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Hybrid teaching and learning with a telepresence robot at Tallinn University

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INTRODUCTION

The case presents the hybrid teaching and learning model where ten physically present persons and three persons through a telepresence robot participated in the STEAM workshop arranged within the master course “Robot-supported learning in the kindergarten and primary school”.

GENERAL CONTEXT OF THE HYBRID TEACHING PRACTICE

- Implementer: School of Educational Sciences at Tallinn University (Tallinn, Estonia)
- Course: Robot-supported learning in the kindergarten and primary school (Master degree)
- Lifetime: from September to December 2022 (individual case)
- Reference: Based on the Interview with Dr. Janika Leoste, Associate Professor of Educational Robotics, School of Educational Sciences as well as on research papers related to this topic
- Compiled and structured by Tallinn University

PHYSICAL SPACE AND PEDAGOGICAL APPROACH

The hybrid teaching was applied within the full-time Master degree course “Robot-supported learning in the kindergarten and primary school”. Classes took place in the EDUSPACE research lab, which has been adapted to be suitable for both, lectures and teamwork for face-to-face (F2F) students and students using telepresence robots (Fig. 1).

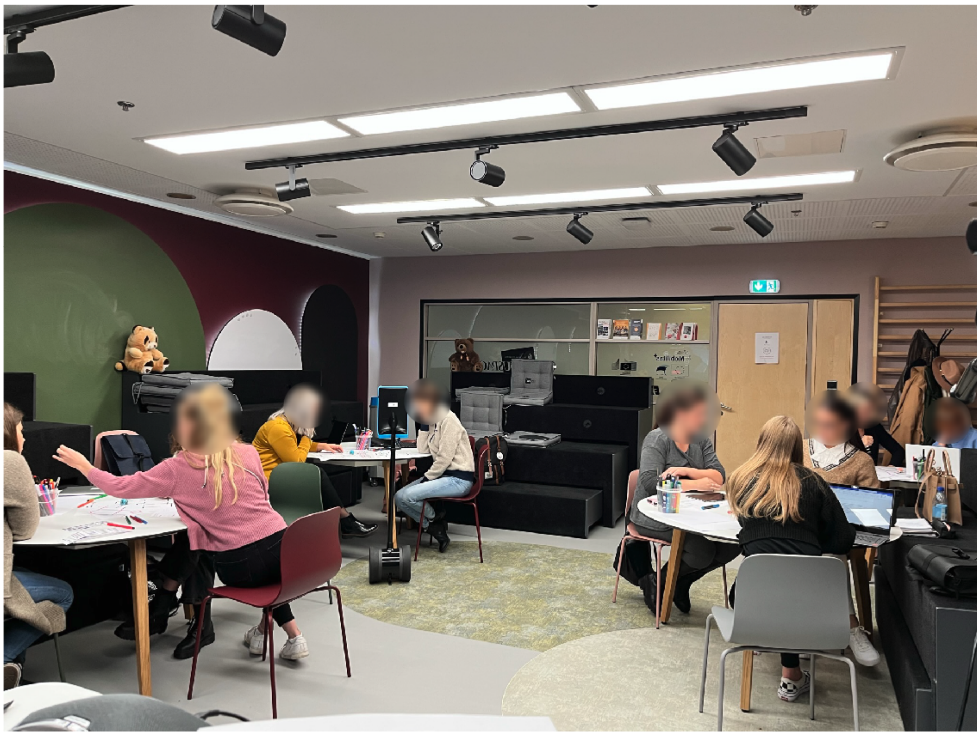

Fig. 1. The workshop setting in EDUSPACE with Double 3 telepresence robot mediated person participating in the group work (image shared by Prof. Leoste).

The tables and chairs of the lab have been rearranged by the teacher to free maximum floor space for the telepresence robots to move while maintaining a comfortable group-work setting for four groups of students. Theory lectures were delivered fully online, and main points were explained in the classroom. Students could choose F2F or remote learning. The remote students as well as visiting professors could participate via telepresence robots.

