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Mobile Telepresence Robots in Education: Strengths, Opportunities, Weaknesses, and Challenges

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Abstract. A mobile telepresence robot (MTR) is a semi-autonomous robot whose movement and interaction with its surrounding environment is controlled by a person from a distance. In education, MTR enable learners or educators to virtually participate in a class from a distance. TRinE: Telepresence Robots in Education is an EU project that aims at providing an interactive toolkit to support educators, learners, and others in order to integrate MTR in education. During January and February 2022, project's partners conducted a qualitative study to collect the experiences and views of educators, learners, and other stakeholders (i.e., administrators, technical support staff, librarians) regarding the use of MTR in education across Austria, Germany, Greece, France, Iceland, Malta, and USA. A total of 19 persons were interviewed and 66 persons participated in 12 focus groups discussions. The findings describe interviewees' experiences with MTR in education as well as the views of interviewees and focus groups' participants with regard to pros, cons, and recommendations of using MTR in education. These findings may help educational policy makers, educational institutes officials, educators, and others to efficiently integrate MTR in education.

Keywords: Distance Learning, Distance Teaching, Human Computer Interaction, Telepresence Robots

1 Introduction

A mobile telepresence robot (MTR) is a remote-controlled robot with mobility and videoconferencing capabilities. Usually, an MTR is equipped with a screen display, camera, audio speaker, microphone, motor, wheels, and wireless Internet connectivity. The remote operator of the MTR can drive and move it, interact with the people and objects around the MTR, and feel like being present there. Telepresence robots have been used in many areas such as offices, health care, hospitals, and schools [1]. MTR can be used by persons who cannot be physically present and walk around at a specific location due to being at a distant location, illness, disability, restrictions (e.g., quarantine, restricted access location), bad weather, war, and more.

The advantage of MTR over videoconferencing in education lies in its ability to move around the class and interact with one or more persons. So, the operator of an MTR in a class may experience stronger feelings of social presence [2], belonging and being part of the class.

TRinE is an Erasmus+ project that aims at providing an interactive toolkit to support educators, learners, and other stakeholders in order to integrate MTR in education [3]. With regard to this project, the researchers conducted a qualitative study to collect the experiences and views of educators, learners, and other stakeholders (e.g., administrators, technicians, IT support staff, librarians) regarding the use of MTR in education. This paper describes the results of the study.

2 Previous Studies regarding Telepresence Robots in Education

Most previous studies use the term telepresence robot (TR) both for static TR and mobile TR. This study focuses exclusively on MTR. Previous studies with regard to TR in education investigated the introduction of TR in various educational settings. When a teacher cannot physically visit the premises of a class due to illness, bad weather, long distance, etc., teacher can deliver teaching using a TR located in the class [4-6]. Similarly, an expert at a distance location (e.g., abroad) or in a limited available time can advise a class via a TR [7-10]. Most previous studies investigated the case of a homebound student (due to illness) participating in a class via a TR [7,9,11-16]. Other previous studies investigated the cases of a language learner abroad communicating with a native-speaker via a TR [17-19], two students at a distance discussing a topic and solving a problem using a TR [2], a teacher teaching mathematics [5] or languages [20] to one student as well two classes at a distance (e.g., in different countries) communicating via a TR [21].

Most previous studies investigated a single case of using TR in a specific class. Using interviews, the current study records the experiences of users who have already used TR in various educational settings in Austria, France, Iceland, and USA. In addition, using focus groups, the current study records the perceptions and opinions of both experienced users and inexperienced educators, learners, and other stakeholders (i.e., administrators, technical support staff, librarians) regarding the introduction of TR in education across Austria, Germany, Greece, Iceland, and Malta.

