Iyer, S. et al. (Eds.) (2022). Proceedings of the 30th International Conference on Computers in Education.
Asia-Pacific Society for Computers in Education

The Influence of Awareness of a Difference between Concept Maps on Transfer: Experimental Investigation on the Efficacy in Collaborative Learning

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Abstract: This study investigated two types of feedbacks which we defined as directive feedback and indirect (facilitative) feedback for collaborative learning on concept explanation task. In this task, we investigated how these different types of feedback will influence on the performance. The results show that learners who received directive feedback outperformed the learning performance of those who did not receive interventions for both performance on learning and transfer performances. Also, learners who received facilitative feedback that present difference did not outperform those who had no intervention in terms of the learning performance. However, learners who receive facilitative feedback outperformed those who did not received an intervention with regard to the transfer performance. In a future study, we will need to investigate the transfer performance in detail and combination of directive and facilitative feedback.

Keywords: Collaborative learning, feedback, concept maps, transfer.

1. Introduction

1.1 Background

The Intelligent Tutoring System (ITS) focuses on learning support system based on learners' model (Anderson, Boyle, & Reiser, 1985). Some studies have recently investigated learning support in collaborative learning (Hayashi, 2020; Olsen et al., 2014). The features of such support based on learners' model are aimed at leading to a correct answer using small steps by revise misconception. By contrast, computer-supported collaborative learning (CSCL) focuses on how to facilitate the learning performance during collaborative learning using a computer (Dillenbourg, 1999). Such research has investigated how to facilitate a collaborative learning process not leading to an answer. Consequently, some feedback leads to an answer and others are not. However, there are no studies that have investigated the effect of intervention when comparing two feedbacks and how each feedback influences learning experimentally.

1.2 Need for Intervention in Collaborative Learning Using Concept Mapping

In collaborative learning, it is necessary to acquire the knowledge of others as a prerequisite. Concept maps are used as a tool to help with this. In Interactive-Constructive-Active-Passive (ICAP) framework, learners are facilitated by building concept maps individually and learners who build those collaboratively outperformed than they who build those individually (Chi & Wylie, 2014).

They have been used in a wide range of fields and investigated not only in practice but also in laboratory experiments. For example, in practical situations, support in collaborative learning using concept maps has been shown to improve the learners' understanding by helping instructors recognize gaps in such understanding using Kit-Build concept maps (Pailai et al., 2017). In addition, Engelmann & Hesse (2010) used tools to visualize the knowledge of others during collaborative learning. These studies have mainly focused on an interface of learning support system. However, it is assumed that learners will be able to use and discuss these awareness tools to support collaborative learning, and that successful collaboration depends on the learners' abilities (Clarebout & Elen, 2006). Therefore, it is necessary for a facilitator to foster the learning performance using not only an interface (e.g., awareness tools) but also feedback (Janssen & Bodemer, 2013). Consequently, this paper investigates the effect of two feedbacks for learning collaboration in the context of using concept maps.

1.3 Directive and Facilitative feedback

The study to investigate feedback have shown the effectiveness of directive feedback and facilitative feedback (Shute, 2008). Directive feedback present information about correction and facilitative feedback present the information about provision (Archer, 2010). In the former, for example, Koedinger et al. (1997) investigated how to provide hints and a procedure for leading to answer when learners make a mistake. As a result, understanding of algebra was facilitated by learners following such feedback based on correct answer. However, some learners do not deepen their understanding. In the latter, for example, Hayashi (2020) investigated feedback that provides the information of the collaborator's eye movement and meta suggestion while learners learn a concept. As a result, learners received the other's information (e.g., knowledge and gaze) and a suggestion regarding the purpose of the task, which fostered their understanding of the concept. In addition, Shimojo & Hayashi (2021) indicated that intervention that learners externalize one own information and exchange the information facilitates the learning performance. In collaboration, learners need to acquire group members' knowledge (Janssen & Bodemer, 2013). Therefore, facilitative feedback is efficacy because learners are aware of group members' different knowledge. As the efficacy of facilitative feedback, the learners receive a collaborative learning process and transfer their understanding and knowledge to another task. Also, near transfer need to identify the basic element and structure of the task (Hung, 2013).

Consequently, two feedbacks are effective for near transfer because directive feedback provides the structure of the task and facilitative feedback provides help to identify basic elements and structure of the task by collaboration. Learners provided the latter feedback is also influenced by individual differences because it is difficult for learners to obtain a collaborative learning process. This paper investigates the effect of two feedbacks in learning performance and transfer performance.

