

Multidimensional Teacher Behavior in CSCL (1)

Anouschka van Leeuwen, Jeroen Janssen, Gijsbert Erkens, Mieke Brekelmans
 Utrecht University, Heidelberglaan 1, 3584CS Utrecht, the Netherlands
 A.vanLeeuwen@uu.nl, J.J.H.M.Janssen@uu.nl, G.Erkens@uu.nl, M.Brekelmans@uu.nl

Abstract: Situated in the field of computer-supported collaborative learning, the aim of this study is to present a multi-dimensional approach for the examination of teacher behavior. Two dimensions were used for coding: focus (what the intervention is aimed at) and means (how the teacher intervenes). Teacher behavior was studied for a period of several weeks. Our results indicate that both focus and means changed as time progressed, and that type of interventions varied between groups. Characterizing teacher behavior as a particular type, as done in other research, is therefore refuted. Conclusions that hold for the whole of the studied period are that number of teacher interventions was related to amount of student activity, and that the teacher focused more on task content than group collaboration. In the discussion suggestions are given for teacher supporting tools.

Introduction

Computer-supported collaborative learning (CSCL) combines collaborative learning with the use of information and communication technologies. There is a broad range of types of supporting tools specifically aimed at helping students carry out the learning task (Soller, Martinez, Jermann, & Muehlenbrock, 2005). In settings in which these tools are used, there often is no mention of the presence of a teacher, i.e., the students seemingly work on their assignment independently.

However, recently there has been a growing interest in the role of the teacher during CSCL. This has led to the development of supporting tools not only for students, but also for the teacher guiding the students (see for example the Argonaut project; Asterhan & Schwarz, 2010). These tools could deliver information that enables teachers to better carry out their tasks, for example about group progress or collaborative processes (McLaren, Scheuer, & Mikšátko, 2010).

To develop and test the effectiveness of supporting tools for teachers, there is a need to know what kind of behavior teachers employ, and what kind of behavior is effective. Many researchers have aimed at first studying which behavior teachers during CSCL display without any supporting tools present (Azevedo, Cromley, Winters, Moos, & Greene, 2005; Greiffenhagen, 2012; De Smet, Van Keer, & Valcke, 2008). What appears from these studies is that teachers face a very complex task (Volman, 2005). The present study aims to contribute to this knowledge base by using a multi-dimensional conceptualization of teacher activities, and by studying the variation in teacher activities between lessons and between groups.

Complexity of a Teacher's Task in CSCL

There are several reasons why the teacher's task of guiding students' learning in a CSCL environment is so complex. First of all, comparable to face-to-face collaborative situations, teachers deal with several types of synchronicity. Not only do they guide several groups' activities at the same time, they also have to focus on both task content and collaboration between students. Furthermore, differences between groups require the teacher to adapt his guidance to the groups' needs (Chiu, 2004). There are also complicating factors that are unique to CSCL. Teachers are offered information not only about the learning result but also about the learning *process*: teachers are able to follow discussions between students, and in some digital environments teachers are given information about students' progress. It may be easier for a teacher to monitor students' learning processes when given this extra information. On the other hand, having access to such amounts of information could also cause an information overload for the teacher (Van Diggelen, Janssen, & Overdijk, 2008).

Analyzing Teacher Interventions among Multiple Dimensions

As was mentioned in the introduction, many researchers have aimed at studying natural teacher behavior in CSCL. The content of teacher interventions is often studied using a one-dimensional conceptualization. When the content of teacher interventions is analyzed, it is almost always the case that each intervention is assigned to one particular category. That is, one dimension is used to categorize teacher interventions, and the categories within the dimension are mutually exclusive. In contrast, it could be argued that each intervention can be studied from multiple angles. In other words, each intervention can be categorized among multiple dimensions.

The content of a teacher's intervention both has a focus and a means. For example, when a teacher tells a group of students to "Start by reading the assignment", the focus is on the regulation of cognitive activities, while the means is an instruction. A similar difference between the 'what' (focus) and 'how' (means) of teacher interventions was also noticed in the literature about teacher regulation of face-to-face collaboration in a review study about scaffolding by Van de Pol, Beishuizen, and Volman (2010). Why is such a distinction useful? Van

de Pol et al. (2010) suggest that “this distinction [...] enables us to look more precisely at interactions and results in more nuanced descriptions of teacher–student interactions” (p. 276).

