

Learning Verbs by Teaching a Care-Receiving Robot by Children: An Experimental Report

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ABSTRACT

We investigate the use of care-receiving robot (CRR) for the purpose of supporting childhood education. In contrast to the conventional teaching agents that are designed to play the role of human teachers or caregivers, the robot here receives cares from children. We hypothesize that by using this CRR, we may construct a new educational framework whose goal is to promote children's spontaneous *learning by teaching* through teaching the CRR. The paper describes an experiment for investigating whether a CRR can promote children's learning English verbs through teaching it.

Categories and Subject Descriptors

I.2.9 [Artificial Intelligence]: Robotics; K.3.1 [Computers and Education]: Computer Uses in Education

General Terms

Verification

Keywords

Care-receiving robot, CRR, learning by teaching, child-robot interaction, child education, learning support, learning reinforcement, direct teaching, robot ethics

1. INTRODUCTION

Most educational robots so far have been designed and developed to play the role of human teachers or caregivers. In other words, they were *caregiving* robots developed to teach or care for children. In contrast, we will deal with a reverse scenario here where the robots are *carereceiver* from the children. By introducing a *weaker* robot than the children and letting them teach the robot, we aim to promote children's spontaneous *learning by teaching* as a result.

The paper describes a study about the care-receiving robot (CRR), which originally started in 2009 [2, 3, 1]. Particularly, here we will reports the results of a field experiment investigating the effects on children's learning English verbs by teaching the CRR.

2. CARE-RECEIVING ROBOT (CRR)

A CRR is a robot that receives care from the people around it. The original concept of the CRR was first proposed in 2009 by the first author of the paper [2, 3]. Conceptually, the meaning of *care* is quite general and thus we can imagine many types of CRR. The most typical scenario using a CRR, we assume, is for learning support or learning reinforcement for children. In this scenario, teachers/parents decide on an educational topic and somehow ask the children to teach the topic to a robot. Then, children teach the robot, which initially is not good at solving the topic but shows improvement based on the children's instruction. It is expected that by introducing a CRR, children would, as a result, be highly motivated to complete the learning topic, thus providing indirect practice (learning by teaching) for the children.

3. A FIELD EXPERIMENT

We conducted a field experiment whose goal is to investigate whether the CRR that we introduce into the classroom can promote children's learning by teaching or not. We chose the venue of an English language school for Japanese children. Thanks to the cooperation of the Minerva Language Institute Co., Ltd. that manages 600 classrooms in Japan, we were fortunate to be able to conduct experiments in a classroom in Tsukuba. Our target subjects were children from 3 to 6 years of age who attend classes in this classroom. After we received approval from the Ethical Committee of the University of Tsukuba for this experiment, we started recruiting participants by explaining and advertising our research to the parents of the children. We used Aldebaran Robotics' Nao to implement the CRR. During the experiment, it was fully teleoperated (wizard-of-oz) using a teleoperation interface developed. Each session (one subject trial) lasted approximately 30 minutes. Figure 1 illustrates the flow chart of the experiment.

Based on repeated consultation with professional teachers at the Minerva Language Institute Co., Ltd., we decided to adopt a verb-learning game using cards. Experimental scenario follows the pattern of a regular lesson in the classroom: (1) Among the 4 word cards obtained during the pre-test, 2 cards are randomly chosen in advance and marked as "With CRR" and (2) From the 4 word cards, Experimenter #1 picks up one card randomly and asks the child its meaning, saying "Show us how to <the verb>." Since the verb is unknown to the subject at this moment, the subject cannot answer the question correctly. (3) Then, Experimenter #1 shows the correct answer by picking up the corresponding object and pronouncing the verb. If the card is marked "With CRR," the

