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Service robot teaching assistant in school classroom

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Abstract— **The Covid-19 pandemic found us unprepared in multiple levels of our everyday lives. After the first lockdown period we are facing the challenge to create a new normality by combining our habits and social norms with precautions against the virus. The educational field is one of the top priority fields with the double role, to educate and keep the students safe. In the current paper, we propose the use of service robots as teaching assistants for students aged 13-17. In a real school classroom environment, we conducted a set of experiments with a course conducted by a teacher and a service robot in the role of his/her assistant. Students' responses in the given questionnaires before and after the course shown that after the interaction with the robot, they statistically significantly believe that the use of robots can make difficult courses more interesting, easier understandable and motivate them to follow a relevant career in the future. Additionally, apart from the educational benefits we propose that it will eliminate the spread of the virus in the class since the teacher will minimize his/her physical contact with the students and the students will have the chance to collaborate through their robot agent.**

Index Terms— **service robot, teaching assistant, school classroom, Covid-19**

I. INTRODUCTION

Service robots are getting involved in many aspects of our lives. The use of robots in the educational field can be beneficial for both students and teachers. A robot can assist the students by having the role of a tutor or a peer assistant while for teachers it can efficiently take the role of an assistant teacher[1]. During the last years, many robots such as RoboThespian, Baxter and Nao have served those roles and have proven beneficial in delivering learning materials[2]. Moreover, an artificial intelligence robot assistant promotes the collaborative learning between teachers, students and smart learning environments[3]. In our study, we conducted real class courses with the service robot STIMEY[4] as a teaching assistant. Our most important findings are that a) students after interacting with a robot teaching assistant (TAR) statistically significantly improved their believes about the efficiency of a robot in the teaching role and b) are intended to follow a future career in courses that before the course found difficult.

II. RELATED WORK

The presence of service robots as teaching assistants in elementary schools can motivate students to learn but only when the robot has the ability to enhance their relationship by cheering or praising[5]. In a real school setting with secondary students, tele-present robots were tested for the ability to perform remote teaching. The use of such tele-present agents gave the teachers the ability to talk to the students and deliver the lesson [6]. The robots' capability to move and carry out physical tasks is one of the aspects that makes a social service robot promising as teaching assistant[7]. Apart from their physical ability, the robots' personality traits play a major role in the humans' attitudes towards them [8]. Learning at home with virtual platforms, chats and social media during the Covid-19 pandemic [9] was unavoidable and we still do not have any clues about the outcome of those methods in the students. The robot's (as well as the human's) physical appearance considered an important factor in the learning process[10], [11].

III. PRESENT STUDY

Based on the research results described in the last section, it is inevitable to use distant-learning tools and practises during the Covid-19 crisis for safety reasons but it is also important to combine those learning techniques with agent's physical appearance such as service robots. For those reasons, we propose the use of service robots in the classroom environment. Through this process, the students will have the chance to meet their classmates and have a course with their teacher, without losing the physical aspect of learning. At the same time, the service robot will provide them a more personalized experience with the use of social media and learning platforms.

A. STIMEY Project

The STIMEY robot (Fig.1) is a mobile robot designed for social support in learning process in STEM studies and it is interconnected with a learning platform, social media and radio. It has speech recognition, chat bot, and it can deliver courses, quizzes and learning activities via the web platform. It can create attachment with the students and increase their socializing via the social media. It can support readymade behaviours such as variety of positive feedback, reinforcement, surprize etc. and use them related to students' commands or quiz answers[12],[13]. The robot can show information in the mobile phone which is connected to its back, move its head and hands, change facial expressions and move through wheels.

B. Hypothesis

Our hypothesis is that students after having a course with a service robot in the role of TAR, will improve their opinion regarding difficult subjects and increase their learning motivation.

IV. EXPERIMENTAL STUDIES

a) Participants

The total number of student participants was 92, 42 Females

43 Males, 7pref. not say, aged 13-17 years old. They were secondary and high school students from five different classes and two different public-school units in the region of North Greece. They all had normal or corrected to normal vision and hearing and the course conducted in their native language. The experimental studies took place on December 2019.