Very few studies on CSCL employ such a two dimensional analysis for the content of teacher interventions. Typically, the methodologies used are similar to either focus or means. Some studies approach the focus of teacher interventions, i.e. what the teacher’s intervention is aimed at. Lund (2004) for example includes the categories ‘Social’, ‘Managerial’, and ‘Pedagogical’. It is generally considered important for teachers to focus on students’ cognitive (task-related) activities as well as social activities within a group (Kreijns et al., 2003). Other studies approach the means of teacher interventions, i.e. how the teacher intervenes. Consider the study by Greiffenhagen (2012), in which the categories ‘Making announcements’, ‘Reminding’, and ‘Suggesting’ are used. Van de Pol et al. (2010) listed the categories of means that are most commonly identified: feeding back, hints, instructing, explaining, modeling, and questioning.

Change between Lessons and Variation between Groups

The research on teacher interventions described so far has a one-dimensional character in the sense that one aspect of the teacher’s task is analyzed (either focus or means). Another characteristic of these studies is that results are often presented on an aggregated level. That is, conclusions are drawn about teacher interventions at a general level. Some researchers aim to characterize particular teacher ‘types’ or ‘moderation profiles’ (Asterhan, 2011). For example, Mazzolini and Maddison (2003) distinguish between a dominating ‘sage on the stage’ and a less pervasive ‘guide on the side’, based on summaries of teacher interventions taken as a whole.

It should be kept in mind that in CSCL environments students often work on a complex assignment that takes multiple lessons to complete. Such tasks contain multiple phases during which students perform different kinds of activities (Erkens, Jaspers, Prangma, & Kanselaar, 2005). It is therefore likely that not only the students’ behavior, but also the type of teacher’s interventions change as the number of sessions progresses (Onrubia & Engel, 2012). This importance of time scales and temporality has recently received great attention in CSCL literature, leading to a movement that calls for a temporal analysis of interaction data. It is emphasized that “temporality matters” (Kapur, 2011; Reimann, 2009), both on a small scale in patterns of turn-taking within interaction and on a larger scale as change or variation between sessions or lessons. As Kapur (2011) notes, “By aggregating counts over time, information about temporal variation is lost” (p. 41). Too little is known yet about the change in teacher interventions between lessons and the variation of teacher interventions between groups.

Aim of this Study

Two methods have been pointed out that could contribute to a better understanding of the complex task teachers face when they guide students’ learning in a computer-supported collaborative learning environment. The first method is to analyze the content of teacher interventions on multiple dimensions: both focus and means. The second method is to analyze teacher interventions taking into account change between lessons and variation between groups. This study aims to bring together these two methods. A case study is presented in which the interventions by one teacher, spread over multiple weeks of activity, are analyzed. The aim is to contribute to the conceptualization of teacher interventions during CSCL, and to contribute empirically to the existing literature on the characteristics and dynamics of teacher interventions in CSCL. The following research questions have been formulated:

RQ1 Which interventions, in terms of focus and means, does the teacher use?

RQ2 How do teacher interventions, in terms of focus and means, change between lessons and vary between groups while students work on the assignment?

Method

Participants

One secondary education history male teacher (age 43, with 15 years teaching experience), and 21 students (age $M = 15$, $SD = 0.6$) were involved in the study, who were all enrolled in the third year of the pre-university education track. Students were assigned by the teacher into groups of three students (7 groups).

CSCL Environment

Students and teacher made use of the CSCL environment called Virtual Collaborative Research Institute (VCRI, see for example Janssen et al., 2007). It was used in a synchronous, co-located setting. All students had their own computer. The assignment involved exploring the topic by reading historical sources in the Sources-tool. Students could discuss the information through the synchronous Chat-tool. Students used the Debate-tool to construct a shared diagram of their arguments. Students used the Cowriter, a shared text processor, to write their texts.

