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Is knowledge best shared or given to individuals? Expanding the Content-based Knowledge Awareness paradigm

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ABSTRACT

In the computer-supported collaborative learning domain the Content-based Knowledge Awareness approach has been established as a reliable way of improving knowledge exchange within transiently collaborating online groups. On this paradigm group members are given insight into the entirety of each other's task-related knowledge content at the outset of their collaboration. The present study aimed to discern the locus of the observed benefit of Content-based Knowledge Awareness by contrasting performance of groups with insight into their partner's knowledge against groups without such insight and, novelly, individuals who had access to the entirety of the group's knowledge but no collaboration partner. Task solving efficiency and long-term retention of the study material were measured. Contrary to expectations, participants in the Individual condition were fastest at solving the study task while retaining the same amount of the studied material as groups who were genuinely collaborating. This finding suggests that when an external representation of a collaborator's knowledge is available, interaction with the collaborator can hinder the exchange of this knowledge.

1. Introduction

As the modern workforce is increasingly faced with cognitively demanding tasks requiring fast comprehension and knowledge acquisition, there is a pressure on educational science to find efficient ways for imparting knowledge. Addressing this demand, computer-supported collaborative learning has grown as a research field promising to marry the benefits of collaborative learning (Johnson & Johnson, 2009) to recent advances in computers and communication technology. Still, many challenges remain to be overcome, in particular when knowledge exchange and problem solving in transiently collaborating online groups are concerned. When a number of people holding different knowledge come together they first need to establish a common ground (Clark & Brennan, 1991), that is, a mutually agreed upon basis for their interaction. It is further advantageous for the group to develop a Transactive Memory system (Moreland & Myaskovsky, 2000; Wegner, 1986), an understanding about who is responsible for which aspect of the task-relevant knowledge. Both common ground and a Transactive Memory system take time to negotiate which potentially defers the accomplishment of the group's task, in particular in transiently collaborating groups. In online scenarios this negotiation is further constrained by the limitations imposed upon the group's interaction by the communication medium (Buder, 2011; Carroll, Neale, Isenhour, Rosson, & McCrickard, 2003). Addressing these challenges, the Content-based Knowledge Awareness (CoKA; also known as Knowledge and Information Awareness) paradigm (Engelmann & Hesse, 2010) has been established as a promising approach to improving knowledge exchange for (learning) task accomplishment and the underlying construction of new knowledge.

1.1. Defining Content-based Knowledge Awareness

On the CoKA paradigm, members of transiently online collaborating groups provide each other with a (visual) representation of the entirety of their task-relevant knowledge content that they hold at the outset of collaboration[1]. Each individual group member

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[1] For historic reasons, in early studies on the paradigm the to-be-exchanged knowledge representations contained hyperlinks to source material containing the information on which the individual group member's knowledge was allegedly based (hence Knowledge and *Information* Awareness). However, the role of these links or the information provided through them has never been clear, nor central to the core assumptions of the paradigm. To emphasize the central role of providing awareness about the knowledge content and to deemphasize the unclear role of awareness about the (allegedly) underlying information, recent publications on this topic (cf. Engelmann, Kolodziej, & Hesse, 2014a; Engelmann, Kozlov, Kolodziej, & Clariana, 2014b) have referred to the paradigm as Content-based Knowledge Awareness paradigm.

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has thus, from the outset of the collaboration *awareness* about the knowledge content held by each other group member. While in the majority of studies on the paradigm the to-be-exchanged representations were provided by the experimenter, with each participant having to internalize their "knowledge" from his or her respective representation at the beginning of the study, the intention of the CoKA paradigm is that the group members themselves generate the to-be-exchanged representations of their task-relevant knowledge content. Research is currently under way investigating how group members can be encouraged to do so in an adequate way (e.g. Engelmann et al., 2014b). CoKA can be further contrasted against related paradigms like Group Knowledge Awareness (Dehler, Bodemer, Buder, & Hesse, 2011) insofar as it aims to bring the entirety of each collaborator's task-relevant knowledge into the attentional focus of the group and its members, not just provide general hints about the context in which each collaborator's specialized knowledge is best placed or viewed (cf. Engelmann, Dehler, Bodemer, & Buder, 2009). Within transiently collaborating online groups CoKA has been shown to enhance performance on the collaborative task (Engelmann & Hesse, 2010), to foster sharing, discussing and cognitive processing of unshared information (Engelmann & Hesse, 2011), to speed up the development of a Transactive Memory system (Schreiber & Engelmann, 2010), and to inhibit the undesirable effects of mutual trust within the group, that is reduce the impact "blind" trust in the potentially incorrect knowledge of the partner has on the collaborative task outcome (Engelmann et al., 2014a).

