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Students' views on telepresence robots in education

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Abstract

To successfully introduce Telepresence Robots (TRs) in education, the students' viewpoints should be taken into consideration. Partners of the Erasmus+ project "TRinE: Telepresence Robots in Education" conducted interviews and focus groups discussions with 25 students across Germany, Greece, Iceland, and Malta. Students praised the mobility and ease-of-use of TRs as well as the feeling of presence while attending classes from a distance. However, they criticized TRs' lack of hands-like actuators, high cost, limited maneuverability, limited battery life, and poor sound quality. In addition, the educational institutes' buildings pose obstacles (e.g., stairs, elevators, and poor Wi-Fi connectivity) to the smooth movement of TRs. Furthermore, using TRs may cause less face-to-face interaction, attention disruption, and privacy issues. Finally, students made several proposals to TRs' manufacturers such as creating TRs with hands, alarms, and better sound quality as well as to educational institutes such as appropriate TRs management policies.

Keywords: Human Robot Interaction, Remote Learning, Remote Teaching, Telepresence Robot, Virtual Presence

Introduction

During and after the pandemic lockdown, the interest in Telepresence Robots (TRs) has increased considerably. TRs are devices on wheels that are wirelessly connected to the internet and allow you to control and drive them remotely. They are equipped with a screen, cameras, microphones, speakers, wheels, batteries, sensors, software, and more. They give their remote drivers access to two-way video and audio communication with the outside world. The remote driver has control of the TR's movement, microphones, and cameras as well as the ability to see, hear, and communicate with nearby individuals. So, TR empowers its remote operator with mobility as well as audio-visual interaction with people around it. The remote operator of the TR feels physically and socially present wherever the TR is moving. Telepresence Robots have been employed in a variety of contexts, including patient healthcare, elder care, and education (Botev & Rodríguez Lera, 2021; Burbank et al., 2021; Fischer et al., 2019; Lee & Han, 2019) . In education, the most common case regards a remote student who participates in a class using a TR (Cha et al., 2017; De Jong, 2021; Dimitoglou, 2019; Fitter et al., 2018; Gallon et al., 2019; Han & Conti, 2020; Newhart et al., 2016; Newhart & Olson, 2017; Newhart & Olson, 2019; Reis et al., 2018; Rinfret, 2020; Rueben et al., 2021; Soares et al., 2017; Weibel et al., 2020). In many previous studies the remote student was a homebound student due to some illness (Cha et al., 2017; Fischer et al., 2019; Gallon et al.,

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2019; Newhart et al., 2016; Newhart & Olson, 2017; Newhart & Olson, 2019; Page et al., 2021; Soares et al., 2017).

During the Erasmus+ project "TRinE: Telepresence Robots in Education" (Häfner et al., 2023; Wernbacher et al., 2022), project partners conducted focus groups and interviews discussions with interested stakeholders across Austria, Germany, Greece, France, Iceland, Malta, and U.S.A. (Perifanou et al., 2022a: Perifanou et al., 2022b; Perifanou et al., 2022c). More specifically, Perifanou et al. (2022b) presented the experiences and perceptions about TRs in education of 20 interviewers (students, professors, teachers, technicians and others) across Austria, France, Iceland, and U.S.A. Also, Perifanou et al. (2022a) reported the viewpoints of 77 persons (educators, students, and administrators) who expressed their views during 13 focus groups discussions across Austria, Germany, Greece, Iceland, and Malta. However, it is interesting to focus specifically on students' opinions and viewpoints since they will be the main beneficiaries from the introduction of TRs in education. For successfully integrating TRs in the educational activities, students should appreciate the advantages offered by TRs to teaching and learning, collaborate with their teachers via TRs, as well as accept, use, and live together with the TRs. So, this study aims to systematically capture the perceptions of students about the introduction of TRs in education at different educational institutions in Germany, Greece, Iceland, and Malta. Also, the current study reports specific students' quotes. Finally, the study identifies points of agreement and disagreement among students participating in interviews and focus groups discussions.

Methodology

This study used interviews and focus groups to uncover students' perceptions with regard to TRs in education. In interviews and focus groups discussions, participants reflect and express their thoughts and viewpoints on the issue under investigation. Despite much interest in TRs in education, the utilization of TR in education is a new and unfamiliar technique and there is not much knowledge and experience with respect to its use (Johannessen et al., 2023; Weibel et al., 2020). To shed light on the exploitation of this new technology in education, the "TRinE: Telepresence Robots in Education" project held interviews and focus group discussions with 25 students via videoconferencing in 4 European countries (Germany, Greece, Iceland, and Malta) during January and February 2022. Two researchers of the TRinE project developed a detailed methodology and questionnaire to help the discussions' moderators (facilitators). They meticulously trained these moderators (facilitators) and delineated the steps and questions for the interviews and focus group discussions, with interviews lasting approximately an hour and focus group discussions spanning approximately one and a half hours. The five-phase discussion encompassed an introduction, brief descriptions and examples of TRs and their use in education, a discourse on the strengths, weaknesses, opportunities, and challenges of TR in education, a discussion of guidelines for the use of TR in education, and concluding remarks and recommendations.

