Exploring Greek students' intention to use Telepresence Robots in Higher Education

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Abstract

This paper aims to present the findings of a series of pilot studies that took place in the context of the TRinE Erasmus+ project and evaluated the potential of using Telepresence Robots (TR) in Higher Education (HE) settings in Greece. The main goal of this study was to measure the acceptance of TR based on students' feedback, after using them in class. This was achieved by deploying a Technology Acceptance Model (TAM) approach. The participants involved in the study were in total 5 HE teachers and 104 HE students. Both students and educators participated in completing a validated questionnaire, which was tailored to the technology of the TR. The findings unveiled generally positive perceptions among the in-class students regarding the usage of the TR. Moreover, the results showcased even more positive perceptions among the out-of-class students concerning TR utilization. Overall, these findings suggest that integrating TR into educational environments has the potential to foster dynamic and interactive learning environments, which could ultimately enhance student engagement and improve learning outcomes.

Keywords

Telepresence Robots, Distance Education, Distance Learning

1. Introduction

The COVID-19 pandemic has been a significant catalyst for the rise of distance education even though the need for distance education existed before this challenging period. A variety of tools became essential as they succeeded in facilitating the remote teaching and learning processes. Telepresence robots (TR) are among the innovative technologies that gained attention and adoption during the pandemic as they allowed students to virtually attend classes, interact with teachers and peers, and engage in various learning activities while physically distanced [1]. TR are mobile remote-controlled devices that represent the remote user via video and audio and their biggest advantage lies in the possibility of users to move around a physical space, providing a more immersive and interactive experience compared to static video conferencing or remote communication tools [2]. But how easy and useful will it be for students to use TR in various educational contexts? Within the context of the Erasmus+ KA2 project *TRinE – Telepresence Robots in Education* (Ref.:2020-1-MT01-KA227-SCH-092408) which focuses on examining how TR is utilized in educational settings at the upper secondary and higher education levels, including classrooms and various electronic learning environments, we conducted various pilot studies in five countries: Greece, Iceland, Malta, Germany and Austria [3]. The main aim of this study was to evaluate the effectiveness of integrating TRs into Higher Education learning environments by examining their acceptance based on Greek students' feedback. In the following sections of this paper, we will briefly describe the research methodology adopted as well as the main research findings collected in Greece.

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2. "TRinE GR Pilots in Higher Education"

2.1. The design of the "TRinE GR Pilots in HE"

The TRinE project partners adopted the *Technology Acceptance Model* (TAM) approach [4] and followed a consistent research procedure. They collaborated with lecturers and teachers in their respective institutions to gather data to answer the question of the effectiveness of integrating a TR into Higher Education educational environments during the academic year 2022-2023. More concretely, a structured data collection protocol was established, along with instructional materials provided to both higher educators and students.

2.1.1. The TAM4Edu Framework

In the context of our survey, which aspires to evaluate the acceptance of TR based on students' feedback, the *"TAM4Edu framework"* was adopted [5]. While there have been several attempts to apply the TAM in the context of Robot-assisted Learning [6-8], the *"TAM4Edu framework"* represents a novel proposal that encompasses the following parameters: a) T*echnology Acceptance Modeling* (red), b) *Determinants of Perceived Usefulness* (green), c) *Determinants of Perceived Ease of Use* (yellow), d) *Intercorrelated dependencies between determinants* (blue).

