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Robot as a Learning Partner for Promoting Proactive Discussion in Peer Groups: A Case Study for Career Development

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Abstract: This paper describes an experiment on peer groups that had a robot as a learning partner, to examine whether the robot could encourage the participants to talk on their own initiative. The authors measured the number of proactive utterances of each participant during the sessions. The authors compared the experimental groups that had robot facilitators, which were manipulated by professional human facilitators, and the control groups, which were also led by professional human facilitators but without a robot. The result showed that the participants in the experimental sessions talked on their own initiative much more than those in the controlled sessions. Finally, the authors qualitatively examined the characteristics of the proactive utterances in the peer group and found that the utterances contained supportive responses, which encouraged the participants to voluntarily join the dialogue promoting the counseling.

Keywords: robot, proactive discussion, peer group, supportive response

1. Introduction

The application of robot technologies to collaborative learning settings is an emerging topic in the research on computer-supported collaborative learning (CSCL). Though robots are not yet a familiar component of our daily lives, the advantages of using robots (i.e., humanoids) to improve our standard of living have been discussed for years in the area of human-robot interaction (Feil-Seifer & Mataric, 2005; Tapus, Mataric, & Scassellati, 2007). As it is for various modes of usage in medical and care areas, researchers from the field of computer science and robotics to learning are discussing the tremendous potential of having robots participate in collaborative learning.

There are two reasons researchers intend to use robots as social partners in learning (Miyake & Okita, 2012; Okita, et al., 2010). One is that the human-like appearance and behavior of robots elicits strong social responses that invite active engagement, so that a robot can work with students as “a learning friend” who helps them enjoy in class or in a small group and thus stay engaged in learning. The body of a robot is designed to approximate that of a human in both form and function, but most robots (except actroids) are not too human-like and still have machine-like properties. This gives people room for imagination and creativity in social interactions and elicits greater empathy. Current technological limitations do not allow robots to work as learning collaborators in the completely same capacity as that of a human teacher or facilitator; they can only explain subjects to the students, comment on students’ ideas, and exchange questions and answers, at least to the extent that the messages could be prepared prior to the sessions or provided by human operators. The other reason is that a robot can be a great interface for collecting the process data of the participants’ learning activities while working as a learning partner, and for reflecting our own facilitation behavior. This enable us to know the mechanisms and design the principles of productive activity in collaborative learning.

In this paper, we focus on the former to find the potentials of the robot as a learning partner in different types of collaborative learning. Recent researches show the effectiveness and limitations of using robots in school settings. Kanda et al. (2004) conducted a study with Robovie, a humanoid robot, in a school setting for 18 days, which helped Japanese children practice English. A large drop in engagement was observed by the second week, indicating that certain social and emotional support was required in order to enhance the collaboration between the learners and the robot. Another research conducted by Okita et al. (2010) used the Honda ASIMO (Advanced Step in Innovative Mobility) as a learning partner for children in various learning settings. They found that children engaged better when the interaction was cooperative and ASIMO used a more human-like voice and gestures. Additionally, the research suggested that in future interventions, the continuous engagement with children and responses of ASIMO be increased. Furthermore, learning scientists conducted studies with robots in structured collaborative learning settings to acquire and construct scientific knowledge through conversation. Miyake (2012) introduced remotely operable robots in a scripted collaborative learning activity based on the Jigsaw method and found that robots as participants provided opportunities to involve children in constructive conversation. It resulted in better learning in that the robots were accepted as “just like the other kid who does not know the answer, but sincerely working to know the answer.” Oshima & Oshima (2013) introduced the same robots in a Jigsaw-based reciprocal teaching activity in the university classroom and compared it with learning activity involving human facilitators. They showed that robots could function as learning partners quite as well as human facilitators; the robots could elicit the same amount of meaningful learning processes and learning outcomes as the human facilitators did.

Although the researchers cited above have indicated that robots as partners for collaborative learning can possibly substitute human facilitators in structured learning settings—with structured scripts and materials—we should investigate the potential of robot facilitation in ill-structured settings—more self-regulated student discussions for them to learn what the students do not know in the absence of educational materials. For example, Miyake et al. (2012) introduced the remotely operated robot for children’s dialogue while the children were walking through the gallery of an art museum. The robot was meant to enhance their viewpoints and help them find something meaningful in the artworks. The researchers reported that such intervention could expand the group’s scope of art appreciation. We need to explore many more cases in both formal and informal learning settings wherein the participation of robots as learning partners was successful.

