“You Win, I Lose”: Towards Adapting Robot’s Teaching Strategy

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***Abstract*—This paper presents a study that aims to address the challenges of creating effective educational robots. To this end, we developed a social educational robot which acts as a peer that is also a learner of a foreign language rather than a tutor teaching it. Children engage in a game with a peer robot which is programmed to either always win or always lose. The purpose of this study is to investigate whether children would learn more if they were winning or losing the game to the robot. The conducted study compares children’s responses and children’s improvements of English vocabulary after a game with the robot. Results indicate that children improve their English after playing with the robot, however which depends on the robot’s adapting strategy.**

Keywords—Human-Robot Interaction; Child-Robot Interaction; Social Robotics; Educational Robotics; Gender Effects

I. INTRODUCTION

The last few years have seen the increase, worldwide, of projects studying the role of social robots in educational applications, for example, robots acting as tutors or teachers, robots acting as learners tools for therapy, instructors in the factory, and learning companions in health-care applications. The study of social robots facilitating educational benefits is an emerging and promising area of social robotics.

A number of projects have explored the role of robots in educational applications within the classrooms [1], in particular robots have been previously used for learning a second language [2]. Findings of Castellano *et. al.* [3] reported that adapting robot’s facial expressions to the status and evolution of the chess game significantly improved children’s positive feelings and engagement with the iCat robot. Robots have been used not only to perform a traditional tutor/teacher role, but also to act as a peer who is a learner itself [4].

This paper presents an ongoing work exploring an adaptive strategy for educational robots where the robot acts as a peer. The robot was programmed to always win or to always lose in a particular condition. We show that robot can make mistakes and this creates a feeling of equality between the child and the robot. We hypothesize that removing the teacher-disciple barrier will make learning process more comfortable for the child. We aim to explore whether children have varying learning outcomes depending on whether the robot doing better/worse than them.

Gender effects have been found throughout child-robot interaction studies, whether we are looking for them [5] or not [1]. Our findings also demonstrate gender effects motivating further research that will explicitly address gender effects with educational robots.

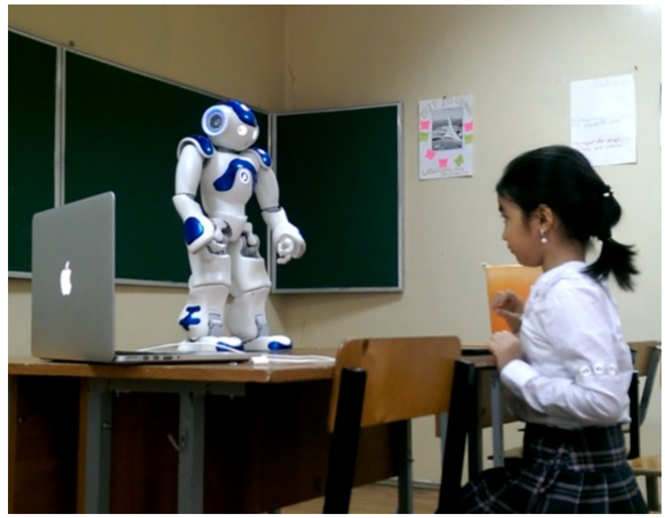

Fig. 1: Experimental Setup

II. ROBOT’S TEACHING STRATEGY

The concept of this research exploits the advantage of a social peer robot which shown to be attractive to children and has proved to be impactful to children’s learning. The robot acts as a peer that is also learning English. They both engage in a game on the Android tablet (Figure 2). At the launch of the Android application, NAO introduces itself and suggests to play a game together. Child is encouraged by the robot to launch the application and click the start button. Upon the start of the game, the child is suggested to choose his or her avatar from four cartoon characters (two male and two female avatars) available. NAO also gets its face-shot avatar. Before the start of the game, NAO explains that they have to take turns and answer five questions each. Each question has a displayed letter (e.g. “A”) and images of three fruits (e.g. apple, pear, and banana). In accordance with the turn, either a child or NAO need to select their answer (e.g. apple because it starts with letter “A”) on the screen. Then, either the NAO or the child get the same letter but different fruits (e.g. avocado, orange, and peach). The difficulty of words is increased question by question. If the question is answered correctly, the NAO robot expresses sadness/happiness gestures and verbal utterances such as “you will get the next one” or “you are genius”. The correct word is displayed and the NAO pronounces it in English with correct pronunciation which is checked by a native English speaker. Upon completion of ten questions (five questions by each opponent), at the end of the game results for each letter are displayed. In the end, if NAO loses, NAO congratulates the child on winning the game and