3 Methodology

Using focus groups and interviews, the researchers collected the opinions of interested stakeholders across Austria, Germany, Greece, France, Iceland, Malta, and USA. The proposed research was reviewed and approved by MCAST's Research Ethics Committee. A total of 19 interviews and 12 focus groups with 66 participants were conducted during January and February 2022. A total of 85 persons participated in the interviews and focus groups discussions. The participants included educators, learners, and other

stakeholders (e.g., administrators, technical support staff, librarians, MTR manufactures). The duration of a focus group discussion was about 90 minutes, while an interview lasted about 60 minutes. The focus groups discussion and the interviews were video recorded (with the consent of the participants). In order to identify patterns and themes related to the participants' views, the videos were transcribed and coded.

4 Results

In this section we briefly present the interviewees' experiences with MTR in education as well as the views of interviewees and focus groups' participants with regard to strengths, opportunities, weaknesses, and challenges of using MTR in education. In addition, participants' recommendations are given with regard to introducing MTR in education. Due to space limitation, only the main results are presented here. Further results are presented in [22, 23].

The interviewees described their experiences with MTR in various settings: 1) Remote educators (at home, office, abroad, ill) teach, advise, and socialize with students; 2) Remote experts, invited professors with disabilities or from overseas give lectures and mentoring; and 3) Remote students (at home, hospital, abroad) attend classes.

Participants in both the focus groups and the interviews mentioned several advantages of using MTR in education across the following themes: 1) Strengths; 2) Pedagogical capabilities; 3) Remote student opportunities; 4) Remote teacher opportunities; 5) General opportunities. The strengths of MTR (such as easy-of-use, mobility, and interactivity) were mentioned 11 times by interviewees and 13 times by focus groups' participants. The pedagogical capabilities of MTR (such as fostering engagement, participation, feel of presence and belonging, and collaboration) were mentioned 30 times by interviewees and 32 times by focus groups' participants. The opportunities given by MTR to remote students (such as enabling ill students or students at abroad to participate in class) were mentioned 10 times by interviewees and 10 times by focus groups' participants. The opportunities given by MTR to remote teachers (such as enabling remote experts to lecture and advise students) were mentioned 8 times by interviewees and 8 times by focus groups' participants. Finally, the opportunities given by MTR to remote students (such as enabling participation in class in case of pandemic and bad weather, or avoiding commuting and long journeys) were mentioned 2 times by interviewees and 7 times by focus groups' participants.

Participants in both the focus groups and the interviews expressed several concerns about using MTR in education across the following themes: 1) Technical weaknesses; 2) Educational and psychological challenges; 3) Environment obstacles; 4) Management and maintenance challenges; 5) Legal and ethical challenges. The technical weaknesses of MTR (such as low quality of audio and video, movement difficulties, and battery limitations) were mentioned 15 times by interviewees and 10 times by focus groups' participants. The educational and psychological challenges (such as fear of using MTR, negative attitudes, human need of being physically present and communicating, and training needs about MTR) were mentioned 17 times by interviewees and 30 times by focus groups' participants. The obstacles of the environment (such as lack

of stable high-speed WiFi everywhere and physical obstacles along the MTR's move) were mentioned 27 times by interviewees and 20 times by focus groups' participants. The MTR management and maintenance challenges (such as cost of MTR and needs for assistants to charge, schedule, assign, and collect the MTR) were mentioned 5 times by interviewees and 17 times by focus groups' participants. Finally, legal and ethical challenges of using MTR in education (such as lack of policies and regulations, privacy, security, and illegal recording) were mentioned 25 times by interviewees and 28 times by focus groups' participants.

In total, interviewees mentioned more times weaknesses (89) than advantages (53) of MTR in education. Similarly, focus groups' participants indicated more times weaknesses (105) than advantages (62) of MTR in education.

Participants in both the focus groups and the interviews made several recommendations to facilitate the integration of MTR in education across the following themes: 1) Recommendations for policies; 2) Recommendations for organizational issues; 3) Recommendations for buildings; 4) Recommendations for MTR functionalities. Recommendations for policies (such as policies for the operator of the MTR) were mentioned 3 times by interviewees and 22 times by focus groups' participants. Recommendations for organizational issues (such as funding) were mentioned 2 times by interviewees and 2 times by focus groups' participants. Recommendations for buildings (such as WiFi everywhere and space arrangements) were mentioned 7 times by focus groups' participants. Recommendations for MTR functionalities (such as connectivity, audio, vision, gesturing, movement, and security) were mentioned 20 times by interviewees and 19 times by focus groups' participants.

