Computers & Education 79 (2014) 28–39

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Supporting teachers in guiding collaborating students: Effects of learning analytics in CSCL

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ARTICLE INFO

Article history:
Received 17 March 2014
Received in revised form
16 July 2014
Accepted 17 July 2014
Available online 24 July 2014

Keywords:
Cooperative/collaborative learning
Evaluation of CAL systems
Interactive learning environments
Secondary education
Teaching/learning strategies

ABSTRACT

The aim of this study was to examine the effects of teacher supporting tools that present summaries, visualizations, and analyses of student participation and discussion on the way teachers guide collaborating groups of students in a digital learning environment. An experimental set-up was used in which authentic student data was converted to simulation vignettes that participants could interact with, enabling them to act as the teacher. The vignettes contained groups that had a problem concerning participation or discussion. When presented with the supporting tools, teachers and student teachers were better able to spot the problems regarding participation, intervened more often in problematic groups as time progressed, and displayed more specific explanations of their actions.

1. Introduction

Teachers increasingly use computer-supported learning in their classrooms to facilitate challenging activities such as collaboration among students. Computer-supported collaborative learning (CSCL) refers to settings in which students collaborate using computer technology (Stahl, Koschmann, & Suthers, 2006). Teachers need to assess students' activities to effectively guide students. During CSCL, students' activities (such as online discussion and working on task products) are usually logged and available for review. Because the amount of data can be quite large, it may be impossible for the teacher to read or interpret all available information (Borges & Baranauskas, 2003; Dyckhoff, Zielke, Bültmann, Chatti, & Schroeder, 2012). So called teacher supporting tools are specifically added to a digital learning environment to present summaries, visualizations, and analyses of student data to the teacher (Casamayor, Amandi, & Campo, 2009). Supporting tools are a form of *learning analytics*, which is defined as the analysis and reporting of educational data for the purpose of optimizing learning and the environment in which it occurs (Siemens & Gasevic, 2012). The present study examines how two supporting tools that focus on participation and discussion among students, affect teacher guidance behavior. First, the challenge of guiding students in CSCL is further described.

1.1. Challenges for teachers guiding CSCL

Teachers guiding CSCL have access to a multitude of student information. In synchronous settings specifically, the teacher is usually able to see who is online, what products are being worked on, and to read and follow the communication between students in multiple groups. On the one hand, the ability to monitor student activities in a real time fashion is experienced by teachers as a way to be involved with students' work and offers the possibility of dynamic, moment-to-moment assessment of learning processes (Asterhan & Schwarz, 2010b). On the other hand, large amounts of data give rise to the challenge of making sense of these data. Especially when the number of collaborating groups increases, the amount of available information may become a burden, causing what is called an information overload (Duval, 2011; Dyckhoff et al., 2012). As more information becomes available, the teacher's attention becomes more scarce (Duval, 2011). The

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http://dx.doi.org/10.1016/j.compedu.2014.07.007
0360-1315/

challenge to filter the relevant information and to stay up to date with the current activities may hinder the teacher's goal to effectively help students. To reach this goal, it is important that the teacher *diagnoses* a student's or a group of students' current level of competence (Van de Pol, Volman, & Beishuizen, 2010). Diagnosis precedes teacher *intervention*, and helps the teacher to decide on the appropriate action in a given situation, at the appropriate time. When information overload occurs, teachers might not be able to accurately diagnose student activities. Instead, the teacher's focus of attention and decisions to intervene may be solely based on previous experiences (Feldon, 2007), which could mean that interventions are not specifically tailored to the need of the learners at a specific moment.

Central to CSCL is the idea that learning takes place largely through collaboration among students (Stahl et al., 2006), for example by expressing and discussing thoughts. It is known that the occurrence of collaboration should not be taken for granted, and that problems may occur in the collaboration between students (Kreijns, Kirschner, & Jochems, 2003). Therefore, an important part of the teacher's task is to diagnose collaborative processes and to intervene when necessary. However, studies on teacher behavior in CSCL have indicated that teachers tend to focus *less* on collaborative aspects (e.g., student participation) than on cognitive aspects (e.g., quality of the group product that is being constructed) of student activities (Asterhan, 2011; De Smet, Van Keer, & Valcke, 2008; Van Leeuwen, Janssen, Erkens, & Brekelmans, 2013). A possible explanation is that some collaborative processes are not directly observable: they are related to *episodes* of activity instead of isolated events. For example, when one of the members of a group of students puts in less effort than the others, this may be hard to become aware of because it is a cumulative property of the collaboration. Collaborative processes can therefore be hard to monitor, requiring the teacher to form a diagnosis of student activities across multiple time points (Tabak, 2004).

