Examination of the robot's role as a helper in learning situations

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Abstract: In this study, we aim to realize Learning by Teaching, in which a person learns by teaching a robot in a learning situation between the robot and the person. In this paper, we report an experiment to investigate the impression of a helper on a recipient in a general learning situation between humans. We focused on the robot's behavior that makes the learner want to teach the robot, concentrating on its weaknesses. We then conducted an additional experiment in which we changed the assisting person from a human to a robot to realize the robot's behavior model. In the future, we will compare these two experiments to examine the behavioral model.

Keywords: Weak robots, supporting behavior, HRI

1. Research Background and Purpose

In recent years, an increasing number of robots have been introduced in the field of education, and various effects have been reported. Han (2008) suggested that robot-assisted English language learning is more effective than textbooks or computer-based learning in terms of children's concentration, interest, and learning (Han, 2008). In addition, a study conducted by Matsuzoe (2013) suggested that a robot's presentation of correct answers and teaching was effective in learning English words (Matsuzoe, 2013). The role of the robot is to be taught, which affects not only the effectiveness of the learner's learning, but also the learner's motivation to learn. Therefore, this study aimed to realize learning-by-teaching, in which the learner learns by teaching a robot. To achieve this goal, this study examines the role of robots in teaching and focuses on weak robots. A weak robot performs actions after eliciting assistance from others (Okada, 2016). It would be useful to design such learning by giving the robot a role, such as weakness, to encourage the learner to teach, which would result in the completion of the learning process. However, previous studies have been vague in their definitions of weakness. In this study, weakness was defined as the desire to help. Therefore, we conducted two surveys to verify what kind of weaknesses can trigger learning-related assistance in learning situations. By comparing these two experiments, the weaknesses of the robot in learning situations were clarified.

2. Experiment 1

As the first step of Experiment 1, we surveyed aid workers' impressions of their aid recipients in person-to-person learning situations.

2.1 Experiment Participants and Tasks

An online questionnaire survey was conducted during the experiment. The participants were asked to respond to episodes in general learning situations regarding their experiences with assistance, reasons for assistance, and impressions of the assisted person. There were 100

participants in the experiment (61 males and 39 females), with a mean age of 40.62 years (standard deviation, 9.15).

The purpose of the experiment was to use a questionnaire to ask participants to answer questions about episodes of assistance in each common learning situation. In the assistance episode, which was an experimental stimulus, the learning situation applied to small, everyday acts of kindness (compassion). A brief survey was conducted on "Please tell us about your compassion during education and learning." This survey and the Compassion Scale by Kikuchi (1988) were used as references to create the assistance episodes. Participants were asked to respond on a 5-point scale (ranging from "never did" to "did more") to record their experience assisting others, based on the Compassion Scale. Participants were also asked to provide a free description of the reasons for their assistance. As for the impressions of the aided persons, the participants were asked to respond to 48 items such as "bright" to "dark" and "strong to weak," from the adjective pairs in the validated scale for measuring personality perception, as well as "smart" to "dumb" and "approachable to inapproachable," for a total of 50 items (Hori & Yoshida, 2001).

2.2 Result

In this experiment, data from 97 of the 100 subjects were used for the analysis. The data were analyzed using exploratory factor analysis for each of the 15 assistive episodes. Initially, for each aid episode, we used the Kaiser-Meyer-Olkin measure of sample validity. The results of the measurement showed a result of 0.87 or higher, for all assistance episodes, indicating the possibility of a potential factor. Based on the above results, factor analysis was conducted by unifying the maximum likelihood method for factor extraction. The results identified 10 factors for the 15 assistance episodes. These factors were activity, sociability, diligence, reliability, politeness, affinity, agreeableness, reactivity, robustness, and impatience. Overall, each factor had a high value for the factor loadings of the items included in the factor, high explanatory power for "introverted," "static," etc., and low as an explanation for the factor (Table1).

Table1 Results of Factor Analysis for Episode 1

item	M1	M2	M3
Dynamic - Static	0.799	0.168	0.185
Lively - Lonely	0.788	0.103	0.264
Energetic - Tired	0.782	0.227	0.227
Smart - Stupid	0.331	0.828	0.146
Decent - Sloppy	0.255	0.827	0.268
Calm - Restless	0.069	0.819	0.239
Like - Dislike	0.224	0.373	0.762
Kind - Strict	0.021	0.208	0.746
Honest - Obstinate	-0.005	0.313	0.711

2.3 Discussion

After conducting the experiment, 10 factors were identified for all 15 episodes. Each factor tended to be low, suggesting that the helper felt some kind of weakness toward the assisting person. It is possible that each factor was characterized by a mature impression of the activity factor and a shy impression of the sociability factor. In many episodes, there were also descriptions of sympathy, such as "because I felt poor," and of concern, such as "because they looked like they were in trouble." This is considered the same tendency of emotional quality as in previous studies on helping behavior (Nakamura & Takagi, 1987). Weaknesses have been suggested to bek involved in learning situations. Additionally, the free descriptions indicated that most participants assumed a friend-like person. This study also attempted to use robots as learning partners. This was done to capture similar trends. Therefore, an additional experiment was conducted by replacing the assistant with a robot.

3. Experiment 2

To conduct Experiment 2, I revised the presentation of the assumed situation and assistance episodes and the aid episodes to fit the robot scenario. The episodes utilized in Experiment 1 were abstracted and thoroughly discussed in the laboratory to create episodes adapted to circumstances applicable to the robot.

3.1 Experiment Participants and Tasks

Similar to Experiment 1, an online survey was conducted for Experiment 2. Participants were asked to respond to a general learning episode regarding the frequency of assistance, reasons for assistance, and impressions of the recipient of assistance. There were 104 participants (59 males and 45 females), with a mean age of 39.98 years (standard deviation, 8.79).

In Experiment 2, the same questionnaire as in Experiment 1 was used, and the participants were asked to respond to questions about episodes of assistance with the robot in each general learning situation. The questionnaire was designed in the same manner except that the questions were changed to the frequency of assistance.

3.2 Result

As in Experiment 1, an exploratory factor analysis was conducted on the 15 assistance episodes, and a likewise procedure for factor analysis was followed. Nine factors were identified, namely activity, sociability, intelligence, reliability, sincerity, favorability, robustness, clarity, and warmth. Overall, each factor tended to have a high factor loading value for the items included in the factor and, as in Experiment 1, a low explanatory value. The structure of each factor was similar to that in Experiment 1, suggesting that the respondents felt the same sense of weakness as in Experiment 1.

3.3 Discussion

Similar to Experiment 1, the results of Experiment 2 suggest a sense of weakness in the learning situations. Among these, sociability, intelligence, reliability, and favorability factors were identified in many episodes. Many factors with similar structures were identified, but more personality-related factors were identified in Experiment 2. This can help realize the robot's behavior. However, in this experiment, we presented only images of the robot and were unable to verify its behavior. In the future, the impressions confirmed in the experiment will be reflected in a behavioral model. This information has been included in the poster presentations.

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