An alternative interface of the VCRI-program was available for the teacher, which allowed him to monitor the online discussions of the students in the Chat-tool in real-time and send messages in order to answer students’ questions. Teachers can examine the texts students are writing in the Cowriter or the diagrams they are

making in the Debate-tool. The teacher intervened by sending messages through the Chat-tool. The program offered the teacher some basic statistical information about students' activities in VCRI's tools (e.g., the number of keystrokes per student). Figure 1 shows the teacher interface.

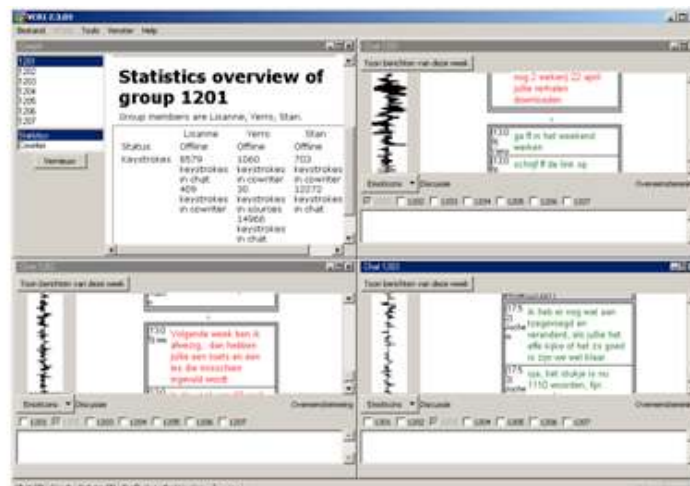


Figure 1. An example of the configuration of the VCRI teacher interface. In this case, the teacher has opened student activity statistics (upper left) and the *Chat*-tool for three of the groups.

Assignment

Students collaborated on a group task about the Cold War. It was an open-ended group task that focused on reading, comprehending, and synthesizing historical sources. The assignment was split into four parts, each resulting in an argumentative text written by the groups of students. The first two parts asked students to reflect on the consequences of World War II and the events during the Cold War. The third part required students to summarize their arguments in a graphical representation in the Debate-tool. This resulted in part four, a final text on why and how the Cold War ended. The class worked with VCRI for 8 lessons of 50 minutes.

Analysis of Teacher Interventions

Each of the teacher's interventions (messages) were coded along two dimensions: focus and means. The codes for focus (Table 1) are based on the distinction between cognitive and social activities, which are the two categories generally considered important for teachers to support students' learning process (Salmon, 2000). These two categories are further split into the object and the meta (regulative) level (Molenaar et al., 2011). Codes for means were derived from the review study by Van de Pol et al (2010). Their categories feeding back, hints, instructing, explaining, and questioning were used, and the category questioning was further expanded by adding diagnosing and prompting. Diagnosing denotes questions that are aimed at checking students' progress. Prompting denotes questions that are meant to help or activate students.

Two independent coders both coded a random sample of about 100 chat messages. Cohen's κ for focus was .77, for means it was .76. After establishing the interrater reliability of the coding procedure, all messages sent by the teacher were analyzed.

Table 1: Coding scheme for the focus of interventions.

Focus	Definiton	Example
Cognitive activities (Cog)	Utterances about task content	"SU means Sovjet Union"
Regulation of Cognitive activities (RegCog)	Utterances about planning of the task / time management Utterances about task strategies	"Start reading the sources"
Social activities (Soc)	Utterances that contribute to the mood within a group or the class or express emotions	"Come on, let's get to work"
Regulation of Social activities (RegSoc)	Utterances about the collaboration process / about strategies for collaboration	"Divide the tasks among your group"
Other	Remaining utterances	

Results

Overall Results

During the 8 lessons the teacher and students worked in VCRI, the teacher sent 391 interventions. Of these 391 interventions, 192 (49.1%) were reactions to student questions. The teacher used the system 6 times between lessons to read student contributions in the Cowriter tool. In every lesson the teacher checked the statistics right at the start of the lesson, and on average another 4 times during the remainder of the lesson.