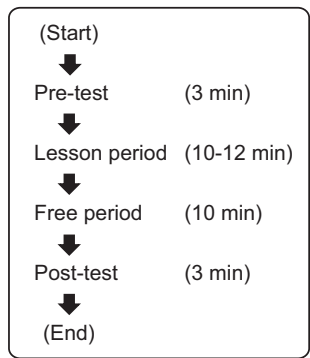


Figure 1: The flow chart of the experiment

game continues to step (4), otherwise they return to step (2), repeating the steps with another card. (4) Experimenter #1 turns to the CRR and asks it the same question. The CRR responds “Yes” and then says “Please pick up” while opening its right hand. Experimenter #1 hands the corresponding object to the CRR. The CRR then holds the object and makes a wrong movement. (5) Experimenter #1 says “No, that is incorrect.” The CRR responds with “Please teach me.” Then, Experimenter #1 takes the CRR by the hand and teaches it step by step (direct teaching). After the direct teaching is finished, the CRR plays back the movement correctly while pronouncing the verb. Then, Experimenter #1 says “Yes, that is correct.” Experimenter #1 repeats the procedure for all 4 word cards to finish the first part of the lesson. The second part of the lesson is performed very similarly using the same 4 word cards. However, this time at step (5), Experimenter #1 asks the child to teach the CRR instead of Experimenter #1.

After the Lesson period is completed, the subject is told to play freely with the CRR by himself or herself for 10 minutes. Meanwhile, the CRR is teleoperated so as to follow steps of (4) and (5) as described above. At the end of each experimental session, a post-test is conducted to evaluate if the subject can answer the questions which he or she could not answer during the pre-test.

4. RESULTS

Figure 2 summarizes the results. Each bar represents the average percentage of post-test questions answered correctly by the 17 subjects. As we can see, the subjects picked up more correct graphic cards for verbs With CRR than without. This experiment was not designed to compare human teachers with the CRR, and, thus, the results should not be interpreted as showing the superiority of the CRR to human teaching. Nevertheless, the results reveal that the idea of the CRR can be implemented in the context of English verb-learning in a real classroom. It can promote and enhance children’s learning by teaching; even verbs that are a challenge to learn with a minimum style of teaching (only about 20% were answered correctly at Without CRR).

5. CONCLUSIONS

The paper reported an experiment in which we introduced a CRR into a real classroom of English instruction for children to promote children’s learning by teaching. The most important idea of this educational framework is to accelerate children’s natural motivation to *caretaking* by introducing the

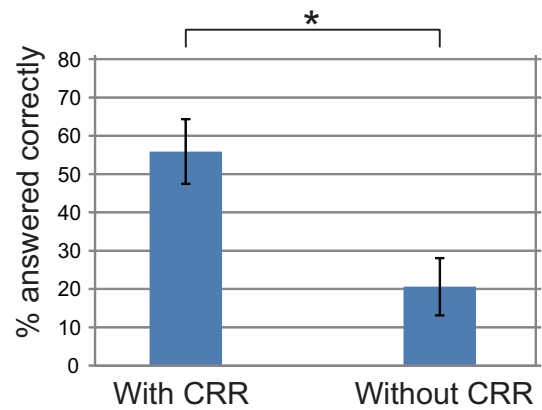


Figure 2: Post-test results: Each bar represents the average percentage of post-test questions answered correctly over 17 subjects. There was a significant difference ($P < 0.05$) in the average percentage answered correctly between verbs With CRR and Without CRR.

CRR. We believe this idea will provide a useful aspect for both the education and robotics research fields. We also realize that the basic idea of the CRR is very general; therefore, in the future, we will explore cases other than vocabulary learning, along with improving the requirements for designing better CRRs.

The most major deficit of the CRR used in the experiment would probably be the limitation of *its* learning capability. Since this was the first experiment of assessing the CRR for the purpose of children’s learning by teaching, we did not put a learning factor into the robot, i.e., the CRR continued making a mistake. This surely made some of the subjects frustrated or irritated. If the CRR can keep learning as humans do, it may evoke a new motivation for the subjects. The appropriate learning dynamics of the CRR is our next important research target.

6. ACKNOWLEDGMENTS

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