Participants and their previous experience

A total of 13 students took part in the class including Erasmus exchange students. Typically, most of the students joined from the classroom and some students participated through the telepresence robot, one as a leading person and two as passengers. All students were females. The age of the cohort was between 22-45 years. No participant had special needs. One student participating through the telepresence robot had no experience in using this technology, and two students who were passengers in the telepresence robot had limited previous experiences. The teacher had more than five years of experience in online teaching and half a year in using telepresence robots. Neither learners nor the teacher had hybrid teaching experiences before.

Initial situation

Tallinn University has extensive experience working with educational innovation. From 1994 it has been a centre of development and research in the field of technology-enhanced learning and teaching in Estonia. The hybrid teaching and learning was already used in the period of 2010-2012 within the Erasmus Mundus master programme on Digital Library Learning (DILL) in the Human Resource Management (HRM) course. Entrepreneurship Seminar on European Virtual Venturing (EVV) was organised and carried out by the Institute of Information Studies in Estonia and Ecole supérieure d'Informatique, réseaux et systèmes d'information, Institute of Training in Computer Science, Networks and Telecommunications (ITIN) in France in March-April 2010, 2011 and 2012 (Virkus and Lepik, 2010; Virkus, 2013). Hybrid learning and teaching began to be employed more widely at Tallinn University due to the restrictions created during the COVID-19 period. Telepresence robots started to be used in the last year after their direct purchase and the creation of a corresponding research group.

Current reason

Thus, the current reason to carry out a hybrid course format more widely was the pandemic-related restriction of classroom teaching. In the period of COVID-19 pandemic mainly online courses were provided. In order to mitigate the risks of increasing student isolation, a hybrid course format was developed that offered the best possible participation in lectures both, in-person and online. However, remote virtual students, being easily forgotten by those physically present, missed the informal pre- and after-lesson classroom conversations and felt sometimes the need to apologise when they wanted to contribute to what was happening in the physical space. One way to deal with these challenges was to integrate Telepresence Robots (TPRs) in the teaching and learning process

(Virkus et al., 2022). Therefore, the teacher started to experiment with the usage of telepresence robots in her classes. Previous research on TPRs in education has shown that this technology could promote social interaction and collaborative learning through incorporating the social dimension into the learning process, enabling students to participate in-person in group work and navigate through remote learning environments (Virkus et al., 2022). Thus, TPRs started to be employed primarily because, in addition to the traditional video conferences conducted via Zoom or Teams, they offered a greater sense of social presence and enabled a better experience of what was happening in the classroom.

Benefits for the student

The main goal was to provide remote students a greater sense of social presence and ensure the quality of the teaching and learning process. For example, Cheung et al. (2018) have highlighted the following benefits in implementing TPRs at the Michigan State University:

- **Persistence and retention:** TPRs help students remain successful in their classes by providing an easy option to overcome challenging circumstances;
- **Student empowerment:** TPRs empower students who experience setbacks and other serious life challenges, allowing them demonstrate their commitment to learning;
- **Comparable learning experiences**: TPRs facilitate active participation and peer interactions during class;
- **Easy implementation**: TPRs offer a flexible, affordable, and simple solution that is relatively easy to implement by students and instructors;
- **Minimal impact on instructors**: although instructors require some training to integrate the system into their classroom, its actual use is typically easier than extending deadlines, changing assignments, or scheduling alternate exam days;
- **Empowerment for student-support personnel**: TPRs enable immediate, short-term assistance for students who were experiencing temporary setbacks, empowering personnel to help students who may have had no other options.

To sum up: Through improved social presence, TPRs can improve learner engagement, interest, confidence, motivation in classroom settings, by allowing teachers to teach lessons and students to participate in classes from anywhere (Leoste et al., 2022a; Virkus et al, 2022).

Learning objectives

The course aimed to support the development of practical skills and educational technological competences for the safe use of simpler robotics tools in the context of primary education, for the integration and diversification of educational and educational activities.
Upon completing the course the students were expected to:

- have an overview about basic educational robotics tools that are suitable for preschool and primary school;

- be able to collaboratively create and adapt robot-supported integrative learning materials;
- be able to evaluate security risks related to the use of robotics tools and make proposals for their management;
- be able to reflect one's own teaching and to design changes in teaching and educating processes.