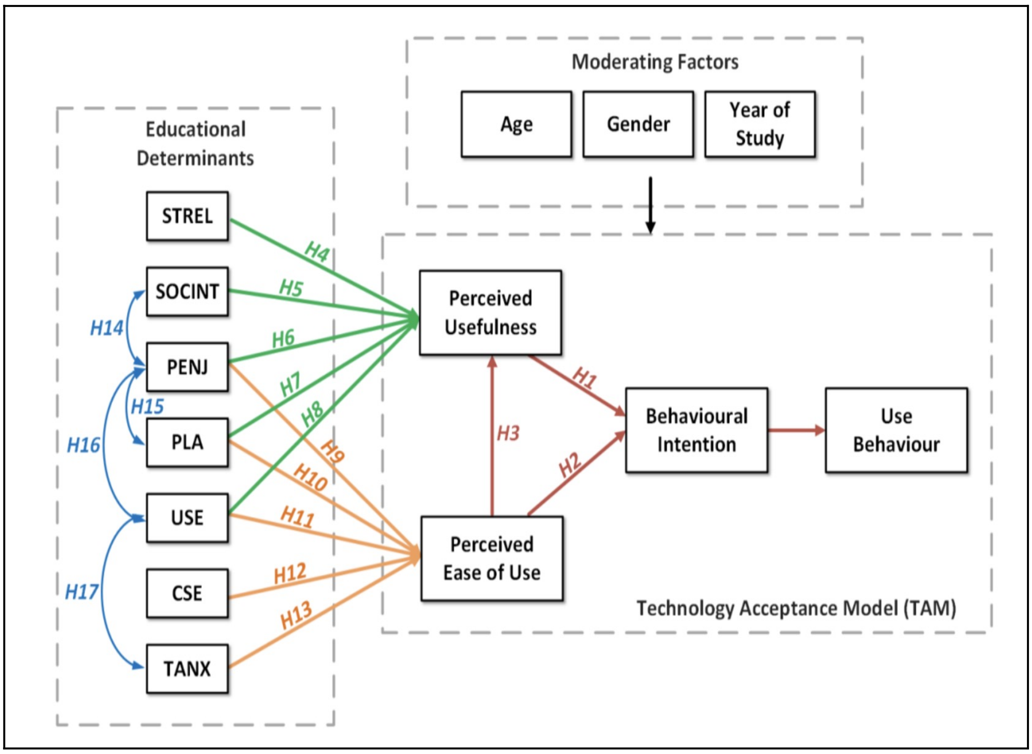

Figure 1: Hypothesis visualisation of the proposed *"TAM4Edu framework"* [5] (The constructs of the framework are described below in the Table 1).

Figure 1 illustrates how these parameters interact within the *"TAM4Edu framework"*, providing a comprehensive model for understanding and predicting technology acceptance in educational contexts. After initially gathering student data through the construction of the questionnaire and analyzing the obtained results, the most suitable questions for each determinant were identified to ensure effective adoption of the *"TAM4Edu framework"* [5]. Subsequently, based on statistical analysis, 24 questions were incorporated into the survey (Table 1) [5]. These questions aimed to assess students' acceptance of technology within each determinant of the proposed framework. Furthermore, it was adopted a 5-point *Likert scale* ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) within the framework. The sequence of questions was randomized, with certain items intentionally reverse-coded to better detect potential disengagement in student responses.

Table 1
Constructs of the TAM4Edu framework [5]

Construct	Acronym	Evaluation Question
Perceived Usefulness	PU1	The technology used in this lecture helped me understand the subject effectively.
	PU2 (R)	I wasn't able to learn the subject effectively through the technology used.
	PU3	The lecturing technology used today enabled me to better understand abstract material.
Perceived Ease of Use	PEU1 (R)	The used technology was rather difficult to operate.
	PEU2	Performing tasks using the technology is intuitive
	PEU3	Overall, I find the technology easy to use
Behavioural Intention	BI1	I look forward to using the same technology again in the near future.
	BI2	The lecturing technology used in this lesson should be used regularly.
Computer Self-Efficacy	CSE1	I was able to finish the given task using the technology without supervision.
	CSE2 (R)	I needed someone to show me how the technology functions first.
Technology Anxiety	TANX1	Technology in general makes me nervous.
	TANX2 (R)	I felt comfortable using the educational technology.
Perceived Enjoyment	PENJ1 (R)	The used educational technology was boring.
	PENJ2	The actual process of using this lecturing technology was enjoyable.
Study Relevance	STREL1	I find the use of such technology as important in my studies.
	STREL2	Using the educational technology was relevant to my studies
Usability	USE1	I find the information from the educational technology used to be very intuitive.
	USE2	Learning how to perform tasks using the technology was easy
	USE3	The feedback from interacting with the system was intuitive.
	USE4	Operating the educational technology was intuitive.
Social Interactivity	SOCINT 1	The lecturing technology promoted discussion and collaboration with classmates.
	SOCINT 2	The used technology permitted me to interact with my class mates.
Perceived Lecture Attention	PLA1	I felt very attentive during this lecture.
	PLA2	Through this lecture I would characterise myself as being concentrated.