First, all participants were informed about the research study's purpose and background, and their right to withdraw at any time was duly emphasized. Participants provided informed consent and documented their profile and demographics. Names and other identifying information were anonymized to ensure confidentiality, and video recordings were securely stored for a limited period of time. The facilitator then explained cases of TR and the use of TR in teaching. The facilitator showed a PowerPoint presentation with pictures of TR in education and a YouTube video to present examples of TR from different manufacturers and different applications of TRs in education. The moderator then led the discussion through a series of informal questions. These questions were used to stimulate discussion allowing participants to present their own perspectives.

Thematic analysis was used to analyse discussion data (Braun & Clarke, 2006). Thematic analysis was employed to identify significant patterns or themes within qualitative data. The process involved data familiarization, initial codes generation, search for themes, review of initial codes, refinement and development of themes, and consolidation and reduction of identified themes.

In order to analyse the discussion transcripts, two researchers employed a systematic coding process. They read through the transcripts multiple times and assigned codes to different sections of the text. They then created a list of codes for the first transcript and continuously modified it while working on the subsequent transcripts. The researchers collaborated to reach agreement on the final code list. To create a hierarchy of topics, they combined subtopic and topic codes across all transcripts. They reviewed and discussed the topics' hierarchy and reached consensus. They also used the transcripts to explore potential or similar topics. When defining and naming topics, they discussed any differences and contradictions in their topic generation process and reached consensus. Lastly, the researchers consolidated and combined similar themes or sub-themes to create the final themes. The process involved multiple revisions, resulting in some subtopics and themes being merged or split.

Findings and Discussion

A total of 25 students gave their viewpoints regarding TRs in education. More specifically, 21 students participated in focus groups' discussions (Germany (6), Greece (1), Iceland (4), and Malta (10)), while 4 students with practical experience in TRs from Iceland gave interviews. More specifically, students without any experience on TRs from Germany, Greece, Iceland, and Malta were invited to participate in focus groups discussions. In addition, Icelander students with experience on using TRs were interviewed. Next, it is presented the students' perceptions regarding the TRs' strengths, opportunities, weaknesses, and obstacles as well as their recommendations on using TRs in educations (Table 1).

Students consider that it is easy to set up a TR, to use a TR and attend lectures. They also appreciate the affordances of freely moving the TR and its camera as well as the ability to remotely participate in lectures. Comparing TRs to zoom calls, they consider that using TRs is more realistic and less likely for teachers to forget the remote student. Overall, they believe that using TRs improves the quality of education. For example, a student remarked:

"So, I think it's a better option than Zoom in that regard. So, it's very easy and intuitive to handle. So, it didn't take much time for me to understand. You just move it with the arrow keys and also, after a few moments, get a good kind of knowledge on how to move it and like, where you are in the space. So that's kind of easy to handle and very intuitive. And, yeah, nice to move around and it actually makes you feel a lot more involved, I would say, than just being in a Zoom Call because you could actually look at the other people, you can actively move around. And yeah, I mean, it's of course a bit strange when you don't know the people of the whole group. But, I would definitely preferred it over a Zoom Call in that use case."

They acknowledge that using TRs increases the remote students' opportunities of attendance and active participation in class, equality, not losing classes and performing better. Also, using TRs enhances the feel of presence of remote persons and helps students with anxiety and social phobia to socialize via a TR. For example, a student stated:

"I think that providing access to education is the advantage, because people live all around and they cannot necessarily get time off from work, especially because it is a flexible education university, and it may be difficult to suddenly take four days off to go and attend classes on campus."

However, students mentioned several weaknesses of TRs such as the absence of kinesthetics, lack of hand-like actuators, lack of human facial and hand gestures for communication, and inability to physically interact with the environment. They also pointed out the high cost, limited battery life, slow turning movements, and poor sound quality of TRs. Finally, they believed that dependency of TRs movements on Internet connectivity causes problems. For example, a student described such a situation:

"Also, if the internet connection was bad on either [name] side or the side of the institute which could happen quite frequently and then the robot was basically just standing around and it's pretty heavy to just push it aside without some effort as the person controlling it - if they lost the connection anymore - also cannot (move it). So, … just imagine that happens like in an elevator or in a crowded corridor, something like that. Then the robot is blocking everything."

