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Teacher regulation of cognitive activities during student collaboration: Effects of learning analytics

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ABSTRACT

By collaboratively solving a task, students are challenged to share ideas, express their thoughts, and engage in discussion. Collaborating groups of students may encounter problems concerning cognitive activities (such as a misunderstanding of the task material). If these problems are not addressed and resolved in time, the collaborative process is hindered. The teacher plays an important role in monitoring and solving the occurrence of problems. To provide adaptive support, teachers continuously have to be aware of students' activities in order to identify relevant events, including those that require intervention. Because the amount of available information is high, teachers may be supported by learning analytics. The present experimental study ($n = 40$) explored the effect of two learning analytics tools (the Concept Trail and Progress Statistics) that give information about students' cognitive activities. The results showed that when teachers had access to learning analytics, they were not better at detecting problematic groups, but they did offer more support in general, and more specifically targeted groups that experienced problems. This could indicate that learning analytics increase teachers' confidence to act, which in turn means students could benefit more from the teacher's presence.

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1. Introduction

Computer-supported collaborative learning (CSCL) is an instructional strategy in which collaboration among students is supported by technology. It is based on the idea that collaboration is beneficial for learning. By collaboratively solving a task, students are challenged to share ideas, express their thoughts, and engage in discussion (Stahl, Koschmann, & Suthers, 2006). Learning during CSCL is seen as an interactive, constructive, and largely self-regulated process. Students' learning activities can be categorized into cognitive activities (i.e., related to the content of the task, for example structuring and analyzing task material), social activities (for example, the occurrence of discussion in terms of agreement and disagreement and participation rates of group members), and regulative activities at both the cognitive and social level (for example, discussing strategies for solving the task) (Janssen, Erkens, Kanselaar, & Jaspers, 2007; Kaendler, Wiedmann, Rummel, & Spada, 2014; Vermunt & Verloop, 1999; Weinberger & Fischer, 2006).

Digital learning environments designed for collaborative learning generally integrate tools for carrying out the task as well as for communication between group members. Together, these tools facilitate the types of student activities mentioned above because they support the sharing of resources and provide an opportunity for communication within the group

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(Erkens, Jaspers, Prangmsma, & Kanselaar, 2005). In the present study, collaboration occurs through a digital learning environment in which students have access to task materials, share a text-editor with their group members, and communicate through a chat facility. Providing these tools, however, does not guarantee that students will adequately finish their task, nor a high quality of discussions (Kirschner & Erkens, 2013; Pargman, 2003; Rummel & Spada, 2005). During CSCL, teachers act as a facilitator of students' activities (Kaendler et al., 2014). Teachers can for example offer thoughts that deepen or broaden the discussion and keep track of the progress that groups of students are making on the task. To do so, it is important that teachers are able to identify all relevant events, including those that require intervention. Because of the generally rapid pace of activities within synchronous CSCL settings and the large amount of available information, supporting student activities is a demanding task. In the present study, we focus on teacher regulation of groups' cognitive activities, which are important because they are directly related to for example knowledge acquisition and of which it is known that students may experience problems (Weinberger & Fischer, 2006). We explore a way of supporting the teacher, namely by visualizations of the collaborating groups' activities. The sections below describe students' cognitive activities, the teacher's role during CSCL, and how the teacher may be supported while regulating students' cognitive activities.

1.1. Students' cognitive activities during collaborative writing tasks

The present article is situated in the context of a collaborative writing task. Groups of students in secondary education synchronously communicate with each other through a chat tool and share a text editor to write an essay based on historical sources, which are all provided within the learning environment. The cognitive activities involved in this task include evaluating and discussing the task material, writing the essay, and reading historical sources. At the level of regulative activities, the groups have to agree on a strategy for completing the task and to monitor their progress. As stated before, students largely self-regulate their activities, but it is known that problems may occur that could negatively influence students' learning gains or the quality of the group product. Two of those problems are described in this section.

The first problem concerns discussion of task material within groups. Researchers generally distinguish between on-task and off-task communication within group discussions (see De Wever, Schellens, Valcke, & Van Keer, 2006, for a review). Discussing the content of the task is most clearly related to knowledge acquisition (Weinberger & Fischer, 2006; Cohen, 1994; see also Carroll's Time-On-Task hypothesis, Carroll, 1963, quoted in Baker, Corbett, Koedinger, & Wagner, 2004). Because of the informal character of synchronous chat communication, students may stray off-task during discussions, which could lead to decreased learning gains. When groups do stay on-task, there is another potential difficulty, namely that the discussion has insufficient breadth (Baker, Andriessen, Lund, Van Amelsvoort, & Quignard, 2007). That is, discussions may be superficial or one-sided when the topic of the discussion lingers on only a limited set of the concepts that are relevant to the task. Limited breadth of discussion could also mean less depth, because the students did not take into account all possible explanations or viewpoints and did not connect these views to each other (Baker et al., 2007). So, the content of group discussions, in terms of on- and off-task behavior and the concept coverage or breadth of the discussion, is one cognitive aspect that teachers can help students to regulate.

The second problem is concerned with how students alternate between cognitive activities. While solving the task, students continuously alternate between writing and discussing (Rummel & Spada, 2005), and engage in activities such as outlining, composing, and reviewing the written text. The groups of students may choose different strategies for writing, such as parallel exploration of the material followed by integration of ideas, or continuous joint construction of text (Onrubia & Engel, 2009). For all strategies, it is important that time is managed in an adequate way. Groups may thus need help to monitor their progress while they engage in the multiple cognitive activities involved with collaborative writing.

If these problems are not addressed and resolved in time, the collaborative process is hindered. The teacher plays an important role in monitoring and solving the occurrence of problems as will be explained below.

1.2. Teacher regulation of students' cognitive activities

The change toward the use of collaborative learning in education also requires changes on the part of teachers. In case of CSCL, teacher regulation takes shape by monitoring the learning activities of students as they independently work with other students on their group assignments, and intervening with feedback and assistance when needed (Anderson, Rourke, Garrison, & Archer, 2001; Kaendler et al., 2014). When the educational goals are to analyze, evaluate, and synthesize knowledge, leading the students towards interaction and experimentation, teacher regulation is more loose (Salinas, 2008; Vermunt & Vermetten, 2004). Even though there is more loose teacher regulation during CSCL, the teacher maintains an important role (Kaendler et al., 2014). One of the teacher's tasks is to monitor the occurrence of problems and to help to resolve them. When problems arise or students do not make enough progress, teachers can offer their assistance. Many researchers have tried to analyze the effects of teaching activities on learning outcomes or the quality of group products during CSCL (for example Hsieh & Tsai, 2012 and Onrubia & Engel, 2012, see Van Leeuwen, Janssen, Erkens, & Brekelmans, 2013, for an overview). From these studies, it appears that the effectiveness of teaching is largely determined by the adaptivity (content and timing) of teacher interventions (Gibbs & Simpson, 2004). Each group of students has different needs, to which the teacher should adapt (Van Leeuwen et al., 2013; Coll, Rochera, & de Gispert, 2014). Thus, as a result of correctly timed and correctly chosen interventions, teacher regulation of CSCL can effectively help collaborating groups.

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