using the telepresence robot.
 5. Provide a specific example of what you found to be the biggest challenge of one of your graduate students using the telepresence robot.
 6. What suggestions would you have for other professors on how to improve how that instructor utilizes this telepresence robot in future classes?
 7. What was the value of this experience for you personally?

Appendix D

Best Practices for the User of the Robot

- There are times when the Wi-Fi connection does not allow video conferencing because it uses too much bandwidth. It is vital that you test the technology long before you need to use it. When you test the technology, please use the *exact* computer and *exact* Wi-Fi connection when you test the technology. Please do a test run days before you need the technology. If this is not an option, please test it at least an hour before the class begins, which will allow you to drive home or drive to school if there is an issue with your Wi-Fi connection.
- In almost all situations, all technological problems are solved by restarting the iPad.
- Always keep yourself on mute when you are not speaking.
- In order to be *present*, please use the arrow keys to constantly face the person speaking. For example, if you were physically present in the room, you wouldn't want to turn your face away from the speaker. This same exact expectation applies to using the robot. Also, the robot uses a wide-angle lens, so your goal is to keep the speaker directly in the middle of your computer screen. When the speaker is on the edge of the screen, it gives the impression that you are looking 10-20 feet in the wrong direction. Simply put, continue using the arrows to keep the speaker in the middle of your screen.
- The professor will do his or her best to call on you throughout the day. However, if you want to speak up, please raise the iPad by clicking on the tall stick in the top white ribbon on the toolbar on your computer.
- If you cannot hear what is being said in the room, please use headphones. If headphones do not work, please change the settings to maximize the sound. These settings are located within the white ribbon at the top of your screen.
- It works best to have a peer in the classroom that helps you with any minor troubleshooting issues. Please exchange cell phone numbers with your peer and then communicate via text throughout the day.