Table 2 summarizes the focus and means of the teacher's interventions for all lessons taken together. The means used most often are Explaining (25.2%), Feedback (22.7%), and Diagnosing (20.1%). The focus of interventions was most on cognitive activities (41.8%), closely followed by focus on the regulation of cognitive activities (39.6%). Relatively few interventions were focused on (regulation of) social activities (together making up 15.1% of interventions).

Table 2: Focus (columns) and means (rows) of all 397 teacher interventions taken together, in percentages.

	Cog	RegCog	Soc	RegSoc	Other	Total
Questioning	0.3	0.0	0.8	0.0	0.0	1.0
Diagnosing	3.3	15.1	0.5	0.5	0.8	20.1
Prompting	11.3	0.0	0.0	1.0	0.0	12.3
Hinting	3.3	4.5	0.0	1.3	0.0	9.1
Explaining	16.1	6.1	0.0	1.0	2.0	25.2
Instructing	0.3	4.0	0.0	0.8	0.0	5.0
Feedback	7.1	9.6	4.0	1.8	0.3	22.7
Other	0.3	0.3	3.5	0.0	0.5	4.5
Total	41.8	39.6	8.8	6.3	3.5	100.0

Some groups were more active than others. It appeared that the higher student activity, the more teacher interventions to the group. Analysis of the individual lessons showed there was indeed a significant relationship between the number of student messages and the number of teacher interventions, $r = .38$, p (one-tailed) $< .01$.

Change between Lessons and Variation between Groups

Figure 2 and 3 display the focus and means of teacher interventions for each of the 8 lessons that students worked on the assignment.

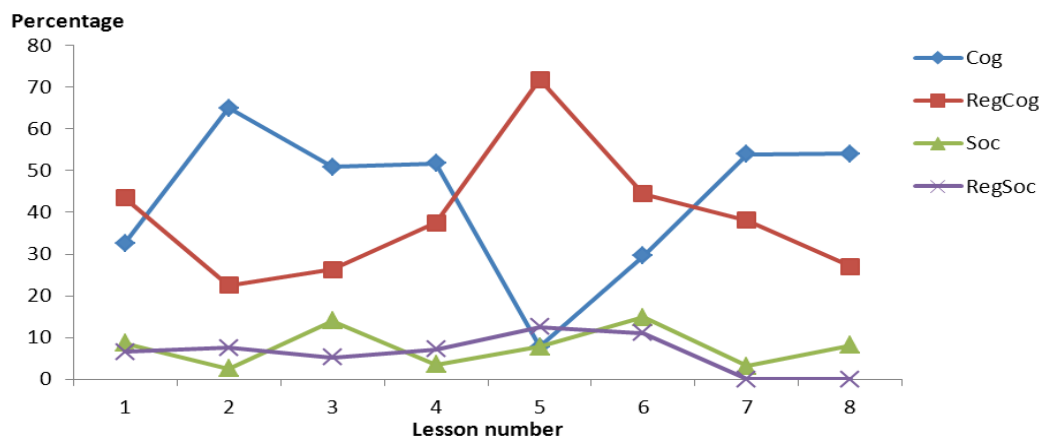


Figure 2. Focus of teacher interventions in percentages, displayed per lesson.

In line with the overall results, the focus is mostly on (regulation of) cognitive activities. However, the relative frequencies fluctuate for each lesson. For example, there is a strong predominance of focus on regulation of cognitive activities during the middle part. A relatively small portion of teacher interventions focused on (regulation of) social activities. These categories score low throughout all lessons. The variation between groups for these categories is relatively high. For example, the coefficient of variation for focus on regulation of social activities in lesson 3 is 1.3 where the corresponding score in Figure 2 is 5%. This means that the standard deviation was relatively high and that the teacher focused on regulation of social activities only in selected groups. The same can be said for the focus on regulation of social activities in later lessons (5 and 6).

As for the means (Figure 3), the most occurring categories found in the overall results (Explaining, Feedback, Diagnosing) are not predominant when viewing each lesson separately. For example, the relative frequency of Explaining is especially low during the middle part, and the relative frequency of Feedback is quite low at the beginning. The other way around it is apparent that categories that score relatively low overall, like Instructing (5% of total), occur relatively often during some lessons. For example, Instructing reaching 20% during the middle part (lesson 6). It thus seems there is a change in the type of interventions as time progresses.