Fig. 2: A snapshot of the question

says that it needs to spend more time learning English. If the child loses the game, the robot shows its happiness in winning but says encouraging words to the child and wishes the child good luck with learning English. It should be noted that the dialog between the child and the robot was in their native language, except for the names of the fruits.

III. HRI Study

The study was conducted in the primary school with 22 children (14 girls and 8 boys). We conducted between-subject study with 9-10 years old children. Each session of the study was a short interaction (5-6 minutes long) between a child and a robot. Half of the children interacted with a winning robot and half of the children interacted with a losing robot. If the child did not answer any of the questions correctly, the robot would also make five mistakes. However, there was not such a case.

A humanoid robot NAO had a pre-recorded male child-like voice. The interaction was conducted in a medium-sized classroom with two experimenters inside. Experimenters monitored and recorded the session progress. The robot was set up with a standing position on a table in the center of the room facing the child. A tablet was placed on the table in between the players. First camera was recording front side of the child, in order to better capture child behavior and emotions, and the second camera was located behind the child recording the whole interaction.

Participants were brought one by one from the class by the experimenter before the start of each session. Child had to answer a pre-test to find out if children knew the fruit names in their native language by showing the fruit pictures. This number was recorded. In addition, children were asked if they know the English translation of these fruits. This number was also recorded. During the post-test the child had to try the same fruits and the number of English fruit names was also recorded.

IV. Results and Discussion

In general children improved their English vocabulary after playing with the robot. The average number of new words learned by children is: 3,5 words. There was no statistically significant difference in number of learned words between different robot conditions as determined by a one-way ANOVA ($F(1, 20) = 0.80$, $p = .40$).

Additional exploratory analysis conducted identified learning differences between boys and girls. A two-way ANOVA test examined the effect of gender and robot condition on children's learning progress. The average number of learned words between genders during different robot conditions was statistically significantly different, $F(1, 18) = 8.20$, $p = .01$. When children played with the always-winning robot, the average number of learned words for girls was 2.17 (SD = 0.50), and the average number of learned words for boys was 1.00 (SD = 0.55) words. In contrast, when children played with the always-losing robot, the average number of learned words for girls was 1.63 (SD = 0.44) words, and the average number of learned words for boys was 3.67 (SD = 0.71).

Strong learning outcomes could have not been observed due to the difficulty of the game: many fruits were simply unknown to the children in their native language (e.g. papaya, fig, etc.) The game could be improved by changing the fruits to the more familiar fruits such as strawberry and clementine. This can be verified by performing more experiments.

V. Conclusion

This study examined the educational benefits of using a social robot as a helper in English learning process and the results are encouraging. The girls who played with winning robot showed average number of learned words 2.17 (SD = 0.50), in contrast to the boys who showed 1.00 (SD = 0.55) with the same game conditions. When children played with the always-losing robot, the average number of learned words for girls was 1.63 (SD = 0.44) words, and the average number of learned words for boys was 3.67 (SD = 0.71). Our results provide a promising basis for HRI for helping children to learn a foreign language. We showed that children had only positive reactions and evaluated the robot as a friend. Our future work will include more familiar words which will help to improve the learning gains of the English vocabulary as well as the efficiency of our educational agent. We will also involve video coding the behaviors of the children during the interaction with the robot. But overall, children reported only positive feelings of the interaction with the robot.

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