Students also point out a number of obstacles due to the environment that prevent the wide adoption of TRs in education. One big infrastructure challenge is that there is not Wi-Fi and Internet connectivity at all places of an educational institute (e.g., inside elevators). Also, a TR cannot move at all places (e.g., stairs) and there is not available support. Additional challenges include the limited availability of TRs at the educational institutes and the long delays in cases of TRs' damages and need to repair them. For example, a student pointed out:

"if the teacher is in the telepresence robot, then the classroom needs to be big enough so that the teacher actually can move around. And I think, for example, if a student has a question, … then the telepresence about can actually go directly to that student and answer the question instead of just being on a big screen in front of the classroom. For that, there should need to be enough space between the chairs and the rows so that the telepresence robot can actually drive through; and in general, in the school, maybe at elevators or stairs, so that telepresence robot can get from floor to floor or from classroom to classroom."

The noise in the class or the environment may prohibit the effective participation of the remote user. Correspondingly, the movement of a TR in a class may disrupt the local students' attention. Some people resist to changes arguing also that the use of TRs instead of face-to-face communication reduces the human contact. Finally, the use of TRs requires consensus from all people involved, while there are risks of overuse and misuse such as privacy threats by illicit recording or using a TR as an excuse to not come to school. For example, a student mentioned:

"we cannot control if anyone is monitoring the office or recording the video stream of the robot … when you really have areas where you are not allowed to have cameras at all."

Students suggested that TRs' manufacturers equip TRs with hands or at least 'raise hands' functionality and sensors for kinesthetics. They also recommended supplying 3D sound, facial recognition (to prevent face recording) as well as notification if the TR is recording or its battery level is low. Regarding the booking and allocation of TRs to students, they proposed a first come first serve facility. Finally, they discourage the use of TRs just for lecturing where students sit and listen the teacher presenting a subject. For example, a student recommended TRs to be equipped with extra features:

"It's a good idea to give the robot collision avoidance function. So, it won't collide into something. So, it's going to stop before it hits something. Also, it could be good to have an auto pathing function, so you can choose where you want to go. And then it's going to go there on its own. So many students who cannot drive it … they can just tell it like where to go and then it's going to go there on its own."

Table 1. Views of students

Themes	Views of Students in Focus Groups	Views of Students in Interviews
Strengths of TR in education	Ease of setup and use; Moving camera ability; Mobility ability.	More realistic interaction than Zoom calls; Physical presence: Teachers are less likely to forget students participating via TR than during Zoom calls;
Opportunities of TR in education	Enhanced access to distant educators and students; Enhanced active participation; Higher sense of presence; Improved inclusion opportunities; Better grades for online learners.	Participate in class even from a distance; It is easy to follow and listen to lectures from a distance; Use in teacher training programs; Opportunity to make friends at a distance; Enable participation of students with social anxiety and phobia; Increase student grades by not missing classes; Enhance the quality of education.
Weaknesses of TR in education	Reliance on Internet connection; Absence of kinesthetics; Absence of hand-like actuators; Inability to physically interact with the environment; Expensive; Low sound quality.	Inability to communicate with humans using grimaces and hand gestures; Limited TR battery life; Low speed when TR takes a turn.
Obstacles & challenges of TR in education	Can be disruptive; Absence of Wi-Fi connection everywhere; Consent restrictions; Low human contact; Overuse; Lack of technical and management support; People resistance to change; Noise in the surroundings; Infrastructural inefficiencies; Possible illegal recording; Scarcity of available TR; Device vulnerability; Delays in replacing broken parts.	Obstacles in TR taking the elevator; TR lost connection in the elevator; Risk of misusing TR; Reserving and using TR without a real need; Very few TRs are available at the university.
Recommendations for TR in education	Provide TR with hand-like actuators; Implement sensors for kinesthetics; Provide 3D sound; Face detection (to prohibit face recording); Not recommended for lecturing; Implement the 'raise hands' feature; Alerts if TR is recording or if battery is low, etc.	Attach hands to the TR; First-come, first-served facility to book TR for students.

