Scripting Collaborative Drawing in Elementary Education

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Abstract. Having learners jointly create combined textual and graphical representations of science topics aims to foster active elaboration of these topics. Collaborative drawing is particularly appealing to elementary school students, but simultaneously requires advanced collaboration skills. To facilitate collaborative drawing among elementary school students, we investigate in an in vivo experiment (N = 92) a collaboration script that orchestrates individual and collaborative learning activities and guides learners to identify and elaborate on differences of their individual drawings in order to create a joint drawing. First results show that elementary school students are enabled by the script to engage in critical reasoning together using their drawings to disambiguate their knowledge communication.

Keywords: Collaborative drawing; elementary education; collaboration script

Constructing Representations

Learners often process textual and graphical learning material superficially and only to the extent needed for current purposes, e.g., passing standard tests (Reiser, 2004). Constructing representations is an approach towards actively processing and disambiguating the learning material (Cox, 1999). By constructing representations, learners are assigned to identify and link relevant pieces of information and thereby self-explain the learning material (Kolloffel, Eysink, & Jong, 2010). Kolloffel and colleagues (2010), for instance, provided learners with tools to represent the subject matter of probability theory in conceptual, arithmetical, or textual format, which engaged learners in externalizing their knowledge to different degrees. Kolloffel concludes that the different representational formats need to be selected and attuned to learners' (advancing) knowledge.

Drawings have been regarded useful for adaptively facilitating young learners' (advancing) knowledge of science topics such as "evaporation" (Brooks, 2009). Combining graphical elements with textual annotations in drawings enables young learners to explicate their understanding of science (Hayes, Symington, & Martin, 1994). Drawings are frequently used in elementary education, but there is yet little systematic research and application of drawings to enrich and enliven early science education (Brooks, 2009).

Collaborative Drawing

On top of being appealing and helping young learners to disambiguate their conceptual understanding, drawing can beneficially interact with collaborative learning (Savinainen, Scott, & Viiri, 2005). On one hand, drawing can facilitate shared focus of small groups of learners and improve their knowledge communication (Gijlers, Saab, Van Joolingen, De Jong, & Van Hout-Wolters, 2009). On the other hand, collaborative learning can further develop cognitive elaboration of the learning material (Cohen, 1994). Then again, collaborative learning in itself is demanding and often characterized by coordination problems and process losses (Barron, 2003). Collaborative drawing may be particularly demanding for learners to coordinate and benefit from. Sharing external representations does not seem to be sufficient for learners to arrive at a shared understanding (Gijlers, et al., 2009).

Collaboration Scripts

Collaboration scripts have been found an effective instructional means to guide learners' interactions and facilitate individual learning outcomes (O'Donnell, 1999). Scripts are a set of instructions that

specify, sequence, and distribute roles and activities among a group of learners. Scripting has been successfully used in both, face to face (O'Donnell, 1999) and computer-mediated environments, e.g., through prompting, and role distribution (Kobbe, et al., 2007). For instance, Weinberger, Ertl, Fischer, and Mandl (2005) have found a peer-critique script to effectively support individual learning outcomes, which distributes, prompts, and rotates the roles of case analyst and critic to groups of three online learners. In a similar vein, we investigate to what extent a peer-critique script facilitates processes and outcomes of collaborative drawing in elementary education. We hypothesize that a peer-critique script facilitates shared focus and critical reasoning and reduces process losses within collaborative drawing dyads.

Methods

Sample and Design. Elementary school students (N = 92), aged 11-12, from four different elementary schools participated in this in vivo study. Students were paired into dyads with a student from their own school. Dyads (n = 46) were formed controlling for students' working preferences and prior knowledge and assigned to a scripted experimental condition or an unscripted control condition.

Learning Materials. Students in both conditions worked on a collaborative drawing task to jointly represent photosynthesis. In both the scripted and the unscripted condition, learners were introduced to photosynthesis by video clip and text, and asked to make a drawing that can be used to explain photosynthesis to another learner.

Experimental Conditions. The script foresaw four distinct phases of drawing with specific instructions. First, students were asked to make an individual drawing of the photosynthesis process. Second, students were asked to exchange their drawings and identify differences between their own drawing and the work of their partner. Students used colors to mark the identified differences. Third, students were asked to discuss the identified differences and find out why a partner decided to represent specific aspects of photosynthesis in a certain way. Students were provided with and instructed to use prompt cards to guide their discussion saying, for instance, "Would you please explain to me why you drew … differently?" Fourth, students were asked to make one shared drawing of the domain. In the unscripted condition the drawing session was not divided into different phases. Students in the unscripted condition were asked to create one shared representation of the domain.

Instruments. To measure the effects of the script, learning outcomes were assessed using a cued recall domain knowledge test. Furthermore, intermediate and final drawings were scored and all verbal interaction was recorded and coded with a coding scheme by Weinberger and Fischer (2006). Dyads were controlled for their prior knowledge and their preference for working with a specific partner.

Results

We predicted specific effects of the script on processes and outcomes of collaborative drawing. Preliminary analyses support these hypotheses. A first inspection of the data indicates that students in both conditions gained domain knowledge. Students in both conditions exchanged relevant domain-related information and referred frequently to their drawing during interaction, thus maintaining and increasing their shared focus. Students in the scripted condition prepared for collaboration by making an individual drawing. Scripted students used these individual drawings in their effort to deepen and

disambiguate the discussion and reach consensus with their partner. Scripted learners engaged in more critical reasoning, both verbally and in their drawings, than unscripted students.

Discussion and Conclusion

The facilitation of sharing knowledge and critical reasoning through the script supports our hypothesis that collaborative learning scenarios – including collaborative drawing – can benefit from this form of additional socio-cognitive guidance. However, the script also reduces learners' degrees of freedom for adapting their drawings to their advancing knowledge.

While we used a pen and paper task and cardboard prompt cards in our in vivo experiment, that are non-responsive to how learners advance in their understanding of the science topic, the findings of this study may have implications for how to design online environments incorporating collaborative drawing. We are currently developing software for tablet PCs and iPads with sharing and awareness features on socio-cognitive aspects of the drawing task that are responsive to the dynamics of collaborative drawing. We will demo the software for collaborative drawing, investigate the software in a comparable setting, and link these results to the fully analyzed results of the pen and paper study.

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