In this study, we introduced a remotely operated robot as a learning partner in peer group sessions for career development. Career development is a serious learning agenda for adolescents in every country because they are at a crucial stage in human psychological development that is strongly linked to identity formation (Morris, 1997). A person’s career development involves the creation of a career pattern, decision-making style, integration of life roles, values expression, and life-role self-concepts (Niles & Harris-Bowlsbey, 2002). However, adolescents who do not have sufficient social experience to examine their identities and roles while working and communicating with peers have difficulty considering their prospective careers. This is also a research agenda in designing informal learning environments because there are few studies in learning sciences research.

As the first step, the purpose of this research is to explore the possibility of using a robot as a learning partner in peer groups to find out whether it creates an environment that encourages participants to talk on their own initiative, especially for their career development. A peer group is defined as a set of people who, through homophily, share similarities such as age, background, and social status. The peer group is expected to help individuals form their own identity, as such groups allow people to escape the direct supervision of people with authority (i.e., teachers, parents, adults, etc.). When among peers, people learn to form relationships on their own and get a chance to discuss their interests. Clinical and social psychologists and psychological practitioners use peer groups to develop self-help groups for people who have serious problems, thereby allowing them to find social support, including information, encouragement, and solace close at hand. This characteristic of the peer group has also been utilized in career development, and is called “peer career counseling.” Ash & Mandelbaum (1982) described a college career proactive development counseling program using peer counselors and revealed that students were sensitized to the career development process. We believe that robots participating in peer career counseling elicit more voluntary participation than do human career counselors participating as facilitators. The reason is there is no hierarchical difference between robots and young participants, and the robots' appearance is more neutral than that of human career counselors; that is, participants feel no anxiety related to hierarchical differences because the robot's appearance and voice can decrease the necessity of social comparison due to the lack of social presence of a human operator, even if the operator is a professional career counselor (cf. similar to computer-mediated communication, as described by Kiesler & Sproull, 1986). From this viewpoint, we expect that remotely operated robots can be learning partners for the participants in peer groups for career development and elicit proactive utterances from the participants in dialogue more than human peer counselors can.

2. Research Method and Design

2.1 Participants and Design

Thirty undergraduate students (sophomores and juniors) in a private university in Tokyo participated in this study. The reason we did not tap the seniors was that sophomores and juniors did not yet need to seek jobs, but it was necessary for them to consider their identity and future career in order to prepare for future job-seeking activity.

Seven professional facilitators participated in this research. They had a National Certificate of Career Consulting Grade 1 or 2, or passed the National Exam of Career Consultant and had more than five years of group counseling experience.

Desktop Robovie-W robots (Figure 1) were used as robot facilitators in the experimental groups. Robovie-W is 30 centimeters tall and has a camera, speaker, and microphone, through which the remote operator and participants can communicate. Robovie-W can also move its eyes, head, and arms in order to convey some form of nonverbal expression. The verbal and nonverbal expressions of the robots were remotely operated by human professional facilitators who had had level of certification in career counseling or similar experiences.

We used a simple experimental study design for looking at the differences of the facilitators (robot vs. human professional facilitator) and seeing if these would affect the participants' discourse in the peer groups (i.e., participating in the discussion more proactively).

Figure 1. Robovie-W: a Desktop Robot

2.2 Peer Counseling Procedure

First, the students were told about the procedure of the experiment and asked to answer the pre-questionnaire (described in section 2.3). Then they were randomly assigned to either the experimental groups, which were facilitated by robots that were remotely operated by professional human facilitators, or control groups, which had no robots and were led by professional human facilitators. Each group was composed of three students and one facilitator (robot or human). The participants sat around a table, as shown in Figure 2.

Figure 2. Experiment Snapshots (Upper: experimental group; Lower: control group)

The seven human professional facilitators (including the two robot operators) were provided the experiment procedure and scenario—what they should talk about with the students during the peer group session, regardless of the difference of the conditions. They were told to strictly follow the procedure and scenario, which emphasized timekeeping and using active listening strategy without any suggestions or comments during the peer group sessions. Here is a sample scenario: “So, please tell us about your dream for the future, Mr. B.”; “What are you planning for the coming summer vacation to prepare for your dream?”; “Your plan is (summary of what Mr. B. says)”; “What do you think of his dream, Mr. A?”; “Do you all have any suggestions for preparing for Mr. B’s dream? Please feel free to discuss this”; etc. This scenario was carefully designed by one of the authors, who had plenty of experience in peer career counseling, and another professional counselor, who was one of the robot operators in this study. In designing the scenario, they referred to the categorization of verbal active listening strategies in the study of Cormier & Cormier (1998).