2.2. Methodology

2.2.1. Data Collection & Instrument

During the academic year 2022-2023, five pilot surveys were conducted in the context of the *TRinE* Erasmus+ project with an average participation of 20 students from various fields in each survey. The TR used was the *Ohmni Robot* [2]. The data collection took place over two days per classroom:

a Pre-Trial day and a Trial day. On the Pre-Trial day, students were first introduced to the *TRinE* project and the *Ohmni Robot* and then they had to fill in a consent form before they start their training on how to interact with the TR. On the Trial Day, during classroom activities, six or seven students (depending on the duration of the lecture) interacted with the TR in a rotational manner. Upon completion of the lessons, both the students and lecturers were asked to complete a questionnaire. The questions were tailored to different groups of respondents: a) students who interacted with the TR in class, b) students who used the TR outside the classroom, and c) lecturers involved in the research. The proposed *"TAM4Edu model"* was separately tested on both students' groups.

With respect to the questionnaire, it comprised 24 main questions, utilizing a 5-point *Likert* scale for measurement, as well as demographic and open-ended questions. All main questions aimed to assess various factors including perceived usefulness, perceived ease of use, behavioral intention, computer self-efficacy, technology anxiety, perceived enjoyment, study relevance, usability, social interactivity, and perceived lecture attention.

2.2.2. Sample

Data collection utilized opportunity sampling inviting lecturers to participate in the study during their lectures. Some students agreed to leave the classroom and take the role of the *"remote student"* who in fact is the *"TR controller"*. This group of students could use the TR to attend the lecture and engage with the other students in the classroom remotely. On the other hand, the remaining students, the *"local (in-class) students"* had the opportunity to participate in the lecture conventionally while interacting with the "remote students" through the TR. Table 2, below, provides an overview of the participants involved in the study.

Table 2
Distribution of sample by age group, gender, and role in the study.

Age	N	Gender	N	Role	N
19-24	97	Male	28	Student Interacting with Telepresence Robot (In class)	72
25-35	7	Female	81	Student Controlling the Telepresence Robot (Out of class)	32
36-49	3	Other	-	Lecturer	5
> 50	2				

A total of 109 responses were collected, with 104 students engaging with the TR to varying extents. Among these students, 32 took control of the TR for at least twenty minutes. The majority of respondents (74%) were identified as female. Regarding age distribution, the largest proportion of respondents (89%) fell into the 19-24 age bracket. Notably, no missing values were detected for any of the data items, avoiding the need for imputation.

2.3. Main Results

The study aimed to investigate the acceptance and effectiveness of integrating a TR in educational settings at higher education levels and concretely at the University of Macedonia in Thessaloniki in Greece in the context of the Erasmus + project TRinE. The results revealed generally positive perceptions among the "local (in-class) students" and "remote (out-of-class) students" regarding using the TR.