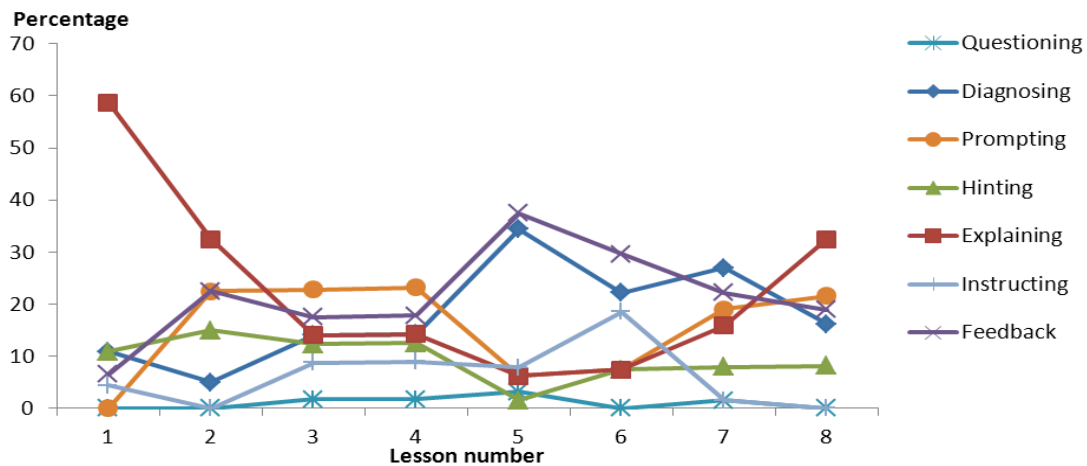


Figure 3. Means of teacher interventions in percentages, displayed per lesson.

Below, some examples of teacher-student interaction are given to illustrate the change between lessons and the variation between groups.

Example Lesson 1: Explaining

At the start of working with VCRI, there is a peak of Explaining (Figure 3). The focus of the teacher’s interventions is equally distributed among cognitive activities and the regulation of cognitive activities (Figure 2). In the first lessons lesson, the teacher explains how to start working and he also explains some basic concepts that students need throughout the assignment. There are also some explanations that deal with the program itself.

Example Lesson 3: Prompting

Next, a period follows in which there is more focus on cognitive activities (Figure 2). The teacher uses more open forms of interventions, such as Prompting (Figure 3). In Table 3, the students are discussing the results of the Second World War. Instead of giving away the answer, the teacher responds by posting counter questions.

Table 3: Example of teacher interventions during lesson 3.

User	Message	Focus	Means
Student 3	I can’t find any reports on damage to the US after WOII		
Teacher	If you can’t find it, maybe there isn’t any? Where did they fight?	Cognitive activities	Prompting
Student 3	the pacific?		
Teacher	What does that mean?	Cognitive activities	Prompting

Example Lesson 5: Diagnosing

In lesson 5 there is a peak in focus on Regulation of cognitive activities (Figure 2) as well as a peak in Diagnosing and Feedback (Figure 3). Looking at the chat protocols, there are two things that the teacher is paying attention to. First of all, he is checking how the groups are doing in terms of progress on the assignment and instructing them to move on to the next part. Secondly, in one of the small groups, it appears there is a collaborative problem (Table 4). One student has been absent for a few lessons and has contributed less to finishing the assignment. The teacher does not think this is a valid reason for lagging on the assignment and tells the students to improve their collaboration.

Table 4: Example of teacher interventions during lesson 5.

User	Message	Focus	Means
Teacher	Have you finished part 2?	Regulation of cognitive activities	Diagnosing
Student 2	no, because sally has been absent the last two lessons		
Teacher	You are perfectly able to finish the assignment without her, I think	Regulation of social activities	Feedback
Student 3	She has written something I don't understand		
Teacher	You're working as a team, so everyone is responsible for the assignment	Regulation of social activities	Feedback

Example Lesson 7: Cognitive Activities

After the dip in focus on cognitive activities, the final lessons show an increase in focus on this area again (Figure 2). The means used in lesson 7 are varied (Figure 3). The chat protocols show that during lesson 7, there is again more time spent on the content of the task. Students start the final part of the assignment, which also accounts for the increase in Explaining.