b) Procedure

The experiment took place in real classroom environment as indicated in Figure 1. The teacher who was assisted by the service robot was specialized in STEM education. The students before the class, field in a pre-test questionnaire (10 minutes) about their attitudes regarding the use of TAR in their class. The questionnaire was designed and evaluated during the STIMEY Project. The pre-test followed a 15-minutes familiarity phase with videos about the robot and its use. The actual course lasted for 30 minutes and the subject was about Astronomy and Physics, explaining the lighting conditions of the moon. It was adapted to the student's level based on their age. The course was conducted by the teacher in collaboration with the robot, which was giving information about the subject, enhanced students to use the social media platform, to share their opinions and gave them feedback during a knowledge quiz relevant to the course. The students worked individually with a pc or tablet and exchanged information through them with their classmates, robot and teacher who was standing at a specific place in class (see Fig.1). After the end of the course, the students filed in another questionnaire with 22 Likert scale questions, evaluated them from "Strongly Disagree" to "Strongly Agree" (e.g. they replied with 1 to 5 'the most difficult course would become more interesting if the teacher had a robot assistant'), 2 multiple choice (i.e. choose with robot's feature helped you understand better the course) and 3 open questions.

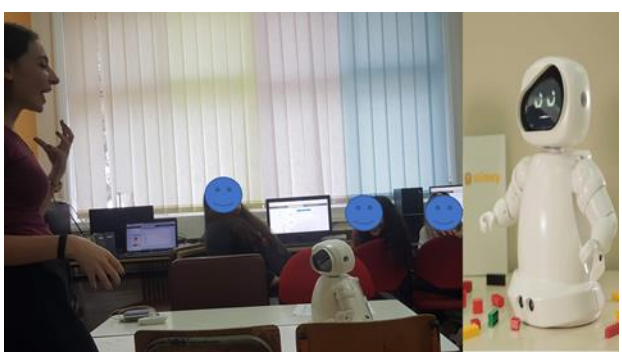

FIG.1: CLASSROOM SET UP (LEFT), STIMEY ROBOT (RIGHT)

c) Data Analysis & Results

For the data analysis we applied a Kruskal Wallis test in order to find demographic variations (gender, age) into students' responses. Additionally, we applied a paired sample t-test to compare the students' answers before and after the class.

The Kruskal Wallis analysis shown no statistically significant differences between students' replies and their age. On the other hand, regarding their gender, boys had more positive attitudes towards STEM and use of TAR ($H(43)=41.99$, $p=0.013$). The students replied that with the use of a TAR, the most difficult subjects would become more: a) *interesting*, before the class (MV=3.9, SD=1.03) and after the class (MV=4.14,SD=0.85) and the difference indicated by t-test significant at $t(90)=2.23$, $d=0.24$,$p=0.029$. b) *easily understandable*, before class (MV=3.54, SD=1.01) and after class (MV=3.93, SD=0.92) statistically significantly at $t(90)=2.27$, $d=0.39$,$p=0.002$ and c) *pleasant* before class (MV=4.22, SD=0.89), after class (MV=4.25, SD=0.89) but the difference proven non-significant. The use of a TAR would α) *help students focus on the course*, before class (MV=3.63, SD=1.02), after class (MV=3.75, SD=0.95) and the difference was no statistically significant but b) *motivate students to follow a future career in the subject taught by the TAR*, before class (MV=3.38, SD=1.11) and after class (MV=3.65, SD=1.05) increased statistically significant at ($t(90)=-2,50$, $d=0.27$, $p=0,014$). Furthermore, after the course students had a positive attitude toward STEM courses and the use of TAR in the related questions after the class (MV=4.11, SD=0.71) and their interaction with the TAR (MV=4.01, SD=0.62). Finally, the more favourable robot's feature was its eyes (49.45%) and head (20.88%).

V. DISCUSSION AND CONCLUSIONS

The use of TAR in the educational process can be beneficial for both students and teachers. In our study, we compared the students' attitudes regarding the use of service robots in education before and after having a class with the STIMEY robot in the role of their teacher' assistant. Results shown that the use of TAR can motivate students to follow a career in subjects that they find difficult and make those subjects more easily understandable. Additionally, students after the course had positive attitudes regarding the robot's ability to give them feedback. Apart from the robot's efficiency in the teachers' assistant role, we propose its use during the Covid-19 lessons. Leyzberg [10] and Ahtinen [11] underline the necessity of physical appearance in the learning process. The use of service robots in classroom can combine the distance with the proximity in education. The robot can go closer to the students who will be able to keep safe distances in the class and provide them a more personalized experience. They will have the chance to be with their teachers and classmates, without loosing the physical 'contact' and at the same time to use smart class technologies. Our future work contains additional experiments in real class environments during Covid-19.

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