In the beginning of the peer group discussion, the facilitator (robot or human) explained how the participants should listen and talk in the peer group, and conducted a short ice-breaking session. Then the facilitator introduced the theme of the peer group, which was “What is your plan for the coming summer vacation to prepare for the future?” After starting the discussion, the facilitator had to follow the scenario described above, concentrating on asking the participants an equal number of times and using the active listening strategy. Surprisingly, all of the participants felt that the robot facilitator was autonomous—that it could understand the dialogue by itself, decide how to facilitate the discussion, and say things on its own initiative. We believe that because the robot’s movements and utterances were not so fluent, the participants considered it real. To maintain ethical propriety, the participants were told after the interview described below that the robots were operated by human facilitators. The facilitators were told to complete the peer group scenario within 30 minutes to keep the length of time uniform for all the groups. After the peer group session, the authors interviewed each group. The participants were then asked to answer the post-questionnaire (also described in section 2.3).

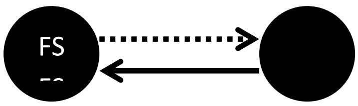
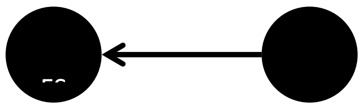
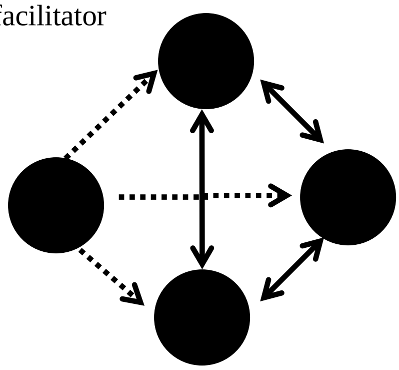
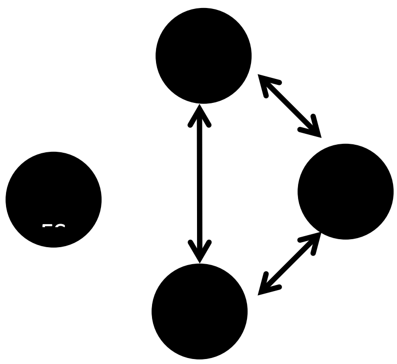
2.3 Data Collection and Analysis

In this study, three kinds of data were collected for research purposes. First, the students’ discussion during the peer group activity was video-recorded and transcribed. The transcription was used for analyzing the interaction between the facilitators (robot or human) and students to examine how students participated in the discourse. Second, questionnaires were conducted before and after the peer group session to examine whether or not the effects of the conditions were significantly different. The pre- and post-questionnaires were designed based on the General Self-Efficacy Scales (GSES) (Sakano & Tojo, 1989), which is a well-formed Japanese instrument to measure the individual's strength of general self-efficacy across a variety of daily life settings. The reason we used this scale is that the effectiveness of peer support may be explained in terms of an individual's improved self-efficacy due to the peer group (Bandura, 1997; Benight & Bandura, 2004). Third, group interviews were conducted to find out the participants' feelings about the peer group experience. The interviews were also video-recorded and transcribed.

The transcribed peer group discussion was coded based on the rule shown in Table 1, regardless of the difference in facilitator (robot or human), in order to clarify whether the students could participate in the discussion proactively with a robot as the facilitator in the peer group. Each student's utterances was coded into (1) an utterance for communicating with the facilitator, prompted by the facilitator (FP-p); (2) a proactive utterance for communicating with the facilitator, without prompting from the facilitator (FP-a); (3) an utterance for communicating with the participants, prompted by the facilitator (PP-p); and (4) a proactive utterance for communicating with the participants, without prompting from the facilitator (PP-a). Two independent coders coded the utterances. The inter-coder agreement was 87.7%, and discrepancies were resolved by discussion.

The questionnaires were analyzed based on three factor scores (aggressiveness of action, anxiety about failure, and social position of ability) that were originally defined in Sakano & Tojo (1989). A two-way (2 x 2 design; experimental/control x before/after the peer-group) within-subjects analysis of variance (ANOVA) was performed on each of the factor scores to examine the difference due to the experimental control.