Discussion

It was argued that an adequate description of teacher interventions during CSCL warrants a multi-dimensional and temporal analysis. In this study, focus and means of teacher interventions were analyzed and compared between lessons and between groups.

Focus

The results show that overall, the focus was mostly on (regulation of) cognitive activities. Within the individual lessons, this dominance was also visible. However, the relative frequencies fluctuated for each lesson. The number of teacher interventions focusing on (regulation of) social activities was much lower, reaching a maximum percentage of about 15%. There was little change between lessons, but large variation between groups. The results from other studies do not uniformly fit with our findings. Asterhan (2011) for example found no instance of social support at all, only interventions aimed at (regulation of) cognitive activities. De Smet et al. (2008) on the other hand found comparable low frequencies for focus on social activities, which increased at the end of the studied period. This contradicts our finding of low variability between lessons.

Many researchers have pointed out the importance of social activities within collaborating groups (Kreijns et al., 2003; Salmon, 2000). From our data it appears that the need to focus on social activities may have been small. A possible explanation for this is that in contrast to distant learning and asynchronous settings, the students in this study already knew each other very well. Therefore, the teacher only intervened when this was absolutely necessary. However, it could be argued that even when there are no apparent problems, it is important that a teacher focuses on the social processes during collaboration and makes students aware of their individual and group behavior (Phielix, Prins, & Kirschner, 2010).

Means

The results of this study show that the means most often used were feedback, explaining, and diagnosing. It must be noted that there was variation between lessons (see Figure 3) and that the general percentages are not an accurate depiction of this variation. Some time periods showed high percentages of open forms of interventions (lessons 2 and 3) while in others closed forms were used more often (for example lesson 6).

Again, it seems the teacher's interventions were group-specific. For example, in the first lessons there were a lot of explanations. It may have been expected that this was due to getting used to working in a CSCL setting, but it turned out that not so much the system, but the assignment needed more attention. In the Results section this was illustrated with some examples. Research has shown that if the task materials exert more control, that is, contain more detailed instructions for carrying out the task, the teacher might need less closed forms of interventions (Onrubia & Engel, 2012). In this case, the task might have exerted a very low amount of control, therefore eliciting more explanations from the teacher.

The change between lessons is consistent with other studies that have studied teacher interventions on multiple time points (albeit with fewer time points than in this study). Hsieh & Tsai (2012) found that means of teacher interventions varied during the three sessions students collaborated. However, the three sessions dealt with separate assignments, not an ongoing assignment like in our study. Gil et al. (2007) divided the data on teacher interventions in three phases; beginning, middle and end, and found differing distributions of means of intervening for each of the five teachers that were studied.

Implications

The combination of coding both focus and means has resulted in a nuanced description of teacher interventions. Although there were some indications of patterns, the general finding is that this teacher's interventions are foremost explained by sensitivity to group needs. Generalizations of teacher behavior into 'types' (Mazzolini & Maddison, 2003) or 'moderation profiles' (Asterhan, 2011) do not reflect the whole complexity of the teacher's task. It is clear from our data that the teacher's method of regulation was not the same throughout the whole timeframe. Instead, it seems the teacher's behavior was context-specific.

Some suggestions may be made about the type of supporting tools to be developed, based on the results presented here. The first suggestion would be to support teachers in monitoring the social activities of groups of students. The benefits of presenting visualizations of agreement and discussion processes to students have already been investigated (Janssen et al., 2007). Studying whether teacher access to such visualizations has an effect on teacher and student behavior would be an interesting step forwards.