In summary, students in both interviews and focus groups discussions agreed that TRs enable the following: i) participation in class from a distance, ii) inclusiveness of students with special needs, iii) remote students not losing class and grades, and iv) remote users feeling and being felt physically present. They also agreed on the inability to communicate with TRs using hand gestures, on the problem of the remote user losing connection with the TR due to the unavailability of W-Fi everywhere (e.g., in elevators), and on the scarcity of available TRs in the schools. A common recommendation was to manufacturers to build TRs with hand-like actuators. Although the students mentioned that there are difficulties in the physical interaction via TRs they also pointed out that this interaction is more realistic than interacting via Zoom calls.

Conclusions

Telepresence robots enable enhanced remote teaching and learning experiences by providing physical presence, mobility, and enhanced interaction that can overcome the limitations of traditional video conferencing tools. TRs can help students to overcome physical, social and emotional barriers enabling students with disabilities, illnesses or other restrictions to participate fully in classroom activities. However, the broad adoption of TRs in education still requires some upgrades to be made by the educational institutes regarding their infrastructures and policies, by the TRs' manufacturers regarding extra TRs' features, and by the teachers concerning their teaching methodologies. For example, the remote user may lose the control of TR since there is not Wi-Fi coverage in all areas of school or university buildings. Furthermore, TRs do not provide the same level of physical presence and social interaction as in-person students which can limit their ability to fully engage in classroom activities and build relationships with peer and teachers. In any case, students expressed positive views toward the integration of TRs in the educational environment. These results are encouraging to foster further investigation regarding the adoption of TRs in education. Future research may include the investigation of the TRs application to specific subjects (e.g., physics, chemistry, biology, medical) at various educational levels (elementary, intermediate, higher education) in various countries all over the world.

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References

Botev, J., & Rodríguez Lera, F.J. (2021). Immersive robotic telepresence for remote educational scenarios. *Sustainability*, 13, 4717. DOI: 10.3390/su13094717

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2), 77–101. DOI: 10.1191/1478088706qp063oa

Burbank, M.D., Goldsmith, M.M., Bates, A.J., Spikner, J., & Park, K. (2021). Teacher observations using telepresence robots: Benefits and challenges for strengthening evaluation. *Journal of Educational Supervision*, 4(1), 68. DOI: 10.31045/jes.4.1.6

Cha, E., Chen, S., & Mataric, M.J. (2017). Designing telepresence robots for K-12 education. In 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN) (pp. 683-688). DOI: 10.1109/ROMAN.2017.8172377

De Jong, D. (2021). Telepresence robots: A phenomenological study of perceptions of graduate students and professors. *Journal of Higher Education Theory & Practice*, 21(5), 143-161.

Dimitoglou, G. (2019). Telepresence: Evaluation of robot stand-ins for remote student learning. *Journal of Computing Sciences in Colleges*, 35(3), 97-111. DOI: 10.5555/3381569.3381582

Fischer, A.J., Bloomfield, B.S., Clark, R.R., McClelland, A.L., & Erchul, W.O. (2019). Increasing student compliance with teacher instructions using telepresence robot problem-solving teleconsultation. *International Journal of School & Educational Psychology*, 7(sup1), 158-172. DOI: 10.1080/21683603.2018.1470948

Fitter, N. T., Chowdhury, Y., Cha, E., Takayama, L., & Matarić, M. J. (2018, March). Evaluating the effects of personalized appearance on telepresence robots for education. In *Companion of the 2018 ACM/IEEE international conference on human-robot interaction* (pp. 109-110). DOI: 10.1145/3173386.3177030

Gallon, L., Abénia, A., Dubergey. F., & Negui, M. (2019). Using a telepresence robot in an educational context. In *Proceedings of the International Conference on Frontiers in Education: Computer Science and Computer Engineering (FECS)* (pp. 16-22).

Häfner, P., Wernbacher, T., Pfeiffer, A., Denk, N., Economides, A., Perifanou, M., Attard, A., DeRaffaele, C., & Sigurðardóttir, H. (2023). Limits and benefits of using telepresence robots for educational purposes. In: Auer, M.E., Pachatz, W., Rüütmann, T. (eds), *"Learning in the Age of Digital and Green Transition", ICL 2022, Proceedings of the 25th International Conference on Interactive Collaborative Learning and 51st International Conference on Engineering Pedagogy*. Vienna, Austria, 27-30 September 2022. Lecture Notes in Networks and Systems, vol 634. Springer, Cham. DOI: 10.1007/978-3-031-26190-9_3.

Han, J., & Conti, D. (2020). The use of UTAUT and post acceptance models to investigate the attitude towards a telepresence robot in an educational setting. *Robotics*, 9(2), 34. DOI: 10.3390/robotics9020034

Johannessen, L.E.F., Rasmussen, E.B., & Haldar, M. (2023). Student at a distance: Exploring the potential and prerequisites of using telepresence robots in schools. *Oxford Review of Education*, 49(2), 153-170 DOI: 10.1080/03054985.2022.2034610

Lee, H., & Han, J. (2019). Analysis on acceptance and use of technology for elementary school teachers in telepresence robot-assisted learning. *Journal of The Korean Association of Information Education*, 23(6), 599-606.