HYBRID TEACHING SCENARIO

Synchronous hybrid learning scenario was used, which meant a technology-rich approach to enacting comparable, shared, and collaborative learning experiences for face-to-face and online participants in real-time. A part of the students were present at the regular learning locations. Other students were not physically present and participated remotely via telepresence robots.
The teacher tried to create a classroom where both physical and telepresence robot-mediated students felt that they were socially present and equally engaged in the learning process. The teacher of the course applied a seminar-based instructional strategy that alternated between whole-class and small-group discussions. The whole-class discussions featured brief content overviews led by the teacher, interspersed with topic discussions between all students in the course. The small-group discussions featured students breaking up into groups of four or five to talk in greater depth about the course content and to give brief presentations on the different course readings.

HARDWARE AND SOFTWARE USED

The main hardware employed for the hybrid course were the **Double 3 two-wheeled robots**, equipped with two cameras, six microphones, a screen and a powerful speaker (Fig. 2). The robot could be controlled remotely. It had an automatic obstacle detection, regulated height and battery life of about four hours. The angle of the cameras and the height of the robot could also be adjusted remotely.

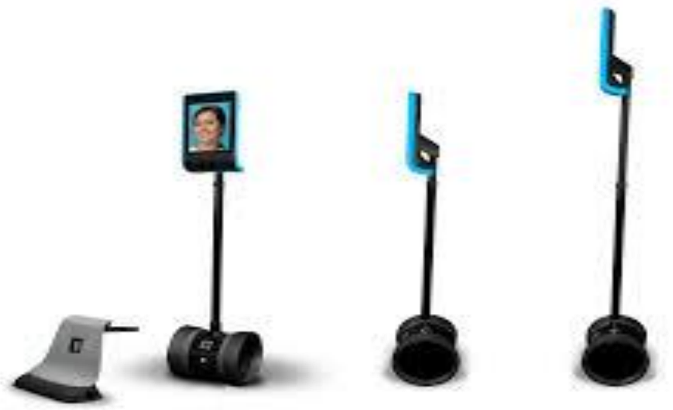

Fig. 2: Double 3 model by Double Robotics (image shared by Prof. Leoste).

An array of 3D sensors enabled the Double 3 telepresence robot to understand its environment, where it was safe to drive, and how to divert around obstacles to reach the destination. Built-in obstacle avoidance meant that completely untrained drivers could drive Double 3 without fear of bumping into walls or people.
Two 13 Megapixel cameras provided an ultra-wide field of view and multiple levels of zoom.
A precision gear motor enabled both cameras to physically tilt up and down. An advanced software algorithm combined all of the movement into one seamless user experience – the user could just point to what he/she wanted to see. The user could read everything - from paperwork on a desk in front of him/her, to the whiteboard across the room.
An advanced array of six microphones helped the driver hear people from farther away and with less background noise. The integrated audio system enabled full-duplex audio (two-way simultaneous audio) to be more robust in challenging environments.
This robot also featured Wi-Fi 5 and Bluetooth 4.2 wireless connectivity and supported multiple driver accounts and visitor passes, as well as screen sharing and multi-viewer video. Thus, five users could have access to the same robot. Controlled from a web-based user interface, the Double Robotics Double 3 was compatible with Windows, MacOS, iOS, and Android.
A more detailed overview of the technology is given in Appendix 1.

Interaction among participants

The teacher interacted with both types of students in a way that they all felt a social presence and that they were engaged. Students in the classroom and robot-mediated students interacted and participated in group work on the same basis.

Assessment

Feedback and reflection on practical assignments were provided to both, face-to-face students and remote students participating via telepresence robots, similarly in a synchronous way or provided online in the virtual learning environment. The assessment procedures were the same as in usual learning process, and there was no difference with hybrid learning.