1.4 Study goal and hypothesis

The study goal of the present study is to investigate the effect of a directive feedback and facilitative feedback during collaborative learning. First, we adapted the learning performance. It is expected that learners who have directive feedback will outperform learners who are without such feedback in terms of the learning performance (H1-1). In addition, it is expected that learners who have facilitative feedback will outperform learners without such feedback (H1-2). Furthermore, it is expected that learners who have directive feedback will outperform learners who have facilitative feedback (H1-3). Second, we adapted the transfer performance, and it is expected that learners who have directive feedback will outperform learners who are without feedback in terms of the transfer performance (H2-1). In addition, it is expected that learners who have facilitative feedback will outperform learners without such feedback (H2-2). Finally, it is expected that learners who have facilitative feedback will outperform learners with directive feedback (H2-3).

2. Method

2.1 Participants

In this study, there were 58 university students majoring in psychology (15 male, 43 female), the average age of which was 19.16 (*SD* = 0.91).

We adapted a factor between participant design. For the control condition, learners were without feedback. For the follow condition, learners were presented correct answer. Finally, for the relative condition, learners were presented difference.

2.2 *Experiment Material*

The learning material was a causal attribution of success and failure based on attribution theory (Weiner, 1985). As the attribution of success, a person infers a cause from three dimensions (internal/external, stable/unstable, controllable/uncontrollable). Learners were asked to infer the anxiety of a student (anxiety of a new semester) using concept maps individually and collaboratively, explaining one own idea to other.

We used two PCs and monitors during the experiment. In addition, the learners made a concept map by using concept map tools that we developed in C#. During the experimental task, we collected the facial expression, eye movement, and audio information using a video camera (Sony, HDR-CX680) and microphone (BeeFly, MF-MKF2020-JP). Figure 1 shows the learning situation and experiment device used.

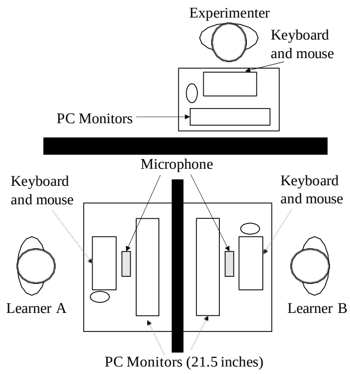

Figure 1. Learning situation and experiment device.

2.3 *Procedure*

The experimental procedure consisted of 8steps. In the present study, the leaners first answered questions regarding attribution theory to confirm whether there is difference in prior knowledge among the conditions (1). Next, the learners were instructed how to create concept map and what concept map is (2). Also, they learned attribution theory by reading learning text (3). After that, the learners learned a pre-test to investigate the experiment task (4). During the experiment task, the learners were asked to make concept maps collaboratively (6) after making such maps individually (5). Learners see each other concept maps that they made individually on the right side and made the concept map of collaboration on the left side. Two different points among the three conditions were whether the learners were provided prompts or not and whether they were provided prompts based on an answer or not. Details will be described in section 2.4 (Structure of feedback system). After the experiment task, the learners took a post-test (7). Finally, the learners made a concept map individually during the transfer task (8). In transfer task, episode was about procrastination and different with experiment task.

2.4 *Structure of Feedback System*

Learners under a follow condition were provided feedback presenting "correct answer", leading to "correct concept maps". We adapted classification that classified cause in episode based on three dimensions as a "correct answer" by using table 3 of Nasu (1989). Based on the classification, we discussed and create simple concept maps as a "correct concept maps". Therefore, we divided the correct maps into nine steps. Figure 2 shows the correct concept maps. When the learners cleared one step of the nine steps, the system provided feedback for the next step. If they proceeded according to the steps, they were able to make the concept of the correct answer. Also, collaborative concept maps in a follow condition were divided into three parts because learners have to write phenomenon (e.g., anxiety) at the top, links (e.g., internal) at the middle, and cause (e.g., effort) at the bottom based on figure 2 to create the correct map. Example prompts were "Create a node called Anxiety at the top of the three divisions. In addition, place the cause of the node at the bottom and the link at the center."

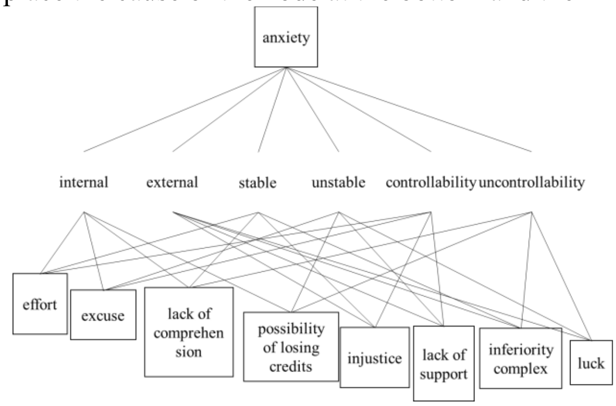

Figure 2. A correct concept map.

