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Prompting Learner-Learner Collaborative Learning for Deeper Interaction: Conversational Analysis Based on the ICAP Framework

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Abstract: There are many studies investigating the type of interactions that are important for the success of collaborative learning. Recently, studies have investigated the use of the Interactive-Constructive-Active-Passive (ICAP) framework to promote collaborative learning, to guide and prompt discussions and encourage wanted behaviors. A previous study investigating grounding and conflict prompts revealed that the target utterances of each prompt were facilitated. However, the analysis of how these prompts deepened the interaction process has not been examined sufficiently. Therefore, the current study reanalyzed utterances generated by dyads; a protocol analysis employing a coding scheme based on the ICAP framework was utilized. The results indicated that interactive utterance is fostered by presenting two prompts. In future studies, we plan to investigate the relationship between learning performance and the ICAP framework.

Keywords: Interactive, constructive, coordination, argumentation, facilitations

1. Introduction

In cognitive, collaborative is beneficial for learners in order to learn various topics (e.g. Miyake, 1986; Shirouzu, Miyake, & Masukawa, 2002). However, collaborative learning does not necessarily outperform individual learning. Therefore, researchers have investigated what types of interactions are important for success and provide support to learners through the use of a prompt and a computer-supported collaborative learning (CSCL) setting (Dillenbourg & Fischer, 2007). Recently, researchers have investigated adaptive support using Intelligent Tutoring System (ITS) in a CSCL setting (Rummel et al., 2008). Therefore, this study focuses on facilitation prompts that support a dyad by the third person. First, from the viewpoint of the Interactive-Constructive-Active-Passive (ICAP) framework, it is crucial to explain why the interaction process is important in collaborative learning. The effect of facilitation prompts is then described.

1.1 Interaction fostering collaborative learning

Many studies have shown that collaborative is better than individual (e.g. Miyake, 1986; Shirouzu et al., 2002). It is important to undertake constructive interaction that learners externalize individualized ideas and obtain different perspectives through collaborative learning activities (Shirouzu et al., 2002). The ICAP framework (Chi, 2009; Chi & Wiley, 2014) has classified these activities. Passive activities include receiving learning material. Active activities include physical manipulation toward learning material. Constructive activities include externalizing a new idea deepened the given information. Interactive activities are when learners discuss substantially and do not ignore the partner's contribution. The ICAP framework shows that learning increases as learners are engage in deeper interaction that is from passive to active to constructive to interactive activities (Chi & Wiley, 2014). There are two evidence for this hypothesis. First, ICAP is hierarchical and deeper interaction activities include shallow

interaction activities. Second, knowledge-change processes underly each activity. Consequently, a support leading from constructive to interactive activities is called for in order to facilitate a deeper interaction between dyads.

Recently, some studies investigated the effect of support by the third person, classifying learning activities based on the ICAP framework. Wiggins, Eddy, Grunspan, & Crowe (2017) quasi-experimentally investigated whether the ICAP framework predicts learning performance in STEM class (i.e., Science, Technology, Entrepreneurship, and Mathematics). As a result, the instructor indicated that learners make more effort to support interactive activities because of the need to ensure sufficient time. Tan (2018) investigated the effect of two cognitive scripts focused on common ground in collaborative learning. It is known that learners do not undertake interactive activities superficially, rejecting an individual idea and not integrating ideas because of not processing that sufficiently. Accordingly, ICAP existed in these studies (Wiggins et al., 2017; Tan, 2018), but interactive activities are not easy to generate by simply collaborating.

It is known that collaborative learning is not successful because it is difficult for learners to understand their partner's perspectives; this is linked to egocentrism conflicting with different perspectives and learners are asked to experience grounding and division of roles as a success factor (Hayashi & Miwa, 2009). Also, learners have difficulty in disagreeing with partner's idea. Because learners have supporting tendencies their idea or perspectives instead of disagreement (Nussbaum & Kardash, 2005). These problems occurred when learners collaborate with partners. Therefore, it is assumed that we need to foster leading from constructive activities to interactive activities in a collaborative learning setting. In collaborative learning, facilitation by a third person is helpful (i.e., teacher and system) to support learners. However, it is not easy to foster interactive activities by a third person. Therefore, it is a challenge for the teacher to foster interaction.