Content creation

All course participants could use similar content developed by the teacher and learning methods and tools. Though, the teacher had to plan her studies in such a way that the telepresence robots did not interfere with the studies (e.g. that the telepresence robot did not stand in such a way that it blocked the view of the blackboard or whiteboard from the learners present) and students participating via telepresence robots could feel the social presence to the same extent as F2F students. Most of Tallinn University's F2F courses were supported by the learning management system Moodle where all the learning resources necessary for learners were available.

Student evaluation

From the point of view of the students, it was considered convenient to participate in a class where telepresence robots were employed. Nevertheless, this technology was quite new to the students and they were a bit confused in the beginning. The communication between the online and remote participants was seen to be difficult.
Most students (nine students out of ten being physically present) felt comfortable when interacting with TPR-mediated persons:
“It was the first time I have seen a telepresence robot, so in the beginning I was quite confused. In the end I got used to it and respected the robot as a member of our group.
Half of the on-site students (five) considered contacting robot-mediated persons easy, while the other half either had not formed their opinion on this matter or (one person) found it difficult (due to robomorphism). For example, one student said:
“Sometimes it was difficult to communicate with the person, and sometimes I forgot that there was another person in the room behind the robot.”
In addition, more than half of on-campus students (six) were able to understand when the telepresence mediated person wanted their attention, whereas three of them had not formed their opinion on this or (one person) were not able to understand it:
“Couldn't answer the question about how well I could tell when a person was trying to contact me, as I never once noticed an attempt to contact me.”

However, all students saw it as a good opportunity to participate in the learning process if they could not be physically present either due to health problems, family or other reasons (Leoste et al., 2022b).

Teacher evaluation

Employing telepresence robots in the teaching and learning process was not as simple as unboxing a telepresence robot and starting to use it. The physical space must be configured to meet the characteristics of the telepresence robots, creating movement corridors for them, offering the possibility to charge it during the lesson (i.e., the charging socket must be located in a place where a telepresence robots-mediated person could observe what was happening in the lesson), and ensure a stable Internet connection. It was also necessary to provide the telepresence robots-mediated persons with digital/electronic possibilities that allowed them to overcome the difficulties of not being able to write on the auditorium’s blackboard/whiteboard or express their emotions using body language. In these cases, it could be appropriate to use a digital board and some additional devices that helped them express themselves in a richer way – or allow them to take part in classroom discussions without interrupting others, enabling them to pose their questions to the teacher or to other students (i.e., simulate raising their hand).
In addition, the telepresence robots should have the ability to notify the audience if there was a problem with them (such as a lack of battery power) in order to allow the telepresence robots-mediated person to continue attending the class, even if it was in a charging station. When conducting hands-on teaching and learning activities such as a STEAM workshop, telepresence

robots need to be provided with appropriate before-hand training on controlling the telepresence robots' different cameras and using zoom-in to better follow the hands-on activities.
Telepresence robots-mediated persons also need training to adjust the TPRs' sound levels to suit group-work, informal conversation or presentations, and training to use the telepresence robots microphone's boost options to hear better in different communication situations. In addition, telepresence robots-mediated persons need to become aware of the robot's battery life and plan ahead using the charger to avoid battery drain. Teachers should also consider changing their teaching methods somewhat, especially in the classes that involve some physical activity or teamwork, in order to ensure that the telepresence robots-mediated students could take part in the classroom activities similarly to F2F students. At least some additional rules should be introduced that ensure a proper classroom environment for teaching and learning (Leoste et al., 2022b).

QUALITY ASSURANCE

The quality assurance processes were carried out in compliance with approved normative documents of Tallinn University. There was an university-wide feedback system in the Study Information System (ÕIS), where both qualitative and quantitative information was collected and analysed. The standard quality procedures, which were also used in this course/workshop, were:

- a survey after the semester and feedback from the students at the end of the semester and during and after the course;
- using learning analytics dashboards for teachers and learners;
- course objectives and learning outcomes were revised/improved every year taking into account students and teachers' feedback.

