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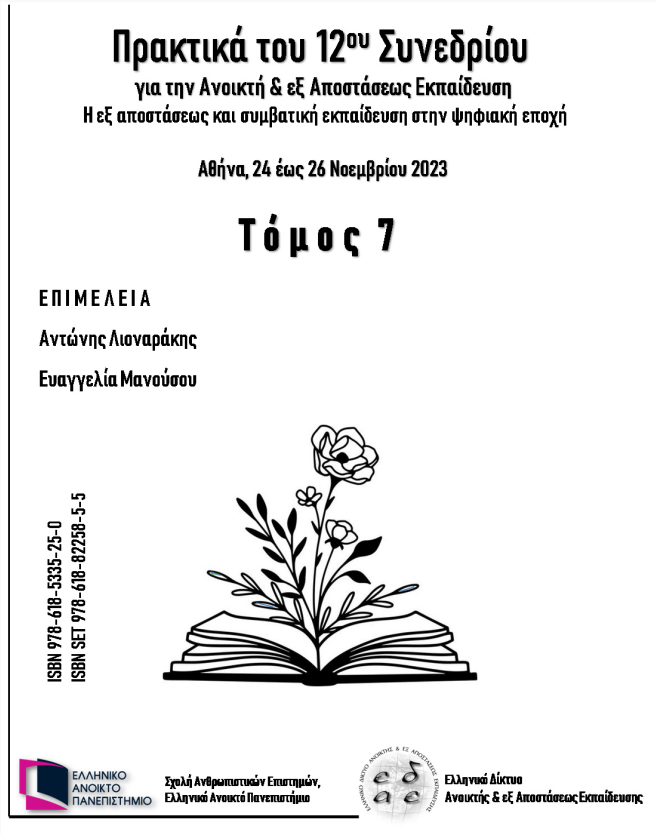

Οι απόψεις των εκπαιδευτικών σχετικά με τα ρομπότ τηλεπαρουσίας στη διδασκαλία

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Educators' views on telepresence robots in teaching

Οι απόψεις των εκπαιδευτικών σχετικά με τα ρομπότ τηλεπαρουσίας στη διδασκαλία

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Abstract

Remote persons can be represented by telepresence robots (TRs) located at another location and be facilitated in their audio-visual communication with other persons and the surroundings at that location. TRs are used in diverse fields including education. However, most of the previous studies have explored particular instances of introducing TRs in education. The present study aims to bring together the viewpoints of educators from different countries and educational institutes. The partners of the Erasmus+ project "TRinE: Telepresence Robots in Education" conducted interviews and focus groups among 46 educators (10 university professors and 36 high school teachers) in Austria, France, Germany, Iceland, and Malta. Findings indicated that educators appreciated that a remote student using a TR can feel and being felt present as well as move around in the class and the school. TRs enhance inclusiveness since the remote user can be an ill student or anyone at a remote location. The educators mentioned TRs' weaknesses such as their unstable Wi-Fi connectivity and poor audio video quality. They also pointed out challenges concerning privacy issues, loss of Wi-Fi connectivity, noisy environments and obstacles along the way as the TR moves (elevators, doors, stairs, etc.). Finally, the

educators recommended that TRs' manufacturers build more user friendly, visible, and accessible TRs as well as educational institutes apply effective TRs management procedures.

Keywords

Human Robot Interaction, Hybrid Learning, Mobile Robots, Remote Learning, Remote Teaching, Teachers, Telepresence, Telepresence Robots, Virtual Presence.