A further suggestion for supporting tools is based on the high amount of Diagnosing interventions performed by the teacher in the current study. Interviews with teachers have shown that one of the main difficulties of guiding students during CSCL is keeping track of all information (De Smet, Van Keer, De Wever, & Valcke, 2009; Van Diggelen et al., 2008). Our results show that the frequency of Diagnosing increased as time progressed. This may have been due to the fact that in the last part of the assignment, the students started writing their final essay. It may have been harder for the teacher during this part to monitor the progress within the groups. This is supported by the fact that 20% of the interventions that the teacher sent to the whole class simultaneously were Diagnosing interventions. Therefore, teachers may benefit from tools that provide information on the status and quality of written products (Dillenbourg, Järvelä, & Fischer, 2009).

Limitations and Future Directions

An obvious limitation of this study is that only one teacher's interventions were analyzed. It is important that more studies are performed within this area, especially ones that have an experimental set-up. On the other hand, case studies do provide the opportunity to study the subject in great detail, which was exactly the aim of this study. Furthermore, in this particular article the conceptualization of teacher interventions also played a big role, which makes the number of participants a less important issue. Another limitation is that although we have described the complexity of studying the content of teacher interventions, there are many more aspects that play a role during CSCL. For example, we briefly stated that in our study, 49.1% of teacher interventions were initiated by a question from a student. Onrubio & Engel (2012) further expand on whether the teacher or the student initiates the conversation. A challenge for future research is to connect all aspects into a coherent image.

Conclusion

The ultimate conclusion that emerges from this study is that the teacher displayed a wide range of types of interventions. Some reasons for this variation were to be expected, such as the peak of explanations and the focus on regulation of cognitive activities at the start of the assignment, while others were highly group specific, such as the need to end a fight between students. We argue for studying teacher interventions as a reaction to the current situation, not as an expression of the teacher's "style". As Schwarz & Asterhan (2011) note, all teacher interventions are useful "as long as they are attuned to the needs of the group and its individual members at that time" (p. 436).

The starting point of this study was the premise that combining focus and means would lead to a more nuanced view of teacher interventions (Van de Pol et al., 2010) and the complex task that teachers face during CSCL. Each of the dimensions on its own indicated clear differences between lessons and between groups, but taken together a broader perspective emerged that pointed to several points of interest in the data.

It is important that a clear picture is obtained of the complexity of a teacher's task to regulate students' learning during CSCL, not only for theoretical purposes, but also for practical reasons. Ultimately, CSCL environments may be designed that not only support students, but also the teacher. By summarizing student activity, for example, the teacher's task of Diagnosing could become easier (Dillenbourg, Järvelä, & Fischer, 2009). Gaining a complete view of what a teacher does by using appropriate methods of analysis, is the first step towards this goal.

Endnotes

- (1) An extended version of this paper was published as: Van Leeuwen, A., Janssen, J., Erkens, G., & Brekelmans, M. (2013). Teacher interventions in a synchronous, co-located CSCL setting: analyzing focus, means, and temporality. *Computers in Human Behavior*, 29(4), 1377-1386. doi:10.1016/j.chb.2013.01.028

References

- Asterhan, C. (2011). Assessing e-moderation behavior from synchronous discussion protocols with a multi-dimensional methodology. *Computers in Human Behavior*, 27(1), 449-458.