TRANSFERABILITY AND SUSTAINABILITY

Hybrid teaching was a flexible option for the teachers depending on the situation of the learning participants. Telepresence robots were excellent means to provide synchronous hybrid teaching, and this model was applicable in other institutions. For a distance learner participating synchronously in a hybrid classroom, the opportunity to move through the classroom in a mediated manner using a telepresence robot could provide social presence and meaningful participation. Although telepresence robots are increasingly accepted in various settings, research on their acceptance in educational contexts is still underdeveloped. Therefore, a Creativity Matters Research Group was established at Tallinn University of Technology (Taltech) which is led by Janika Leoste and includes Sirje Virkus from Tallinn University who conducted this interview. The main focus of the Creativity Matters Research Group (https://cm.taltech.ee/people/) is on innovative technology-enhanced learning methods in higher education including telepresence robots.

TIME COMMITMENT

The course of 6 ECTS included 40 lectures/seminars during one semester (one lecture/seminar lasted 45 minutes). In addition, it took one week to plan the course. Before each class, one hour was spent setting up the technology and the learning space so that it was suitable for the use of the telepresence robot. Additional two hours were dedicated to the student feedback analysis, and one hour - to the reflection.

Highlights

There is a need to think through the scenarios when the use of telepresence robots makes sense. Presumably, telepresence robots can be almost useless when the whole educational institution is in distance mode, as their prices (about 7000 EUR per unit) do not justify providing all students with telepresence robots. On the other hand, the telepresence robot could support individual students or teachers who are not able to participate on site for good reasons. These reasons could involve COVID-like infectious diseases, permanent or temporary mobility disability, or participation from far away (from another city, country or rural area) for valid reasons. In these cases, especially if it is a student who has to attend different classes, it is probably necessary to provide them with a support student who carries the telepresence robots over thresholds and stairs (Leoste et al., 2022b).

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Annex 1: Hardware and Software of the Double 3 model by Double Robotics

Hardware	**Software**
Cameras 2 x 13 Megapixel Unified Pan/Tilt/Zoom Module - One super wide angle lens, one super zoom lens - 30 FPS and Night Vision Mode	*Core Features* Unlimited Minutes Click-to-Drive Mixed Reality UI Pan–Tilt–Zoom Motorised height control Lateral Stability Control (LSC)
Sensors 2 x Stereo vision depth sensors (Intel® RealSense™ D430) 5 x Ultrasonic range finders 2 x Wheel encoders (2048 PPR each) 1 x Inertial Measurement Unit (9 DoF)	*Video Protocol* WebRTC 128-bit AES encrypted
Processors, Memory, and Storage NVIDIA® Jetson™ TX2-4GB System-on-Module - 256-core NVIDIA® Pascal™ GPU Architecture - Dual-core NVIDIA® Denver 2 64-Bit CPU - Quad-core ARM® A57 Complex - 4GB 128-bit LPDDR4 Memory - 16GB eMMC 5.1 Flash Storage	*Fleet Management* User account management Scheduled Access Controls Call Quality Reports Aggregate all accounts by email domain Google Apps Single Sign-On (SSO) Integration Branded Subdomain Branded User Interface
Battery 4 hours of runtime, 2 hour recharge time Li-ion	*Collaboration Features* Multiple Driver Accounts Visitor Pass Screen Sharing (Chrome to robot's screen) Multi-viewer Video (up to 5 simultaneous viewers)
Audio 6 x Digital microphones with beamforming 8-watt full range speaker	*Supported Driver Interfaces* Mac or Windows PC with Chrome, Firefox, or Safari iPad and iPhone, or Android with Chrome
Display 9.7-inch LED-backlit multi-touch LCD Remotely-adjustable height (47” to 60” tall)	*Developer API Available*
Wireless Connectivity Wi-Fi - Intel Dual-Band Wireless-AC (2.4GHz, 5GHz) Bluetooth 4.2	
Colours	

User-replaceable silicone trim (5 colours available)	
Developer Expansion 2 x USB 3.1 SuperSpeed ports Top and rear hardware mounting points	