Περίληψη

Απομακρυσμένα άτομα μπορούν να εκπροσωπούνται από ρομπότ τηλεπαρουσίας (TRs) που βρίσκονται σε άλλη τοποθεσία. Τα TRs χρησιμοποιούνται σε διάφορους τομείς, συμπεριλαμβανομένης της εκπαίδευσης. Ωστόσο, οι περισσότερες από τις προηγούμενες μελέτες έχουν διερευνήσει συγκεκριμένες περιπτώσεις (κάθε φορά) εισαγωγής των TRs στην εκπαίδευση. Η παρούσα μελέτη έχει ως στόχο να συγκεντρώσει τις απόψεις εκπαιδευτικών από διαφορετικές χώρες και εκπαιδευτικά ιδρύματα. Οι εταίροι του Erasmus+ έργου "TRinE: Telepresence Robots in Education" διεξήγαγαν συνεντεύξεις και ομάδες εστίασης μεταξύ 46 εκπαιδευτικών (10 σε τριτοβάθμια και 36 σε δευτεροβάθμια εκπαίδευση) σε Αυστρία, Γαλλία, Γερμανία, Ισλανδία και Μάλτα. Τα ευρήματα έδειξαν ότι οι εκπαιδευτικοί εκτιμούν ότι ένας/μια απομακρυσμένος/η μαθητής/τρια που χρησιμοποιεί ένα TR μπορεί να αισθάνεται και να νιώθει παρών/ούσα καθώς και να κινείται στην τάξη και το σχολείο. Τα TRs ενισχύουν τη συμμετοχή, δεδομένου ότι οι απομακρυσμένοι χρήστες μπορεί να είναι άρρωστοι μαθητές/τριες ή οποιοσδήποτε σε απομακρυσμένη τοποθεσία. Οι εκπαιδευτικοί ανέφεραν τις αδυναμίες των TRs, όπως η ασταθής συνδεσιμότητα Wi-Fi και η κακή ποιότητα ήχου και εικόνας. Επισήμαναν επίσης τις προκλήσεις που αφορούν ζητήματα προστασίας της ιδιωτικής ζωής, απώλεια της συνδεσιμότητας Wi-Fi, θορυβώδη περιβάλλοντα και εμπόδια κατά τη διάρκεια της κίνησης των TRs (ανελκυστήρες, πόρτες, σκάλες κ.λπ.). Τέλος, οι εκπαιδευτικοί συνέστησαν στους κατασκευαστές των TRs να κατασκευάσουν TRs που να είναι πιο φιλικά προς τον χρήστη, εμφανίσιμα και

οικονομικά καθώς και στα εκπαιδευτικά ινστιτούτα να εφαρμόσουν αποτελεσματικές διαδικασίες διαχείρισης των TRs.

Λέξεις-κλειδιά

Αλληλεπίδραση ανθρώπου-ρομπότ, υβριδική μάθηση, κινητά ρομπότ, εξ αποστάσεως μάθηση, εξ αποστάσεως διδασκαλία, εκπαιδευτικοί, τηλεπαρουσία, ρομπότ τηλεπαρουσίας, εικονική παρουσία.

Introduction

A telepresence robot (TR) is a remote-controlled device on wheels that is operated by a remote user using a computer, tablet, or smartphone (Häfner et al., 2022; Perifanou et al., 2022a, b, c; Wernbacher et al., 2022). It is equipped with software, wireless connectivity, a screen display, microphones, speakers, cameras, motors, wheels, and a battery. People and things nearby the TRs can be seen and heard by the remote operators (drivers) of the TRs, and vice versa. As a result, the remote operators have the feeling that they are in the same place as the TRs. The TRs' drivers are able to virtually approach certain individuals or objects up close, navigate around them, and zoom in on them. The operators are free to navigate the TRs wherever, whenever, and however they like (as close as possible, from any angle), as well as to see and hear what they want.

TRs have a variety of applications in the workplace, at home, in elder care, in education, and in healthcare. The promise of TRs has already been demonstrated in a number of academic fields, including Business communication (Edwards et al., 2016); Engineering (Fitter et al., 2020); Informatics (Dimitoglou, 2019; Gallon et al., 2019; Puarungroj & Boonsirisumpun, 2020); Laboratory (Okundaye et al., 2020); Language (Burbank et al., 2021; Gallon et al., 2019; Liao & Dudek, 2020; Liao & Lu, 2018; Liao et al., 2022; Shin & Han, 2017; Tanaka et al., 2013); Mathematics (Burbank et al., 2021; Gallon et al., 2019; Lim & Han, 2019); Psychology support (Fischer et al., 2019); Public administration (Rinfret, 2020); Science learning (Cha et al., 2017; Schouten et al., 2022); Special education (Fischer et al., 2019; Page et al.,

2021; Zoder-Martell et al., 2021). However, according to Johannessen et al. (2023) and Weibel et al. (2020), to fully comprehend how TRs work in educational practice, more research is required.