1.2 Support of interaction using facilitation prompts

ITS has investigated adaptive supports based on the state of learners for individual learning (Anderson, Corbett, Koedinger, & Pelletier, 1995). Researchers in the area of ITS has recently investigated supports for collaborative learning. (Walker, Rummel, Koedinger, 2014). For example, Walker et al. (2014) investigated effect of adaptive support through the use of prompts based on learners' state. Also, one of the types of support involves collaborative learning by pedagogical conversational agents (PCA) that is an interactive facilitator using language. Tegos & Demetriadis (2017) investigated whether PCA intervention based on academically productive talk (APT) which fosters building on their prior knowledge facilitates reasoning. As a result, learners who are intervened by PCA based APT outperformed learners who are not intervened by that. Recently, our study (not yet published) developed two different prompts for two conversational activities (i.e., coordination and argumentation) and investigated the effect of prompt that facilitate coordination or argumentation. Coordination is utterance leading to success in collaborative such as grounding and reaching consensus. Argumentation is utterance leading to strength epistemic status and dispute the idea deeply such as challenging and concession. Therefore, to investigate the effect of facilitation by presenting prompt developed based on the protocol data, we compared grounding condition presenting prompt fostering coordination and conflict condition presenting prompt fostering argumentation to control condition. As a result, the grounding and conflict conditions outperformed the control condition on each utterance activity. Consequently, these studies (Tegos & Demetriadis, 2017, Walker et al., 2014) show the effect that prompting by using the third person to intervene facilitates collaborative learning process.

From the above, providing a support facilitation of utterances related coordination and argumentation could yield interactive utterances from constructive because of removing the difficulty of understanding partner's perspective and disagreeing with partner from learners in collaborative learning. In a previous study of ours (not yet published), we examined the effect of present two facilitation prompts that fostered coordination or argumentation in collaborative learning. However, the study has not showed whether two prompts are benefit for leading learners from constructive to interactive activities. Therefore, we investigate to conduct conversational analysis based on the ICAP framework. The prompt that fosters coordination could facilitate interactive utterances because learners need to establish common ground and reach consensus with each other. In addition, the prompt that fosters argumentation could facilitate interactive utterances because learners need to claim their idea based on their partner's idea and disagree with partner' idea.

1.3 Purpose and hypothesis

This current study focuses on becoming form constructive utterances to the interactive utterance that is a collaborative learning process where the interaction is deeper in ICAP framework (Chi, 2009; Chi & Wylie, 2014). Taking this consideration, the purpose of this study is to investigate the effect of presenting two prompts fostering coordination or argumentation that could facilitate from constructive utterance to interactive utterances. H1 is the prompt which fosters coordination could facilitate interactive utterances. The evidence for H1 is that learners could engage in interactive utterances because they need to acknowledge partner's utterance, agree and disagree with the partner for consensus by facilitating sustaining mutual understanding and reaching consensus. H2 is the prompt that fosters argumentation could facilitate interactive utterances. The evidence for H2 is that learners could engage in interactive utterances because they need to consider the partner's idea by facilitating challenge and concession.

2. Method

2.1 Participants

In this paper, we reanalyzed the dataset of our study (not yet published). A total of 94 learners (31 males, 63 females) participated with the average age being 19.85 (SD = 1.44). Participants were randomly assigned to the control, grounding, or conflict condition. Dyads collaborated without a prompt in the control condition. In the grounding condition, dyads received a prompt that facilitated coordination. In the conflict condition, dyads received a prompt that facilitates argumentation.

