Social Robots in Educational Institutions

They came to stay: Introducing, Evaluating, and Securing Social Robots in Daily Education

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***Abstract*— In this paper, we present a methodology that Blue Ocean Robotics, as a creator of emerging robotic solutions, has compiled based on experiences collected from "Innovation Projects", where we implement robots in Danish municipalities on a long-term basis. Furthermore, we report on the results from two of our projects where three social robots were successfully implemented into educational institutions, increasing the children's concentration time and concentration efficiency.**

Keywords*— Child-Robot Interaction; Daily Education; Long-Term Interaction)

I. Introduction

Social robots for education are becoming more available to the public and will likely play an essential role in educational settings soon. Thus, it is important to study Child-Robot Interaction (CRI) and the effect of robots on children in the wild, especially over a long term. In this paper, we describe how we introduce social robots to schools and kindergarten outside the lab with a business-oriented approach. The institutions invest in robots with the aim of using them daily over an unforeseeable time. We accompany their personnel until we are sure that they feel familiar enough with the robotic solutions to use them on daily basis.

II. Previous Work

Previous work has shown that social robots can enhance play, learning, self-confidence and social skills [1, 2, 3]. They can be designed for specific application scenarios in child development such as to diagnose and study autism [4] as well as to treat and assist children with autism [5].

Work in Human-Robot Interaction increasingly reports findings from long-term observations of CRI outside the lab. Reference [6] and [7] study children's engagement over a period of two months with focus on the novelty effect of the robots. Reference [8] identify key issues when designing robots for long-term Human-Robot Interaction by studying children playing chess with a social robot. Reference [9] present a novel methodology for experimental studies on robot-assisted play based on a long- term study of children with autism. However, to our knowledge, no studies have addressed an integration over an unforeseeable period, where educational institutions invest in social robots.

III. Empirical Study

A. Robots

The social robots used for the project presented in this study are Romibo, Zeno and Nao. Romibo by Origami Robotics is controlled from an IPad. In our projects, it is used to train social and academic skills, including social interaction and social communication. Zeno is a 56cm tall humanoid robot by RoboKind for children with special needs. Its face has seven degrees of freedom, which allows it to express various emotions. We use it to teach children to express empathy, acceptable behavior in social situations and self motivation. Nao is a 58cm tall humanoid robot by Aldebaran that is very rich in its movements. We use it to increase social interaction in the class room by encouraging children to play games together with Nao.

B. Participants

Participants in our Innovation Projects are municipalities that are interested in implementing innovative robotic solutions. The results presented in this paper were collected together with educational institutions from two municipalities. Five Romibos were used at a primary school with 29 five to seven year-old children. One Zeno was used at kindergarten practicing inclusion with a seven-year-old boy with special needs. Another Zeno was used at a school for children with special needs with five children with the cognitive age of six years. One Nao was used at a kindergarten with a group of 12 three to four year-old children. The pedagogues working with the children and the robot were the class teachers of the respective groups.

Fig. 1. Setup of a session with Zeno, a pedagogue (left) and two children.

C. Procedure

Blue Ocean Robotics works with partners in two phases for every new robotic solution. The first phase is called Innovation Project phase, and the second, subsequent phase, is the Implementation Project phase. The overall purpose of the Innovation Project phase is to show and demonstrate how the robot solution performs in the given application scenario.

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After this phase, successful robotic solutions are chosen for large scale implementations. This paper focuses on the first phase, where the robots are introduced to the institutions during 14-16 weeks including two to three workshops, training sessions, weekly interviews and inquiry forms.

D. Data Analysis

Group / Number of Children	*Concentration time before/after*	*Concentration efficiency before/after*
Zeno Kindergarten		
Weak / 1	7 min / 30 min	70% / 100%
Zeno School		
Medium Strong / 1	10 min / 10 min	50% / 50%
Medium / 1	10 min / 10 min	50% / 50%
Medium Weak / 2	5 min / 15 min	40% / 75%
Weak / 1	2 min / 15 min	20% / 75%

Table 1: Business case calculations for Zeno in kindergarten and school.

During the past three years, we developed the following evaluation model based on our experiences from around 20 executed Innovation Projects with different municipalities. The model comprises seven factors to evaluate the inclusion of a robotic solution in the organization during the whole Innovation Project phase: 1) User experience 2) Work processes in the Organization 3) Competences of the personnel 4) Service/ Support/ Training 5) Infrastructure of the respective building 6) Business-Case 7) Technical adaptation of software and hardware. Factors one to five and seven are evaluated with the help of qualitative data. Factor six is evaluated with quantitative data. Business case calculations for social robots are focusing on situations in which the robot can prolong and enhance concentration for children. We chose these parameters in consultation with the pedagogues after noticing a positive influence of the robots on the children in these areas. Together with the pedagogues, we evaluate how strong or weak the children are in regard to focusing on a certain task (Table 1: group of children). We then calculate the time every child is able to concentrate on a task with and without the use of the robot. In addition, we specify the children's concentration efficiency and motivation when working with and without the robot. It is important to note that the evaluation is based on the teachers' individual perception as well as different tasks and lessons.

IV. Results

The results show that there is an increase in concentration time and concentration efficiency. Children working with Romibo could on average concentrate 8 min longer than without the robotic solution and their concentration efficiency increased by 18%. Teachers estimated that the children working with Nao could concentrate 14 min longer and their concentration efficiency increased by 2.3%. The child playing with Zeno in the kindergarten could concentrate 23 min longer with an increased concentration efficiency of 30% (Table 1). A qualitative analysis done by the pedagogue also shows that the child uses new signs and facial expressions when interacting with Zeno. The three weakest children playing with Zeno in the school could on average concentrate 11min longer and their concentration efficiency increased by 42% (Table 1). No differences were found for the two stronger children playing with Zeno.

V. Conclusion and Future Work

To conclude, in the past three years we have collected hands-on data on how to mature robotic solutions in organizations and compiled an evaluation model for this. In this paper, we have used one factor of the model, the business case, to evaluate three social robots in educational institutions. The results show that long-term usage of these robots in the class room can increase children's concentration time and concentration efficiency for certain exercises. However, there are more factors of CRI that need to be addressed in these calculations. In the future, we would like to explore, how we can further evaluate social robots in educational institutions during a 16-weeks period and longer. We will focus on the qualitative evaluation of the interaction and tackle challenges such as identifying the right user type, the time pedagogues have available to prepare and conduct the sessions and their lack of technological skills. We hope that this will enable pedagogues to use social robots regularly and evaluate CRI during daily usage after the Innovation Projects phase.

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