1.2. How learning analytics tools may support teachers

A possible way to support teachers in monitoring and guiding student activities (including their collaboration) in CSCL is by enhancing digital environments with learning analytics tools (Casamayor et al., 2009). The traces left by student activities can be automatically collected, analyzed, and reported back to both students and teachers for the purpose of optimizing learning (Siemens & Gasevic, 2012). Learning analytics that are specifically aimed at supporting the teacher may serve a number of functions. They can be placed on a continuum of how much control or choice is left to the teacher (Duval, 2011): from providing overviews of data to suggesting particular actions to even undertaking those actions (for example by automatically sending a message to a student).

Concerning the issue outlined above, namely the challenge of diagnosing in particular the collaboration among students in a synchronous setting, teachers may be best helped by the addition of tools that support the process of diagnosing. Providing the teacher with summaries of the collaboration between students may lower the information load and free up time to spend on helping students. This information can complement the teacher's own knowledge and thus serves no prescriptive function; the teacher is free to decide whether or not to act on the information provided by the tools (Asterhan & Schwarz, 2010a). Having access to up-to-date information helps the teacher to decide whether intervention is necessary, and if so, which intervention is appropriate (Lajoie, 2005).

Supporting tools may be particularly useful to diagnose *collaboration*. Aggregating time-spanning collaborative events to a visible summary eliminates the necessity to observe all student activities to assess the quality of student collaboration. In this study, two of such supporting tools are used. They are aimed at two aspects which are considered prerequisites for good collaboration (Janssen, Erkens, & Kanselaar, 2007; Kreijns, Kirschner, & Vermeulen, 2013). First of all, it is important that all students *participate* and put in equal amounts of effort, because that way each student can contribute to the group process and engage in knowledge construction. Furthermore, on-task participation positively correlates with learning outcomes (Saab, Van Joolingen, & Van Hout-Wolters, 2007). Unequal distribution of activity of individual members within groups could thus lead to reduced productivity or reduced learning outcomes for at least some of the group members (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003). It was shown that providing students with a visualization of each group members' relative contribution led to increased student participation and increased coordination activities within groups (Janssen, Erkens, Kanselaar, & Jaspers, 2007). It is expected that showing such a visualization to teachers can be beneficial for students' learning processes as well, because the teacher can immediately see whether there is unequal distribution of activity and thus whether there is cause for further investigation or intervention within a group.

Secondly, the quality of students' *discussion* could be a problem. If students engage in discussions that are both critical and constructive, this can enhance learning (Rojas-Drummond & Zapata, 2004). However, during online discussion, it is sometimes the case that students do not critically reflect on each other's contributions and agree on everything (termed cumulative talk by Mercer, 2000), or the reverse, that students cannot reach an understanding and get stuck in a disagreement (also called disputational talk; Mercer, 2000). It is therefore important that teachers monitor the way students communicate. A possible way to support the teacher in doing so is by a tool called the Shared Space (SS, see Janssen, Erkens, & Kanselaar, 2007). The SS visualizes the degree to which students are in agreement or disagreement and when provided to students was shown to have an effect on their perceptions of the discussion (Janssen, Erkens, & Kanselaar, 2007). Again, our expectation is that this tool can be beneficial to the teacher as well by making visible an important property of discussion that otherwise would require the teacher to read students' utterances in an in-depth way. The SS serves as a summary of episodes of discussion that can help the teacher to monitor eventual problems.

Some researchers have expressed concern that instead of supporting the teacher, learning analytics tools add an extra layer of complexity (Sharples, 2013). Of course, the interpretation of supporting tools should not be a burden. The tools in this study are therefore offered as visualizations that are easy to interpret (Tergan & Keller, 2005), see Section 2.3.

1.3. Research question and hypotheses

The aim of this study is to examine the effects of two teacher supporting tools that offer moment-to-moment analysis of two properties of collaboration: participation and discussion. The effects are studied in terms of how teachers diagnose and intervene whilst guiding collaborating groups of students. An experimental setup was combined with the use of authentic classroom situations. Participating teachers are presented with CSCL simulation software that either contains supporting tools or contains no additional tools. Teachers are presented with student data in the form of fragments lasting several minutes that are drawn from authentic CSCL data. These fragments or vignettes are the same for participants in both conditions, thereby eliminating unpredictable classroom elements such as time pressure or