2.2 Experimental material and system

The present study utilized text about attribution theory, specifically that based on success and failure. In order to understand attribution theory, dyads were shown an episode. This is related to the task that dyads conducted in the experimental task. In the experimental task, Cmap Tools (https://cmap.ihmc.us/) was used because dyads made one individual concept map and one collaborative concept map. Our study (not yet published) developed prompts based on the coding scheme from Meier, Spada, & Rummel (2007) and Asterhan & Schwarz (2009). Meier et al. (2007) broadly classified into five dimensions: (1) communication, (2) joint information processing, (3) coordination, (4) interpersonal relationships, and (5) motivation. The following are prompts (excluding motivation) used in the grounding condition: (1)"Talk with each other to understand their idea and con firm if the partner understands the content", (2) "Ask a question that is not written to the partner about causal attribution", (3) "First, explain to the partners. Next, build a concept map,", (4) "Don't talk unilaterally. Let us consider the partners.". On the other hand, Asterhan & Schwarz (2009) was broadly classified with the following three dimensions: (1) non-argumentative moves, (2) non-dialectical arguments, (3) dialectical argument. The following are prompts used in the conflict condition: (1)" Ask your partner a question about an utterance that is unclear ", (2)" Not just listen to your partner's idea or claim but agree with it ", (3)" Let's describe opposite ideas against your partner's idea or claim. Include evidence for this." .

2.3 Procedure

The experiment consisted of the experimental task and the explanation of the concept map and how to make one. The experimental task included individual phase and collaboration phase. Firstly, the experimenter explained the concept map and dyads read learning text about attribution theory individually. Second, in the individual phase (10 minutes), dyads conducted the task (Weinberger & Fischer, 2006) applied the causal attribution of success and failure to the episode (10 minutes). Narrative of a student was why the student was anxious about a promotion. In this study, dyads were asked to build concept maps about causal attribution and create individually at that time. Finally, in the

collaboration phase (15 minutes), the dyad created a concept map collaboratively referring individual maps. They could not see each other because of monitors and communicate with orality offline.

2.4 Dependent variables

In this paper, a coding scheme was developed based on Chi (2009), Chi & Wiley (2014) and Wang, Yang, Wen, Koedinger, & Rosé (2015) to capture active, constructive, and interactive utterance. Table 1 shows a part of the coding scheme and the relevant definitions. In addition, items of utterance about concept maps were added (e.g., utterance about concept map; reflection of an idea on the concept map). To investigate the reliability of coding, we conducted a third-person coding based on previous study (Schneider & Pea, 2014). A second coder coded 20% of the data which was randomly selected from the pool of all utterances. Next, to investigate the reliability, we conducted Krippendorff's alpha coefficient. The results show that the coder's matching rate was 0.74, which indicates that the coding was reliable.

Table 1. *Coding scheme about ICAP*

Item and definition	Example
Active: *Repeat/Paraphrase* The learners simply repeat the text or conversation.	"Peter said that my score was bad."
Constructive: *Justify or provide reasons*: The learners propose one's own idea or hypothesis.	"I think the effort is internal because of himself."
Interactive: *Reflect idea on concept map*: The learners agree with partner and reflect the result or understanding of partner's concept map.	After *justifying or providing reasons* of Constructive, "Okay, I will write effort in internal."

3. Result

3.1 Conversational activities in collaborative learning

We firstly investigated how dyads undertook interactive, constructive, active utterances during collaboration without prompt. For this test, a within-subjects ANOVA was conducted. As a result, there was a significant difference among interactive, constructive, active utterances (F (2, 58) = 13.10, $p < .001$, *partial* $\eta^2 = 0.31$). Therefore, multiple comparisons of the Shaffer method were performed, and the ratio of interactive utterances was significantly lower than active and constructive utterance ($p < .001$).

3.2 The ratio of interactive utterances during the task

Next, a between-subjects ANOVA was conducted to investigate H1 and H2. Figure 2 shows the comparison of control, grounding, and conflict conditions with respect to the ratio of interactive utterances among interactive, constructive, active utterances in each condition. As a result, there was a significant difference between conditions (F (2, 84) = 135.95, $p < .001$, *partial* $\eta^2 = 0.76$). Therefore, multiple comparisons in the Shaffer method were performed and the conflict condition and the grounding condition were significantly higher than the control condition ($p < .001$).