5 Discussions and Practical Implications

This study provided a list of main themes with regard to strengths, opportunities, weaknesses, challenges, and recommendations for the introduction of MTR in education. Educators, students (and their parents) as the main users of telepresence robots in an educational setting can be inspired by current practices and experiences of respondents and encouraged by the positive feedback from early adopters. Students who face obstacles to physically attend classes can use MTR to participate and being part of the class. In addition, educators and experts can provide teaching and mentoring from a distance using MTR. External experts could participate in class via an MTR to save travel time and costs.

One of the main benefits for students is the feeling of belonging and being part of the class when using such an MTR. The feeling of social presence improves learning and can help the recovery process of sick students. Using a MTR makes it easier for them to return to school.

Despite the advantages that MTR offer compared to other tele-teaching technologies (e.g. Zoom sessions), there are a number of weaknesses that may depend on the technology or other pedagogical, psychological, environmental or administrative aspects. For example, the move of MTR is difficult if there are too many physical

obstacles in the building such as stairs, lifts, doors and assistance for the robot is not possible, or if WiFi full coverage requires additional high costs.

Education policy makers and school headmasters can develop strategies and guidelines based on the recommendations. They can use the presented information to select appropriate MTR and take appropriate technological, environmental, and organizational steps. One of the most important tasks here is to issue usage and safety regulations for all users of the MTRs to ensure their smooth utilization.

For the technicians who are to set up the mobile telepresence robots in the facilities of the educational institutions, our results provide a list of recommendations and technical obstacles that should be solved, e.g. high-speed WiFi coverage, possible physical obstacles, positioning of the docking stations, considerations for spare parts, maintenance scheduling and repairing, etc.

Currently, MTR encounter several obstacles for their effective integration in education. However, it is expected that many of these issues (such as high cost, limited WiFi coverage everywhere, lack of policies and support, lack of MTR functionalities) will be soon resolved. For example, the prices of sensors and other hardware components are decreasing, their quality is advancing, and companies are constantly improving software features. Such advances include the management of MTR fleets or the use of artificial intelligence (AI) algorithms for collision detection, pathfinding, simultaneous translation or even facial recognition. In some aspects, MTR shares threats in the area of privacy such as other technologies like augmented reality and self-driving cars, where the sensors deliver real-time data from the environment. Solving these problems in one area will automatically solve the problems in the MTR domain.

Our findings should enable MTR manufacturers to plan their future features based on the given recommendations. What some providers already offer is a developer kit for those users who want to adapt the hardware and software capabilities of their MTR devices to their own requirements. Such modular principles could be further adopted by the community to overcome current limitations. However, some of the technological weaknesses and threats, e.g., in the area of safety and security, could not entirely be solved by technology in the near future or the solution will not be affordable.

6 Conclusions and Future Research

This paper presents concentrated results of a comprehensive study in the field of MTR in education. The study employed interviews and focus groups discussions with the aim of gaining insights into the opinions and attitudes of different target groups. Twelve focus groups and nineteen interviews were conducted with a total of 85 participants across seven countries. The participants had varying degrees of experience with the technology, some of them have been using it for years, others only knew about it recently. The results of this study include opinions and attitudes towards MTR technology as well as recommendations for the use of MTR in educational institutions.

A next step is to create a validated approach for the use of MTR in the classroom. A toolkit will include a knowledge base, a set of guidelines for user-friendly and efficient integration, best practices for educational scenarios from experienced users and much

more. The overarching goal is to increase presence, social learning, and inclusion in classrooms and university classes, and to compensate for the lack of mobility or limited travel of students, faculty or other staff. MTR could enhance learning and intercultural exchange and prepare students for the workplace of tomorrow.

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