Newhart, V.A., Warschauer, M., & Sender, L. (2016). Virtual inclusion via telepresence robots in the classroom: An exploratory case study. *The International Journal of Technologies in Learning*, 23(4), 9-25. DOI: 10.18848/2327-0144/CGP/v23i04/9-25

Newhart, V.A., & Olson, J.S. (2017). My student is a robot: How schools manage telepresence experiences for students. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 342-347). DOI: 10.1145/3025453.3025809

Newhart, V., & Olson, J.S. (2019). Going to school on a robot: Robot and user interface design features that matter. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *26*(4), 1-28. DOI: 10.1145/3325210

Page, A., Charteris, J., & Berman, J., (2021). Telepresence robot use for children with chronic illness in Australian schools: A scoping review and thematic analysis. *International Journal of Social Robotics,* 1-13, 1281-1293. DOI: 10.1007/s12369-020-00714-0

Perifanou, M., Economides, A. A., Häfner, P., and Wernbacher, T. (2022a). Mobile telepresence robots in education: Strengths, opportunities, weaknesses, and challenges. In: I. Hilliger et al. (Eds.) *Educating for a New Future: Making Sense of Technology-Enhanced Learning Adoption, Proceedings of EC-TEL 2022, 17th European Conference on Technology-Enhanced Learning*, pp. 573-579. Toulouse, France, 12-16 September 2022. Lecture Notes on Computer Science (LNCS) 13450, Springer. DOI: 10.1007/978-3-031-16290-9_52

Perifanou, M., Häfner, P., & Economides, A. A. (2022b). Users' experiences and perceptions about telepresence robots in education. In*: Proceedings of EDULEARN 2022, 14th International Conference on Education and New Learning Technologies,* pp. 9870-9879. Palma de Mallorca, Spain, 4-6 July. IATED. DOI: 10.21125/edulearn.2022.2379

Perifanou, M., Galea, M., Economides, A.A., Wernbacher, T. & Häfner, P. (2022c). A focus group study on telepresence robots in education. In: *Proceedings of EDULEARN 2022, 14th International Conference on Education and New Learning Technologies*, pp. 9936-9944. Palma de Mallorca, Spain, 4-6 July. IATED. DOI: 10.21125/edulearn.2022.2397

Reis, A., Martins, M., Martins, P., Sousa, J., & Barroso, J. (2018, June). Telepresence robots in the classroom: the state-of-the-art and a proposal for a telepresence service for higher education. In *International Conference on Technology and Innovation in Learning, Teaching and Education* (pp. 539-550). Springer, Cham. DOI: 10.1007/978-3-030-20954-4_41

Rinfret, S. R. (2020). Telepresence robots: A new model for public administration course delivery. *Journal of Public Affairs Education*, 26(3), 380-390, DOI: 10.1080/15236803.2020.1744798

Rueben, M., Syed, M., London, E., Camarena, M., Shin, E., Zhang, Y. & Matarić, M. J. (2021). Long-term, in-the-wild study of feedback about speech intelligibility for k-12 students attending class via a telepresence robot. In *Proceedings of the 2021 International Conference on Multimodal Interaction* (pp. 567-576). DOI: 10.1145/3462244.3479893

Soares, N., Kay, J.C., & Craven, G. (2017). Mobile robotic telepresence solutions for the education of hospitalized children. *Perspectives in health information management*, 14(Fall):1e. PMCID: PMC5653953

Weibel, M., Nielsen, M.K.F., Topperzer, M.K., Hammer, N.M., Møller, S.W., Schmiegelow, K., & Bækgaard Larsen, H. (2020). Back to school with telepresence robot technology: A qualitative pilot study about how telepresence robots help school-aged children and adolescents with cancer to remain socially and academically connected with their school classes during treatment. *Nursing open*, *7*(4), 988-997. DOI: 10.1002/nop2.471

Wernbacher, T., Pfeiffer, A., Häfner, P., Buchar, A., Denk, N., König, N., DeRaffaele, C., Attard, A., Economides, A.A., & Perifanou, M. (2022). TRinE: Telepresence robots in education. In: *Proceedings of the 16th annual International Technology, Education and Development Conference (INTED),* pp. 6514-6522, IATED. DOI: 10.21125/inted.2022.1653