Table 1: Coding Rule for the Participants' Utterances

	Utterance prompted by the facilitator	Proactive utterance
Communication between the facilitator and the participant	**FP-p** An utterance in response to the facilitator's prompt 	**FP-a** An utterance without any prompt 
Communication between the participants	**PP-p** An utterance toward the other participants, prompted by the facilitator 	**PP-a** An utterance toward the other participants without any prompt from the facilitator 

3. Results and Discussion

3.1 Effectiveness of the Peer Group for Career Counseling Purposes

We examined the difference in the effectiveness of the peer group first because it is the prerequisite for this study to ensure that the effect is almost same in both conditions; we consider it useless if the robot facilitator could not achieve the same or better effect.

The ANOVA on the factor score "aggressiveness of action" showed a significant main effect of before/after the peer group (F (1,28) = 4.860, p < .05), and no other significant main effect or interaction was observed. The ANOVA on the other two factor scores also showed significant main effects of before/after the peer group: anxiety (F (1,28) = 4.964, p < .05) and social position: (F (1,28) = 17.968; p < .05); no other significant main effect or interaction was observed. Therefore, we can confirm that the peer group was effective in the two conditions from the viewpoint of self-efficacy and that there is no significant difference on the effectiveness of the peer group sessions; that is, the peer group facilitated by a remotely operated robot was effective without any significant difference from the one that was facilitated by a human.

3.2 Differences of Students' Participation in the Peer Groups

We compared the students' participation in the two conditions (robot or human facilitator) based on the coding of their utterances during the peer group session. We performed a t-test on the number of each category of utterances. The Welch's t-test was performed if two samples had possibly unequal variances. The results (Figure 3) showed that significant differences between the conditions on the number of utterances categorized as FP-p (t (18.848) = 5.697, p < .001), FP-a (t (16.746) = 3.656, p < .001), and PP-a (t (16.986) = 2.139, p < .05), but no difference in the category PP-p (t (28) = .100, *n.s.*).

The first significant difference on FP-p explained that the human facilitators could prompt the participants' utterances during the peer group discussion. It seemed that the human facilitator could speak fluently and use his/her active listening strategy in responding to the participants' utterances, but the robot lacked fluency because the operator could only input messages on the control software using the keyboard after understanding the participants' utterances. In other words, it took time to respond, thus decreasing the opportunity to intervene in the conversation at the right time in order to prompt the participants' utterances. In contrast, the second significant difference on FP-a explained that the participants spoke to the robot facilitator a lot more than they did to the human facilitator.

The third significant difference on PP-a explained that the participants in the experimental group participated in the discussion much more proactively than in the control group, even with fewer prompts from the robot facilitator. In contrast, the utterances between the participants (PP-p), which were prompted by the facilitator, did not differ between the conditions. Likely, the reason is the need to strictly follow the scenario, in which the facilitators in both conditions had to prompt the discussion

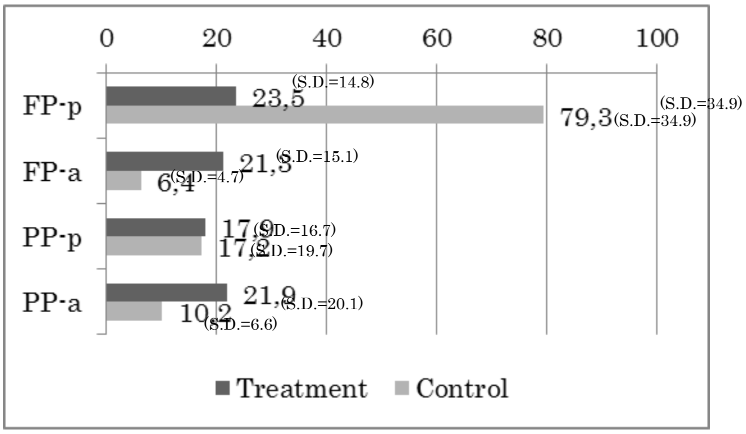


Figure 3. Number of Participants' Utterances Categorized as Forms of Communication

by saying, “Do you have any suggestions for preparing for Mr. A’s dream? Please feel free to discuss this.” The conversation that followed the prompting was not influenced by the conditional difference because the robot facilitator did not have to respond or intervene unless necessary.