During Erasmus+ project "TRinE: Telepresence Robots in Education" (Häfner et al, 2022; Wernbacher et al., 2022), project's 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. Although educators are the catalyst for adoption of TRs in the teaching practices, there are not many studies on their perceptions (Burbank et al., 2021; Chen et al., 2022; Leoste et al., 2022). Burbank et al. (2017) reported the viewpoints of remote observers who used a TR to view teaching in two preschool-aged classrooms. They highlighted that TRs allow flexibility but they cannot capture classroom nuances and there are privacy and safety concerns. Chen et al. (2022) found that K-12 school teachers who drove TRs to take fieldtrips reported significantly higher scores in embodiment, social presence and engagement than those who just watched the same fieldtrip through a recorded video. Preliminary results by Leoste et al. (2022) showed that higher education personnel perceived telepresence robots to have a great potential to enhance educational activities and they call for more studies in this area. So, it is imperative to further and exclusively investigate educators' perspectives and their recommendations for effectively integrating TRs in teaching. The current study intends to answer the following research questions (RQ):

RQ1: What are the educators' perspectives about TRs in teaching at different countries and diverse institutes?

RQ2: At which issues the educators agree and disagree?

Methodology

The study uses semi-structured interviews and focus groups to gain insights into the educators' viewpoints. Initially, a methodology was designed by two educational technologists. The ethical approval was obtained by the ethical committee of the project coordinator's university. The TRinE project partners conducted interviews and focus groups with 46 educators (10 university professors and 36 high school teachers) in Austria, France, Germany, Iceland, and Malta. The interviews and focus groups were conducted using videoconferencing. The duration of an interview was on average approximately 60 minutes and a focus group about 90 minutes.

The participants consented to participate in the interviews and focus groups and were recorded. They were briefed on the TRinE project and its goals, and were given a chance to ask any questions they might have. Privacy was maintained as much as possible through the principles of anonymity, confidentiality, and personal data security. The participants were free to express their opinions and ideas in the discussion. Then they were asked questions about their viewpoints regarding TRs in teaching. After all the recommendations, the group came up with some final ideas. The recordings were analyzed to extract themes (patterns that are important or interesting) from the data. The themes that emerged from the interviews and focus groups were data-related topics. The two educational technologists followed a six steps methodology (Braun & Clarke, 2006): 1) Getting familiar with the data, 2) creating initial codes, 3) looking for themes, 4) reviewing themes, 5) defining and identifying themes, and 6) producing the report. After becoming familiar with the interview data, the two researchers assigned codes to data segments that were related to a certain topic. When there were issues on the coding, the researchers talked them out and reached an agreement. After all was said and done, they agreed upon the specific themes.

Findings and discussion

A total of 46 educators (10 university professors and 36 high school teachers) provided their viewpoints regarding TRs in teaching. More specifically, 36 educators

from Austria (8 high school teachers), Germany (5 university professors), Iceland (14 high school teachers), and Malta (3 university professors and 6 high school teachers) participated in the focus groups. In addition, 10 educators from Austria (1 university professor and 1 high school teacher), France (1 university professor), and Iceland (7 high school teachers) gave interviews. Next, we present the educators' perspectives regarding the TRs' strengths, opportunities, weaknesses, and obstacles as well as their recommendations on using TRs in teaching (Table 1).

The educators appreciated that TRs enable the feel of presence, remote interaction, communication, socialization, and on-off campus student teamwork, as well as mobility since the TRs can move around class something that cannot be done with Zoom calls. They recognized that it is easy-to-use TRs from any remote place anytime. For example, an educator appreciated that:

> "*enables you to be a participant, to see it happen and be able to ask a question, and be asked a question, having some form of an interaction and communication other than just simply being fed in an one way direction where the content is brought to you and you are just on the receiving end*."