With regards to the "local (in-class) students" views, the integration of the TR in educational settings has been perceived as enjoyable and relevant by them, enhancing their learning experience. More than 75% of them somewhat or strongly agreed that the TR enabled better participation in classroom activities remotely, promoted discussion and collaboration with classmates, and facilitated interaction with peers. In fact, many students reported feeling comfortable and found the interaction with the TR intuitive, which aided them in completing tasks without supervision. Among the respondents, 55% of the students agreed with this opinion, 30% were neutral, while 15% disagreed. This suggests that while most students had a positive experience with the TR, there remains a small group that encountered difficulties or felt less comfortable, indicating a need for further support or training for some users. Furthermore, the majority of them found the process of using the TR enjoyable and reported feeling attentive and focused during the whole time involved in class activities while using the TR. Additionally, all "local (in-class) students" indicated that they did not find the TR usage boring, nor did they experience any nervousness towards this technology. On the contrary, opinions were divided regarding the intuitiveness of performing tasks while interacting with the TR. While some students found the TR easy to use and felt confident in completing tasks independently, others were less certain. Despite some challenges, such as initial difficulties in interaction, the majority of students recognized the TR's potential to enhance classroom activities and expressed a desire for its regular use in future classes. They highlighted the TR's contribution to making remote participation more accessible and engaging, underlining its significance in their studies. The overall consensus suggests that while initial training may be necessary, the long-term benefits of using the TR justify its continued integration into higher education learning environments.

Similarly, the results revealed generally very positive perceptions among the "remote (out-of-class) students" regarding using the TR. Even though most of them expressed that using the TR was not very relevant to their studies over 80% of students expressed positive sentiments towards various aspects of the TR technology in their academic pursuits. They highlighted the importance of TR technology in their studies, found the process of using the TR enjoyable, and felt confident in completing tasks with minimal supervision. Furthermore, they perceived learning to operate the TR easy and reported feeling very comfortable while using it and not so nervous. However, the majority of them stated that they needed help to be shown how to use it while their opinions were divided regarding the intuitiveness of operating the TR. With regards to participation, the majority of the remote (out-of-class) students reported that the use of TR significantly enhanced their ability to participate in classroom activities remotely, allowing them to engage more actively in discussions and collaborative tasks. The greater part of them also stated that the TR made it possible for them to perform class activities effectively and intuitively, with minimal learning effort required to operate the robot. This seamless interaction helped maintain the social and collaborative aspects of learning, fostering a sense of inclusion and participation even from a distance. Furthermore, most students noted that using the TR increased their attentiveness and concentration during class activities, which contributed to a more engaging learning experience. They found the technology neither boring nor complicated suggesting its potential for regular use in educational settings. Interestingly, all students expressed anticipation for future use of the TR technology. Lastly, these findings underscore the positive impact of TR technology on "remote (out-of-class) students" academic experiences and suggest a high level of acceptance and satisfaction with its usability and functionality.

The main difficulties reported by all students in the open-ended questions are the following: 1) *Network Connectivity Issues:* The TR required a dedicated wireless network. Connection losses occurred between the remote operator and the TR, requiring reconnection and provoking difficulties in their collaboration. Problems also arose when the TR switched between wireless networks, often resulting in signal loss and requiring manual reconnection; 2) *Audio Quality Problems:* Remote operators had difficulty hearing local users when there was noise in the laboratory due to the lack of noise cancellation functionality. Additionally, remote operators had to wear headphones to prevent audio feedback that made communication impossible; 3) *Screen Visibility Limitations:* Remote operators wanted the ability to zoom in on local users' screens in the laboratory and vice versa. This was particularly requested by local users even when remote users were sharing their screens.

3. Conclusions & Final Remarks

In conclusion, this study aimed to assess the acceptance and effectiveness of integrating TR in higher education settings. The results showed overwhelmingly positive perceptions among both in-class and out-of-class students regarding TR use despite the technical issues occurred. These findings suggest that integrating TR technology can foster dynamic and interactive learning environments, potentially improving student engagement and learning outcomes. Furthermore, ongoing statistical analysis indicates a significant relationship between the perceived ease of use of TR and the intention to utilize it. Further details will be presented in a future paper.

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Declaration on Generative AI

During the preparation of this work, the author used "Grammarly" in order to do a grammar and spelling check. After using this tool, the author reviewed and edited the content as needed and took full responsibility for the publication's content.

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