

The Difference That Counts: Guiding Knowledge Exchange by Visualizing Levels of Co-Learners' Knowledge

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Abstract: Many studies have shown that the complementarity of co-learners' knowledge has a positive effect on knowledge exchange in collaborative learning. It has also been proven that visualizing given levels of knowledge guide co-learners' questions and answers during the exchange. However, the question remains unanswered as to what extent visualized relative and absolute levels of knowledge have an influence on behavior. To find an answer to this question, which could also be used for optimizing complementarity-based group formations, we have systematically varied learners' knowledge levels relative to learning partners' levels (continuous distance) and absolute levels of knowledge (three levels) in 33 visualizations to investigate associated question and explanation intentions. The results confirm a strong influence of distances on intentions, moderated by absolute knowledge levels. In addition, we report from which distance learners decide to ask questions or provide explanations.

Theoretical background

Knowledge exchange is a core activity of collaborative learning, which can be triggered in learning groups by distributing learners' characteristics in specific ways (Dillenbourg & Jermann, 2007). Common approaches to group formation target to group learners with complementary knowledge by either forming groups of learners with given characteristics, or by providing teammates with complementary information, both aiming at promoting a mutual exchange of knowledge that enables learners to solve tasks for which their own knowledge is not sufficient (Dillenbourg & Jermann, 2007). Either way, providing co-learners additionally with the information, on which the group formation is based on, might further improve knowledge exchange. Cognitive group awareness tools visualize such knowledge-related information in order to improve the awareness of learning partners' knowledge and to suggest specific behaviors (Bodemer, Janssen, & Schnaubert, in press). Research in this area has revealed that group awareness improves co-learners adaptation of communication in terms of applying better strategies when asking questions on a learning topic and of providing more elaborated explanations to less knowledgeable learning partners (Dehler Zufferey, Bodemer, Buder, & Hesse, 2011; Erkens, Bodemer, & Hoppe, 2016). It can be assumed that these effects depend on the levels of knowledge relative to a learning partner and the absolute levels of knowledge. Since this has not yet been investigated, the present study aims to identify guidance principles that can be triggered by visualizing knowledge-related information and to use them for the improvement of group formation. For this reason, we investigate the research question of what influence the visualization of relative and absolute knowledge levels has on the exchange of knowledge. We assume that the intention to ask increases with an increasingly negative distance between own and partner knowledge (H1a) moderated by the level of knowledge (H1b) and the intention to explain increases with an increasingly positive distance (H2a) moderated by the level of knowledge (H2b). In addition, we investigate exploratively thresholds of knowledge distance from which learners start asking questions or giving explanations on a learning topic.

Method

We investigated the effect of visualized levels of knowledge in an online study with 126 participants (46 men; 80 women; age: $M = 27.63$, $SD = 11.88$). To test our hypotheses, we have varied the continuous predictor *relative level of knowledge* (distance values between the visualized bar of the participant and the bar of a learning partner ranging from -5 to +5) and the categorical moderator *absolute level of knowledge* (no knowledge, little knowledge, medium knowledge) in 33 systematically created visualizations (see Figure 1). For the purpose of capturing the dependent variables, we asked the participants to report for each of the visualizations their intention to ask a question and to give an explanation on a six-point scale (from (1) 'strongly disagree' to (6) 'strongly agree'). In addition, we have calculated thresholds for each participant based on binary logistic regressions. Resulting values x_1 ($x_1 = -\beta_0 / \beta_1$) describe the knowledge distance at the turning point of the logistic function meaning the visualized distance from which learners start asking or explaining.

Results

In order to answer our first research question, we investigated the impact of visualized levels of knowledge on knowledge exchange. For this purpose, we have used a moderation analysis with the distance values as predictor,

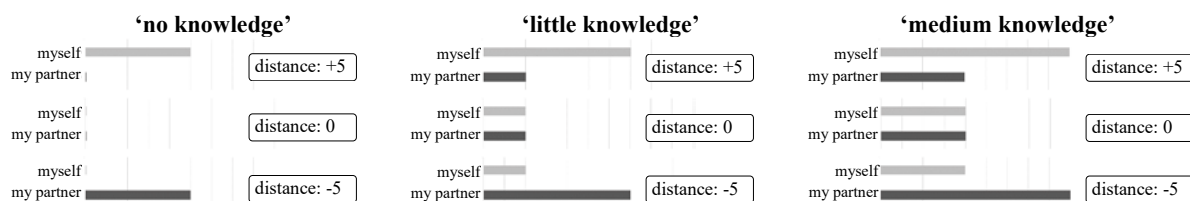


Figure 1. Extract of visualizations used. The 9 examples show the visualizations of the highest (+5), lowest (-5) and not given (0) distance between co-learners for all absolute levels of knowledge (no, little, medium).

absolute level of knowledge as moderator and the intention to ask or to explain as dependent variable. We dummy coded the absolute level of knowledge and used Helmert contrasts. Regarding hypothesis 1, results indicated that the intention to ask increases with decreasing distance, especially when the absolute level is 'no knowledge'. The interaction explained a significant increase in variance regarding the intention to ask, $\Delta R^2 = .06$, $F(2, 27) = 6.57$, $p < .01$. Regarding hypothesis 2, results indicated that the intention to explain decreases with decreasing distance, especially when the absolute level is 'no knowledge'. The interaction explained a significant increase in variance in the intention to explain, $\Delta R^2 = .05$, $F(2, 27) = 5.64$, $p < .01$. To answer our second research question, we have calculated thresholds at which learners begin to ask or to explain. We identified three groups: (1) learners with an intention to ask questions or give explanations, depending on the given knowledge distance, (2) learners who would always ask and explain, and (3) learners who would never ask or explain. As far as group (1) is concerned, we found that most of the learners (23 out of 79) were already starting to ask questions from a distance of 1 (indicating that learners know a little bit more) and 29 out of 80 learners would start giving explanations from a distance of -1 (indicating that they know a little bit less).

Discussion

The results indicate that the visualized knowledge differences of co-learners who have a similarly high overall knowledge on a topic should be as large as possible for each sub-area of the topic. Furthermore, the absolute level of knowledge seems to be relevant for knowledge exchange. While the high intention to ask questions is similar across absolute levels of knowledge when the visualization shows that a learning partner knows more than a learner, the intention to ask is especially low when the visualization shows a more knowledgeable learner in combination with a learning partner with no knowledge. Similarly, learners demonstrate a high intention to explain beyond the absolute levels of knowledge, if they are made aware that they know more than the learning partner does. Furthermore, they offer the learning partner little explanation, especially if the visualization shows a more knowledgeable learning partner in combination with no learner's knowledge. Taken together, this suggests that we should take into account for group formation that one co-learner should alternately have no knowledge. Regarding the question of a necessary minimum distance between co-learners, we have found that learners often start asking questions, although the visualization shows that they know a little more than their partner (with increasing intention, the more a learning partner knows compared to a learner). Further, they start giving explanations, although the visualization shows that they know something less than their partner (with increasing intention, the less a learning partner knows compared to a learner). Thus, there seem to be minimum differences from which learners start showing a specific behavior, but they lie outside our expected range, and a minimum at first glance does not seem to be a relevant for grouping. However, this could be different under real conditions, so levels of knowledge and thresholds should be further explored in the field based on these first promising results.

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