Under a relative condition, learners were provided feedback not based on an answer. In particular, the system provided information of different nodes and links between a pair in an experimental task (pre-individual).

2.5 Dependent Variables

This study used the learning and transfer performances as dependent variables by scoring the concept maps during the experiment and transfer tasks. The coder scored using 1 to 5 points. Here, 1 point indicated that the concept maps did not include three dimensions, whereas 5 points indicated that concept maps included three dimensions (internal/external, stable/unstable, controllable/uncontrollable) and associated three dimensions. First coder scored all of data. We calculated Krippendorff's alpha coefficient between first coder and second coder to investigate the reliability of coding by first coder based on (Schneider & Pea, 2014). The second coder scored 20% of all data. As a result, the coder's matching rate was 0.63. Therefore, that the coding was reasonably reliable and the coding of first coder was adopted.

3. Result

3.1 Evaluation of Experiment Task

In this section, we compared three conditions in the evaluation of the concept maps during the experiment task to test H1-1, H1-2, and H1-3. Figure 3 shows a comparison of the three conditions in the evaluation of the concept maps. We conducted a one-way ANOVA and there was a significant difference between conditions (F (2, 55) = 3.55, $p < .05$, and *partial* $\eta^2 = 0.11$). As a result of multiple comparisons in Shaffer method, the evaluation under the follow condition was higher than that under the control condition ($p < .05$). In addition, there were no significant differences between the control and follow condition, or between the follow condition and relative condition ($p = .20$, $p = .20$).

Consequently, H1-1 was supported, but H1-2 was not. In addition, H1-3 was partially supported because the evaluation under the follow condition was only higher than the control condition.

3.2 Evaluation of Transfer Task

In this section, we compared three conditions in an evaluation of the concept maps during a transfer task to test H2-1, H2-2, and H2-3. Figure 4 shows the comparison of the three conditions in the evaluation of the concept maps. We conducted a one-way ANOVA and there was a significant difference between conditions (F (2, 55) = 7.51, $p < .01$, and *partial* $\eta^2 = 0.22$). As a result of multiple comparisons in Shaffer method, the evaluation under the follow condition and the relative condition was higher than that under the control condition ($p < .01$, $p < .01$). In addition, there were no significant differences between the follow and relative conditions (p = .20). However, there were no significant differences between the follow and relative conditions (p = 0.36).

Consequently, H2-1 and H2-2 were supported, but H2-3 was not because there was no significant difference between the follow and relative conditions in the transfer performance.

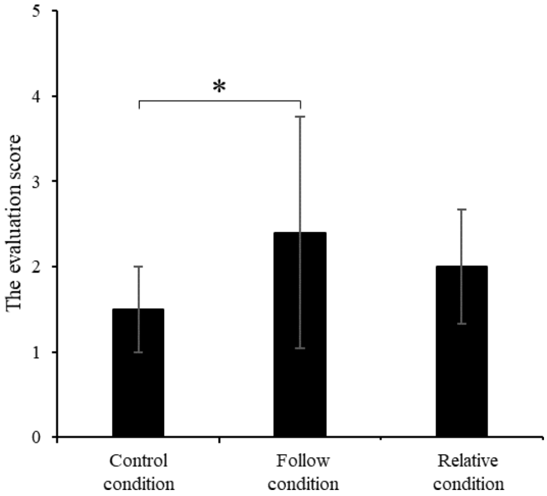

Figure 3. Comparison of three conditions in evaluation of concept maps of experiment task. Error bars are the standard deviation and * represents $p < .05$.

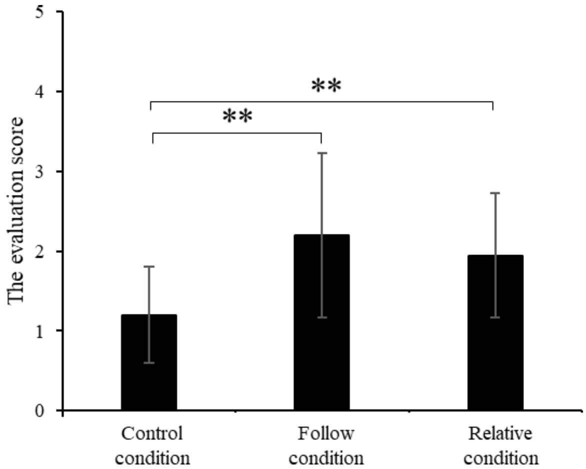

Figure 4. Comparison of three conditions in evaluation of concept maps of the transfer task. Error bars are the standard deviation and ** represents $p < .01$.