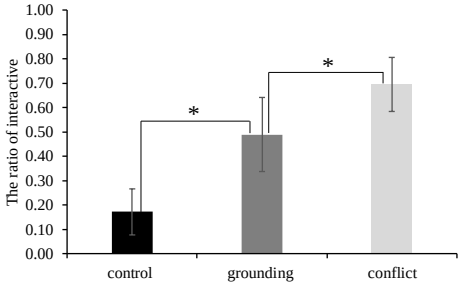

Figure 2. The comparison of interactive of 3 condition. Also, error bar is standard deviation.

In addition, the conflict condition was significantly higher than the other two conditions ($p < .001$).

These results supported H1 and H2. However, the average ratio of no labeled utterance that is not active, constructive, or interactive was 0.81 in the conflict condition. Many of learners talked about how create a concept map. This result indicates that active, constructive, and interactive utterances depicts a small ratio in conversation even if dyads in the conflict condition undertook such utterances.

4. Discussion

4.1 Interaction process of in collaboration learning based on the ICAP framework

The purpose of the present study was to investigate how the interaction process became deeper through the use of grounding prompts and conflict prompts. First, conversations were analyzed in learner-learner collaborative learning settings without prompts with a protocol analysis based on the ICAP framework. The results revealed that dyads use fewer interactive utterances in collaborative learning than in other activities of this study. As majority of research shows, learners do not demonstrate interactive utterances as necessary (e.g. Hayashi & Miwa, 2009). The present study presented evidence of these results by coding utterances based on the ICAP framework. However, this study chose to focus on utterances instead of all behaviors. Chi & Wylie (2014) showed that building concept maps is a constructive activity. Therefore, we will need to use behavior in order to investigate collaborative process in detail.

4.2 Prompting dyads to the deeper interaction process

The results of the comparison between conditions showed that the use of prompts facilitated interactive utterance. This indicates that interactive utterance is fostered by facilitating coordination or argumentation. Therefore, H1 and H2 were supported. Interactive utterance of the ICAP framework included activities that were equivalent to coordination and argumentation in this study. For example, communication in one of the coordination prompts leads to the construction of common ground which includes asking and answering to understand other contents of utterance (Clark & Schaefer, 1989). In addition, dialectical argumentative moves in one of the argumentative prompts the challenge and rebuttal that criticizes each other (Schwarz, Neuman, & Biezuner, 2010). Furthermore, dyads in the conflict condition had a higher ratio of interactive utterances than those in the grounding condition. Dyads in the conflict condition needed to take partner's idea into consideration because they were not able to critique without the partner's idea. Therefore, interaction becomes deeper by presenting a conflict prompt compared to a grounding prompt.

Another important point is that the coding schema developed in this study was based on Chi (2009), Chi & Wylie (2014) and Wang et al. (2015) and included interactive utterance type (e.g., Acknowledgement of partner's distribution) and not utterance necessarily generated by presenting a conflict prompt. In other words, a conflict prompt facilitates more interactive utterances compared to a grounding prompt, but the result also showed utterances related ICAP were a small ratio of all conversations. In future studies, it is crucial to present the prompt that fosters interactive utterance directly and investigates what part of the interactive utterance is facilitated through conflict prompts.

5. Conclusion

To lead from constructive to interactive utterances, learners need to be facilitated coordination or argumentation. Our previous study investigated whether dyads who received prompts generate more coordination utterances and argumentation utterances. Therefore, this study investigated whether interactive utterances are generated through the use of prompts that foster one of the interactive utterances by reanalyzing our previous study utilizing a conversational analysis based on the ICAP framework. The results show that the ratio of interactive utterances was greater in grounding and conflict conditions than in the control condition. In addition, dyads presented with the conflict prompt generated more interactive utterances than dyads presented with the grounding prompt. However, dyads do not generate interactive utterance as a deep process sufficiently though some interactive utterances

are facilitated by presenting prompts in attempt to foster one of these processes. In addition, we need to investigate the relationship between learning performance and the interaction process in a future study. The present study contributes to CSCL study that aim to lead deep interaction of learners in collaborative learning by providing a facilitation prompt.

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