- Asterhan, C., & Schwarz, B. (2010). Online moderation of synchronous e-argumentation. *International Journal of CSCL*, 5, 259-282.
- Azevedo, R., Cromley, J. G., Winters, F. I., Moos, D. C., & Greene, J. A. (2005). Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia. *Instructional Science*, 33, 381-412.
- Chiu, M.M. (2004). Adapting teacher interventions to student needs during cooperative learning: how to improve student problem solving and time on-task. *American Ed Research Journal*, 41(2), 365-399.
- De Smet, M., Van Keer, H., Valcke, M. (2008). Blending asynchronous discussion groups and peer tutoring in higher education: An exploratory study of online peer tutoring behavior. *Computers & Education*, 50(1), 207-223.
- De Smet, M., Van Keer, H., De Wever, B., & Valcke, M. (2009). Studying thought processes of online peer tutors through stimulated-recall interviews. *Higher Education*, 59(5), 645-661.
- Dillenbourg, P., Järvelä, S., & Fischer, F. (2009). The Evolution of Research on Computer-Supported Collaborative Learning: From Design to Orchestration. In N. Balacheff, S. Ludvigsen, T. de Jong, A. Lazonder, S. Barnes (Eds.), *Technology enhanced learning: Principles and products* (pp. 3-19).
- Erkens, G., Jaspers, J., Prangma, M., & Kanselaar, G. (2005). Coordination processes in computer supported collaborative writing. *Computers in Human Behavior*, 21(3), 463-486.
- Gil, J., Schwarz, B. B., & Asterhan, C. (2007). Intuitive moderation styles and beliefs of teachers in CSCLbased argumentation. In C.A. Chinn, G. Erkens & S. Puntambekar (Eds.), *Mice, minds and society. Proceedings of the CSCL Conference* (p. 219-228). International Society of the Learning Sciences, Inc.
- Greiffenhagen, C. (2012). Making rounds: The routine work of the teacher during collaborative learning with computers. *International Journal of CSCL*, 7(1), 11-42.
- Hsieh, Y. & Tsai, C. (2012). The effect of moderator's facilitative strategies on online synchronous discussions. *Computers in Human Behavior*, 28(5), 1708-1716.
- Janssen, J., Erkens, G., & Kanselaar, G. (2007). Visualization of agreement and discussion processes during computer-supported collaborative learning. *Computers in Human Behavior*, 23, 1105-1125.
- Kapur, M. (2011). Temporality matters: Advancing a method for analyzing problem-solving processes in a computer-supported collaborative environment. *International Journal of CSCL*, 6(1), 39-56.
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments. *Computers in Human Behavior*, 19, 335-353.
- Lund, K. (2004). Human support in CSCL: What, for whom and by whom? In J.W. Srijbos, P.A. Kirschner, R.L. Martens, & P. Dillenbourg (Eds.), *What we know about CSCL and implementing it in higher education* (Vol. 3, pp. 167-198). Norwell, MA: Kluwer Academic Publishers.
- Mazzolini, M., & Maddison, S. (2003). Sage, guide or ghost? the effect of instructor intervention on student participation in online discussion forums. *Computers & Education*, 40, 237-253.
- McLaren, B. M., Scheuer, O., & Mikšátko, J. (2010). Supporting Collaborative Learning and E-Discussions Using Artificial Intelligence Techniques. *International Journal of AI in Education*, 20, 1-46.
- Molenaar, I., van Boxtel, C. & Slegers, P. J. C. (2011). Metacognitive scaffolding in an innovative learning arrangement. *Instructional Science*, 39, 785-803.
- Onrubia, J., & Engel, A. (2012). The role of teacher assistance on the effects of a macro-script in collaborative writing tasks. *International Journal of CSCL*, 7(1), 161-186.
- Phielix, C., Prins, F. J., & Kirschner, P. A. (2010). Awareness of group performance in a CSCL environment: Effects of peer feedback and reflection. *Computers in Human Behavior*, 26, 151-161.
- Reimann, P. (2009). Time is precious: Variable- and event-centred approaches to process analysis in CSCL research. *International Journal of CSCL*, 4(3), 239-257.
- Salmon, G. (2000). *E-moderating. The key to teaching and learning online*. London: Kogan Page.
- Schwarz, B., & Asterhan, C. (2011). E-Moderation of Synchronous Discussions in Educational Settings: A Nascent Practice. *Journal of the Learning Sciences*, 20(3), 395-442.
- Soller, A., Martinez, A., Jermann, P., and Muehlenbrock, M. (2005). From mirroring to guiding: A review of state of the art technology for supporting collaborative learning. *International Journal of AI in Education*, 15, 261-290.
- Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review*, 22, 271-296.
- Van Diggelen, W., Janssen, J., & Overdijk, M. (2008). Analysing and presenting interaction data: a teacher, student and researcher perspective. ICLS'08 Proceedings of the 8th international conference on International conference for the learning sciences - Volume 3.
- Volman, M. (2005). A variety of roles for a new type of teacher: Educational technology and the teaching profession. *Teaching and Teacher Education*, 21, 15-31.