4. Discussion

The present study investigated how directive feedback based on an answer and facilitative feedback not based on an answer influence learning by comparing their feedback. We focused on the learning and transfer performances. H1-1 was supported, but H1-2 was not supported. In addition, H1-3 was partially supported because the evaluation under the follow condition was only higher than that under the control condition. For the transfer performance, it was expected that learners who have directive feedback would outperform learners without feedback in terms of the transfer performance (H2-1), learners who have facilitative feedback would outperform learners without feedback (H2-2), and learners who have facilitative feedback would outperform learners with directive feedback (H2-3). H2-1 and H2-2 were supported, but H2-3 was not supported. Consequently, each feedback was effective on the transfer performance.

Koedinger et al. (1997) indicated that directive feedback based on an answer is effective in terms of the learning performance. On the other hands, Hayashi (2020) indicated that facilitative feedback is effective. This study indicated that directive feedback is effective in terms of the learning and transfer performance while making a concept map. However, the results also differed from those of previous studies (e.g., Hayashi, 2020) in terms of the non-solution-based feedback. The effectiveness of the feedback was only confirmed in the transfer performance. Hung (2013) showed that near transfer needs to identify the basic element and structure of the task. Therefore, directive feedback is effective because learners acquired the basic element and structure through referring correct concept map. Also, facilitative feedback is effective because learners acquired those through referring other concept maps and externalizing based on other's idea.

This result indicated that both feedbacks have each effectiveness and contribute to how to facilitate collaborative learning using computer. Although the effectiveness of each feedback was confirmed, because the transfer task was done immediately after the experimental task it is necessary to examine the effect of not the near transfer but the far transfer after a longer period of time. Also, we will need to investigate the learning performance in greater detail and combination of directive and facilitative feedback in the future.

Acknowledgements

This work was supported by JSPS KAKENHI Grant Number JP20H04299.

References

Anderson, J. R., Boyle, C. F., & Reiser, B. J. (1985). Intelligent tutoring systems. *Science*, *228*(4698), 456-462.

Archer, J. C. (2010). State of the science in health professional education: effective feedback. *Medical education*, *44*(1), 101-108.

Chi, M. T., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. *Educational psychologist*, *49*(4), 219-243.

Clarebout, G., & Elen, J. (2006). Tool use in computer-based learning environments: Towards a research framework. *Computers in Human Behavior*, *22*(3), 389-411.

Dillenbourg, P. (1999). What do you mean by collaborative learning?. In P. Dillenbourg (Ed.), Collaborative-learning: Cognitive and Computational Approaches (pp. 1-19). Oxford: Elsevier.

Engelmann, T., & Hesse, F. W. (2010). How digital concept maps about the collaborators' knowledge and information influence computer-supported collaborative problem solving. *International Journal of Computer-Supported Collaborative Learning*, *5*(3), 299-319.

Hayashi, Y. (2020). Gaze awareness and metacognitive suggestions by a pedagogical conversational agent: an experimental investigation on interventions to support collaborative learning process and performance. *International Journal of Computer-Supported Collaborative Learning*, *15*(4), 469-498.

Hung, W. (2013). Problem-based learning: A learning environment for enhancing learning transfer. *New directions for adult and continuing education*, *137*, 27-38.

Janssen, J., & Bodemer, D. (2013). Coordinated computer-supported collaborative learning: Awareness and awareness tools. *Educational Psychologist*, *48*(1), 40-55.

Koedinger, K. R., Anderson, J. R., Hadley, W. H., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. *International Journal of Artificial Intelligence in Education*, *8*(1), 30-43.

Nasu, M. (1989). A study of Weiner's attribution theory of achievement motivation. *The Japanese Journal of Educational Psychology*, *37*(1), 84-95.

Olsen, J. K., Belenky, D. M., Aleven, V., & Rummel, N. (2014). Using an intelligent tutoring system to support collaborative as well as individual learning, *Proceeding of the 12th International Conference on Intelligent Tutoring Systems (ITS2014)*, 134-143.

Pailai, J., Wunnasri, W., Yoshida, K., Hayashi, Y., & Hirashima, T. (2017). The practical use of Kit-Build concept map on formative assessment. *Research and Practice in Technology Enhanced Learning*, *12*(1), 1-23.

Schneider, B., & Pea, R. (2014). Toward collaboration sensing. *International Journal of Computer-Supported Collaborative Learning*, *9*(4), 371-395.

Shimojo, S. & Hayashi, Y. (2021). Facilitating explanation activities using a concept map in collaborative learning: Focusing on coordination and argumentation process, *Cognitive Studies*, *28*(4), 499-521.

Shute, V. J. (2008). Focus on formative feedback. *Review of educational research*, *78*(1), 153-189.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological review*, *92*(4), 548-573.