They also welcomed the opportunity that a remote teacher or an expert can teach a class from any place using a TR. For example, an educator commented: "*Teachers use TR when they are abroad, when they are sick or when the weather is really bad.*" Also, a remote student can use a TR to collaborate with students in campus. For example, an educator mentioned: "*students from an Erasmus project visited the school with a robot and got a guided tour with it*." Furthermore, TRs improve inclusiveness in education since ill students can attend a class from home avoiding dropout the class. For example, an educator stated:

> "*I think it is a wonderful way to, what shall we say, to maintain teaching even if you are not on location, and still have students on campus, so I think this is the strength and, yes, that it is actually possible to continue as if I were on university campus*."

According to the educators, TRs' weaknesses include their dependency on Wi-Fi connectivity that may cause TR freeze when the connection is lost. Also, TRs need frequent charging and lack geolocation tracing. In addition, educators complained

that TRs provide low resolution of images and inefficient zoom. Due to the poor sound quality of TR, it is difficult for the remote user to follow conversations with local people. When they compared TRs to Zoom calls, they found that it is more difficult to use TRs and requires extra work. Finally, TRs cost a lot, lack kinesthetics and hand-like actuators, and cannot physically interact with the environment. For example, an educator described that:

> "*Wi-Fi issues in the school may mean the device loses signal in certain rooms or as it moves down certain corridors. This may in turn cost the school lesson time. Similarly, there may be Wi-Fi issues in the remote locations where a student or teacher are learning or teaching form home*."

Some educators had negative attitude towards teaching a class via a TR. For example, they said: "*for them appearing as teacher through TPR makes no sense*." Educators claimed that the use of TRs reduces the human contact and may also disrupt the class. Also, the remote operators may feel disabled when the TR freezes (e.g., due to battery depletion or lost internet connectivity) or the TR cannot move at some places (e.g., stairs, closed doors, elevators). They thought that the educational institutes put up various obstacles such as the following: not enough support and information about TRs; limited availability of TRs; obstacles along the way of the TR movement; not Wi-Fi connectivity everywhere in the buildings; noise environments (hallways, school yards, lack of soundproofing). The educators expressed worries about psychological issues as well as cases when the TR falls down the stairs or hits a wall. Finally, they mentioned the need to obtain consent for using the TR from all involved. For example, an educator remarked that:

> "*Consent may be also difficult to obtain from the parents of the student learning from home, as they may be uncomfortable with a camera and microphone in their home environment.*"

The educators made several recommendations, mostly to TRs manufacturers. They would like TRs to be more visible, user friendly and accessible, with improved audio and video quality, hand-like actuators, and sensors for kinesthetics as well as be less expensive. Recommendations to educational institutes include improvements for the TRs' reservation process, clear strategies in place before introducing TRs, and

suitable infrastructure for TRs. Finally, they advise to limit the TR's use to necessity, implement suited teaching methodologies, assess and act on psychological issues, and ask users to meet in-person before using TRs. For example, an educator pointed out that:

> "*The school needs to be prepared with the psychological preparation and support needed for students who might be learning in class with a TR device that introduces them to harsh realities and possibly sickness and death at closer quarters*."

***Table 1**: Views of educators.*

Themes	Interviews Educators' views	Focus Groups Educators' views
Strengths of TR in teaching	Increases mobility. Moves around while giving class to students; Communication is as good as teaching live; Students can interact remotely.	TR mobility; Easiness of TR setup and use; Tech ubiquity at remote location.
Opportunities of TR in teaching	TR builds presence; TR helps to socialize; Run courses in spite of the place; Suitable for teamwork. Encourages collaboration between students on and off campus; Allows ill students to participate in class from home; Prevents dropouts for students who attend remotely.	Increased sense of presence; Improved access to educators and students located at distant areas; Improved active participation; Increased equality of chances; Facilitates virtual visits from experts;
Weaknesses of TR in teaching	Poor wireless Internet connectivity; Sound Quality. It is difficult for the remote user to hear talks between students; Low resolution images & video; Inefficient zoom; TR's charging; Lack of TR location tracing; It is more difficult to use TR and requires extra work than Zoom calls;	Reliance on Internet connectivity; Sound quality is poor; Lack of kinesthetics; Absence of actuators that resemble hands; Unable to interact physically with the environment; High price;