3.3 Characteristics of Proactive Utterances in the Peer Groups

To clarify how the participants proactively spoke in the experimental groups, we further examined the characteristics of the proactive utterances qualitatively from the viewpoints of active listening skills. As mentioned earlier, Cormier & Cormier (1998) categorized verbal and nonverbal active listening skills. The verbal skills comprise reflecting, clarifying, paraphrasing, and summarizing. Paine et al. (1989) also mentioned that the facilitator should try to elicit supportive responses from other members during the self-help group session in order to encourage the peer group members to disclose their private issues.

The scenario given to the facilitators asked them to use three of the verbal skills described by Cormier & Cormier (1998): clarifying, paraphrasing, and summarizing. However, reflecting the participants’ emotions, including supportive responses, was not required since it was difficult for the robot to react smoothly to the participants’ utterances, considering the short interval that the operator needed to input the message. In addition, we had to find out if the peer groups in both conditions produced a positive mood that encouraged the members to disclose what they thought. It was necessary to examine whether the groups in both conditions truly became peer groups, where participants had proactive conversations on their own initiatives.

Afterward, we analyzed the supportive responses in the proactive utterances. Table 2 shows the number of supportive responses in the peer group session in both conditions. We considered “Yup yup,” “Mm-hm,” “Ha,” “Hmmm,” “I know,” “Aha,” and “Oh, yeah?” as supportive responses in the conversation. Although “Yes,” “Yeah,” and “Well” are also supportive responses, we did not include them, as it is difficult to distinguish them from simple answers.

Table 2: Number of Utterances as Categorized as Supportive Responses

	Facilitator’s utterances		Participants’ utterances	
	Experimental Groups	Control Groups	Experimental Groups	Control Groups
Yup yup	0	49	22	6
Mm-hm	0	9	0	0
Ha	0	11	2	1
Hmmm	0	5	12	3
Heh	1	73	5	8
I know	0	27	1	0
Aha	62	104	7	6
Total	63	278	49	24

As shown in Table 2, the facilitator’s supportive responses in the control groups far outnumbered those in the experimental group. In particular, “Aha” was introduced in the scenario given to the facilitators in both conditions because the facilitators considered it so easy, even for the robots. That is the reason “Aha” was used to some extent even in the experimental groups. However, other expressions for supportive responses were not used in the experimental groups because it was very difficult for the robot operators to use for immediate intervention to the participants’ conversation.

In contrast, the participants in the experimental groups used more supportive responses than those in the control groups did. A chi-square test was performed on the total number of supportive responses to determine if the tendency of supportive responses differed between the conditions. The result showed a significant difference ($\chi^2(1) = 69.664$, $p < .01$), indicating that there were significantly many supportive responses from the participants in the experimental groups and from the facilitators in the control groups. We consider this as evidence that the peer groups with a robot facilitator became much more participant centered than those with a human facilitator.

4. Conclusion and Future Work

This study involved adolescent peer groups with remotely operated robots and human professional facilitators. In the experimental group, the robots, operated by human facilitators, were expected to elicit proactive utterances from the participants. We examined if this affected the participants' discourse in the peer groups. The findings revealed that both experimental and control peer groups produced similar results with regard to self-efficacy improvement—one of the standards used in evaluating the effectiveness of peer groups for career development. Additionally, the participants in the experimental groups talked on their own initiative during the sessions. The participants in the experimental groups used supportive responses much more than those in the control groups did. We consider this as powerful evidence that the robot has the potential to create a more participant-centered proactive discussion than the human facilitator can because these responses were recognized as the denominator of their self-facilitation. One of the reasons the participants could participate so proactively was the robot's disfluency in communication, as they needed to activate the use of supportive responses in order to supplement the flow of the peer group session.

This study indicates the possibility of using a robot as a learning partner in a peer group to help participants engage and talk on their own initiative. However, the disfluency in communication is considered both an advantage and a disadvantage. In the group interview after the experiment, the participants in the experimental groups mentioned that they felt comfortable talking about themselves to the robot, and also felt the need to help the robot when they noticed that it had difficulty communicating with them. However, some participants mentioned that they worried about the disfluency of the robot's communication. We consider that the robot's features (appearance, disfluency, etc.) are useful in eliciting active communication from students, but certain refinements are also necessary so as not to make the participants feel anxious during the peer group session.

Much work is still needed to reinforce meaningful communication for prompting learners to think about serious topics, such as their identity or career development. We need to further investigate the learning process based on the transcribed conversation in order to design a richer behavior model using the robot as the learning partner.

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