1.2. The locus of the CoKA effect

Despite various studies demonstrating an improvement of the collaborative effort due to CoKA it remains somewhat unclear whether CoKA improves the interaction between members of a group or whether the benefit of CoKA stems from the entirety of the group's task-relevant knowledge being available to all group members from the outset. In past CoKA studies (e.g. Engelmann & Hesse, 2010; Schreiber & Engelmann, 2010) groups with CoKA were usually compared to groups without CoKA, that is, groups which had to find a joint solution for the study task without being able to access the knowledge visualization of their partners. Only by externalizing their knowledge on a shared workspace or through verbal interaction could the participants in No-CoKA groups provide each other with an appreciation of their individual knowledge. Such No-CoKA scenarios were considered prototypical of online collaborative settings and it was found that enriching them with the opportunity to gain insight into the collaborative partner's knowledge content from the outset improved the outcome of the interaction and learning. Rarely has it been considered, however, that if each group member has access to the knowledge content of the entire group, interaction between group members might not actually be necessary for learning to occur. Only one study (Engelmann, Baumeister, Dingel, & Hesse, 2010) has so far compared performance of groups with CoKA to the performance of individuals with access to the group's entire knowledge content representation. Because in that study groups with CoKA outperformed individuals with access to the entire knowledge of the group, it was concluded that interaction is important for learning. Since preceding studies have shown an advantage for interacting groups with CoKA over interacting groups without CoKA, it was postulated that CoKA benefits collaborative learning by structuring and improving the interaction within the group.

If, however, the benefit of CoKA were only in improving the interaction within the group then the other aspect of CoKA, namely that all task-relevant knowledge is made available to all group members from the outset should not matter. Indeed, one would expect, all else being equal, that individuals who are able to interact and do not each have access to the entirety of the group's knowledge should outperform individuals with access to all the task-relevant knowledge from the outset, but for whom interaction is prohibited. This should be particularly the case when the learning task is complex: Collaborative interaction in learning has been argued to be of distinct benefit on complex learning tasks (Kirschner, Paas, & Kirschner, 2009). On the other hand, past research has also shown that learning together can be challenging with groups often failing to effectively coordinate their learning efforts (e.g. Barber, Rajaram, & Aron, 2010). It is therefore important to test whether the benefits of being able to interact in a group, without CoKA to structure and improve this interaction, will be sufficient for those groups to outperform individual learners. This leads us to the first and main research question which we aimed to address in this study:

R1. *Will groups of interacting individuals with CoKA, groups of interacting individuals without CoKA and (nominal) groups of individual learners, with no means to interact but who from the outset each have insight into the entirety of the knowledge available to the group, show differences in performance on a complex learning task?*

1.3. Shortcomings of the CoKA paradigm

1.3.1. No measures of long-term effects

The present study further aimed to address a number of shortcomings of previous CoKA studies. Thus, while settled in the field of computer-supported collaborative learning, previous CoKA studies neglected to investigate the long-term effects that having insight into the collaboration partners' knowledge has on the retention of the study material. Although it was generally observed that participants collaborating with CoKA are more effective at solving the study task, arguably showing better comprehension of the study material, and are better able to recall which group member held which piece of knowledge (Engelmann & Hesse, 2010; Schreiber & Engelmann, 2010) their ability to retain the knowledge gained and exchanged during their collaborative interaction over a longer period was never the subject of study. Showing that CoKA groups are able to recall more studied material over the long-term is important, however, since a learning paradigm that does not cause a long-term increase in knowledge is of limited value for education. Our second research question was therefore:

R2. *Will the to-be-comprehended concepts within a learning task be better remembered by participants working in groups with CoKA and will this potential recall advantage be still observable after one week's time?*

1.3.2. Heavy reliance on concept maps

Another challenge to the external validity of the CoKA approach, which we aimed to address in the present study, is that in previous studies to-be-exchanged knowledge was exclusively represented through concept maps (Novak & Cañas, 2006). Concept maps are a form of diagram that permits the graphical representation of hierarchical, propositional knowledge. Concepts are depicted as nodes and the relations between concepts are symbolized by lines or arrows connecting the concepts. Thus in a typical CoKA study group members are given a concept map representing their partial knowledge on a specific issue which they then have to integrate with the concept maps of their collaboration partners, so that the correct solution for the study problem transpires. However, concept maps are by far not the only means to visualize knowledge,