Obstacles & challenges of TR in teaching	Privacy issues; Feeling limited in one's ability to move freely everywhere; Frozen TR when wireless connection is lost; Noise-related issues; TR is not embodied.	Problems with consent; Lack of support and information; Obstacles along the way of the TR; Lack of Wi-Fi connectivity everywhere; Environmental noise; Possible disruptions; Decreased human contact; Scarcity of TRs in schools; TR vulnerability; Psychological effects.
Recommendations for TR in teaching	Make TR more visible; Improve TR reservation/booking process at the school; Ensure that TR is user friendly; Enhance accessibility; Improve audio and video quality.	Increase TR's visibility; Put appropriate procedures in place; Apply suitable teaching methodologies; Put the human factor first; Evaluate and address psychological problems; Implement kinaesthetic sensors; Provide hand-like actuators; Use just as necessary; Lower price; Create the necessary infrastructure; Meet in person before using TR.

Summing up, both interviewers and participants in focus groups discussions agreed that that major strengths of TRs include their ability to move and enable a sense of physical presence for the remote user. They also agreed that TRs provide opportunities and flexibility to students, teachers or experts at distant locations to participate in classes and other educational activities. Furthermore, they emphasized that TRs enhance inclusiveness by enabling ill students to participate in classes from home. Our results are in line with Leoste et al. (2022) who found that higher education personnel valued the replacement of social presence and the creation of a sense of social presence to be the main benefits and opportunities of TRs. Also, Chen

et al. (2022) found that TRs were effective in affording teachers' telepresence, embodiment, and social presence.

However, since TRs depend on wireless connectivity, the remote operator may lose connection with the TR when the TR is moving in areas that are not covered by wireless networks (e.g., Wi-Fi). Currently, TRs do not provide good sound quality and the remote users face difficulties to hear people in noisy classes or environments. Also, physical obstacles (e.g., furniture, bumps on the floors, stairs) in the corridors, halls, auditorium, and rooms prevent TRs to move freely. Furthermore, interviewers raised privacy concerns while focus groups participants pointed at the difficulties to obtain consent forms from people affected by the use of TRs. Similarly, teachers' observers raised privacy concerns (Burbank et al., 2017) while higher education personnel worried about the high cost and failures of TRs as well as the lack of necessary infrastructure and the lack of knowledge and skills (Leoste et al., 2022).

There were also some conflicting opinions regarding the interaction via TRs. Some interviewers mentioned that communication is as good as teaching live but they also pointed out the difficulty of the remote user to hear talks between students. Also, some focus groups participants mentioned the decreased human contact. Furthermore, some focus groups participants pointed out that it is easy to use TRs, while some interviewers mentioned that it is more difficult to use TRs than Zoom calls.

Finally, they recommended to TRs manufacturers build TRs that are more visible, user friendly, and accessible and to school administrators improve the management of their TRs fleet.

Conclusions

This study presents the findings of interviews and focus groups with 46 educators (10 university professors and 36 high school teachers) in Austria, France, Germany, Iceland, and Malta regarding the use of TRs in teaching. The responders agreed that TRs may provide remote teaching and learning opportunities as well as communication and collaboration. The remote users feel like they are part of the class, and the class feels the remote users like being present. However, they also

admitted several challenges, such as the difficulty of using TRs in elevators and stairs, the poor audio quality, the inadequate Wi-Fi coverage of educational institutes, the noisy environments, privacy concerns, and more. The educators recommended that TRs' manufacturers should develop more user-friendly, visible, and accessible TRs, with improved audio quality, hand-like actuators, and sensors for kinesthetics as well as less expensive TRs. Finally, educational institutes should improve the management of their TRs fleet.

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