The Implementation of Care-Receiving Robot at an English Learning School for Children

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ABSTRACT

A Care-Receiving Robot (CRR) is a robot which is designed so as to be taken care of by humans. The original concept of CRR and its application to reinforce children's learning by teaching was proposed by [4]. In contrast to the conventional use of '*childcare robots*' which play the role of care-givers (taking care of children), here we will introduce a reverse scenario where a robot is a care-receiver (being taken care of by children). The framework is presupposed to be promising not only because it could accelerate children's spontaneous active learning by teaching but also because it would be considered as being ethically safer and acceptable to a wider range of societies. This paper reports our pilot trials whose goal is to implement CRR at an English learning school for children. From the trials we have already observed that the robot we implemented induced children's care-taking behaviors.

Categories and Subject Descriptors

I.2.9 [**Artificial Intelligence**]: Robotics; K.3.1 [**Computers and Education**]: Computer Uses in Education; K.4.1 [**Computers and Society**]: Public Policy Issues—*ethics*

General Terms

Verification

Keywords

Care-receiving robot, childcare robot, child-robot interaction, robotics for children, learning by teaching, early childhood education, language education

1. INTRODUCTION

We have been conducting research in the area of robotics that supports early childhood education. The first author of the paper started this line of research in 2004 when the author with his colleagues conducted a long-term field experiment of immersing a small humanoid robot into a classroom of children younger than two years old [3, 5]. The project was part of the RUBI project whose goal was to support early childhood education by using robots [1]. Over the three-year trial period, we observed the socialization process between toddlers and robots and found many important factors pertaining to robots for children [3, 5].

During this time, some industrial companies were releasing robot products which play a role similar to human care-givers. NEC's PaPeRo was advertised as '*childcare robot*' featuring its nursing-aid use. Later on Yujin Robot Company put iRobiQ on the market, which also advertised that it was for educational service similar to a teacher's role. However, at the same time, these trends had evoked a controversy of robot ethics warning that the overreliance on these technologies could produce unwelcome side effects such as children's unpredictable emotional development due to the lack of attachment to human care-givers which is crucial [2].

The idea of Care-Receiving Robot (CRR) has been germinating from these backgrounds. From what we had often seen in the field trial mentioned before and what we felt was promising was actually a reverse scenario where children took care of a robot. Although the robot here was completely the opposite of the childcare robots described before, it is true that we had found many evidences showing that children were very motivated to take care of a robot, and the type of interaction had sustained for a long period of time [3]. Therefore, we proposed the use of CRR for the purpose of reinforcing children's learning by teaching [4]. We hypothesized that this framework could promote children's spontaneous care-taking behaviors towards the robot, which would contribute to keeping children's interest in the educational task itself as a result, and helping their learning effectively. We also feel that this framework would be ethically safer than the childcare robots and acceptable to a wider range of societies.

This paper reports pilot trials whose goal is to implement a CRR in the classroom of an English learning school for children in Tsukuba. We will explain how it was implemented and present early results showing how the CRR induced children's care-taking behaviors.

2. EXPERIMENTAL FIELD

To implement and test CRR, it is preferable to conduct the experiments at a classroom where children are supposed to learn something. Thus, we chose the venue of an English learning school for Japanese children. Thanks to the cooperation from Minerva Language Institute Co., Ltd. which manages 600 English learning schools for children in Japan, we could start the project at a classroom in iias-Tsukuba, a big shopping mall (estimated 12 million visitors per year) located in Tsukuba. Our target subjects are children between 3 to 5 years old (we may expand the range in the future).

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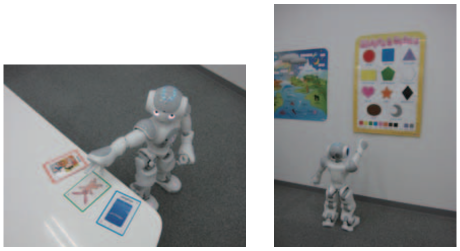

Figure 1: Educational materials used in the classroom and Nao: (left) flashcards, and (right) posters, both used for vocabulary learning.

3. THE IMPLEMENTATION OF CRR

Firstly, we prepared a small humanoid robot platform (Aldebaran Robotics' Nao) to perform all the activities of a regular class at the experimental site described in the previous section. For this, we studied the class schedule and observed the students to learn about the different behaviors which are necessary for the robot to perform. Then, we programmed the robot to perform the required movements.

During the 3 days of the pilot trials, the class was conducted according to the regular format. The class began with everybody holding hands and singing a song, followed by five different games to learn English vocabulary and the class ended with everybody again joining hands and singing a song. The robot was teleoperated by an experimenter from the next room while another experimenter stayed inside the class to ensure the safety of the children and the robot. There were 2 to 5 subjects in each session. The parents of the children were also present inside the class as is the custom for the regular classes at this school for the mentioned age group. The sessions were videotaped by two camcorders installed in the classroom. The experimental protocol was approved by the ethical committee of the University of Tsukuba.

Figure 1 shows typical educational materials used in the classroom. Particularly, flashcards and posters are often used for vocabulary learning. During the games for learning English vocabulary, the teacher asks questions to the students by using these materials. On Day-1 and Day-2, the robot performed like a student who knew all the correct answers whereas on Day-3, it was made to make mistakes during the entire session. Furthermore, on Day-3 we introduced an unsupervised project section (the teacher was not involved in the activities in this section) where the robot tried to finish two different tasks by itself. One task involved identifying the names of colors by pointing to some colored balls provided to it. The other task involved identifying animal names by pointing to some flashcards. Children were allowed to freely interact with the robot in this section.

We analyzed the videos of all the sessions and coded all the behaviors of the children that could be categorized as care-giving actions. We also coded any actions by the children that would result in learning reinforcement of the vocabulary learnt at the school. Table 1 summarizes the results.

During the experiment session on Day-1, we noticed that the children were a little shy in initiating interaction with the robot. However, on Day-2 and Day-3, we found that children initiated interaction with the robot more spontaneously. But, we observed a big difference in the average number of care-giving instances resulting in learning reinforcement between Day-2 (0.27) and Day-3 (0.63). This may have been the result of the change in the error rate of CRR. Till Day-2, CRR was operated to answer correctly to all the questions whereas on Day-3, it was operated to give only incorrect answers. Also, introducing the unsupervised project section has helped us study the spontaneous impulses of the children when interacting with CRR. We made some very interesting observations, for example, children came up with their own method of teaching when CRR was continuously making mistakes. We intend to analyze these unexpected behaviors and report them more formally in a future work.

Table 1: Behavioral coding results.

Trial	Average number of care-giving instances (per min)	Average number of care-giving instances resulting in learning reinforcement (per min)
Day-1	0.38	0.25
Day-2	0.67	0.27
Day-3	0.77	0.63

Our future goal is to test whether CRR can really help acquire new learning as well as to measure the impact of CRR on children's ability through learning reinforcement. We also intend to investigate the ideal learning dynamics for CRR to acquire new knowledge along with the children.

4. CONCLUSIONS

The paper reported our early trials in implementing CRR. Although it might be too early to predict the entire range of parameters that can be manipulated to create a high-impact learning reinforcement tool, the initial results show promise in utilizing CRR for children's learning reinforcement.

5. ACKNOWLEDGMENTS

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