Small-group Face-to-Face Discussions in the Classroom: A New Direction of CSCL Research

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Abstract: This paper presents a relatively new direction of CSCL research: small-group learning *in* the classroom. This research direction has received relatively little attention within the CSCL community. In this paper we explore the possibilities of collaborative technology in the classroom. We use the distinction between task-related and social-emotional interactions as a criterion for computer support. It is hypothesized that the students will use the collaborative technology purely for task-related interactions when the characteristics of the tool closely match the conditions for an effective task performance. It is assumed that these task-related interactions stimulate knowledge elaboration and learning within the student group. Our findings indicate that all computer-mediated interactions were task-related and facilitated knowledge elaboration. Oral communication was about the social-emotional aspects of the collaboration, and the planning and regulation of the collaborative activities.

Introduction

Small-group learning refers to the *intelligent* social practice of a group of students who work together on a common task. The denomination 'intelligent' emphasizes that the group has the ability to alter their learning activities in response to past experiences, new information or divergent perspectives. This ability cannot be traced back solely to individual cognition but rather emerges from students' interactions. It is assumed that, *under the right conditions*, students may benefit from their collaboration and will outperform students who learn alone. Small-group learning as an instructional method demands a lot from the students. Students have to work together on a common task, often without close guidance from the teacher. They have to deal with various problems, cognitive as well as social in nature. It is assumed that use of computers may help the students to overcome some of these problems. Computers could facilitate collaboration and learning within the group and it may support the students to achieve their learning goals.

A wide variety of computer applications has been developed to support small-group learning. These tools stimulate specific cognitions and behaviors that are expected to be beneficial for learning. We distinguish three small-group learning situations for computer support (Figure 1). Our categorization is based on one type of collaborative learning practice: problem-solving discussions. It underlines that small-group learning is generally organized around a problem-solving task and that it takes its shape as a *problem-solving discussion*.

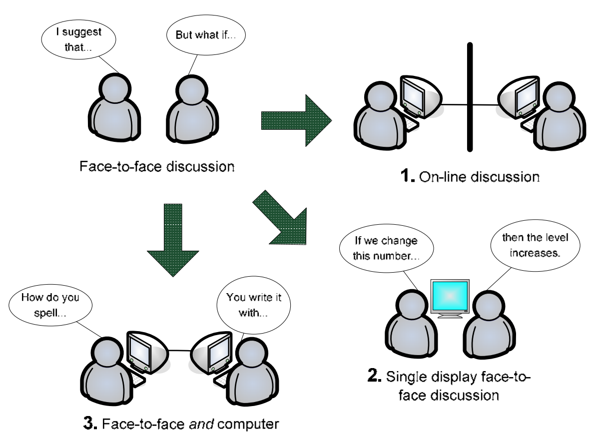


Figure 1. Three situations of computer support for small-group learning

The first situation (upper right corner of Figure 1) refers to the use of computers to connect students who are dispersed in time and/or space. The majority of CSCL research focuses on this type of situation where *all* the interactions are mediated by the technology. For many researchers, this represents the archetypal CSCL research context. The other two situations of figure 1 have a fundamentally different orientation. They consider the existing classroom context as taken for granted. These situations have two distinctive features: 1) students are in the same room in close proximity and 2) they communicate face-to-face. The *second situation* (lower right corner of Figure 1) represents a situation where students are co-located and work with a stand-alone computer application. These applications typically model a problem situation that the students have to investigate. Such computer models display processes that change with respect to time. Students can manipulate the model and get feedback about their intervention by running a simulation. This form of CSCL – sometimes referred to as '*single-display groupware*' – has received some investment in terms of research. The *third situation* represents a learning environment where students communicate face-to-face *and* simultaneously use a collaborative technology. It means that one part of their communication will be face-to-face, while the other part will be computer-mediated. This situation is the object of our study.

The combination of face-to-face and computer-mediated communication is largely ignored by the CSCL community. CSCL research mainly focuses on situations like distance collaboration, online learning and virtual teaching where the support is primary considered as a means to bridge time and space between the students. Overcoming time and space limitations has a direct added value, but it also leads to a specific focus. It considers group interaction, in its broadest sense, as the main determinant for collaboration and learning. However, research into distance learning indicates that it is extremely difficult to facilitate the full range of group interactions by collaborative technologies. Computer-mediated interactions are often restricted to those interactions that mirror the cognitive processes in a group (Kreijns, Kirschner and Jochems, 2003). An enrichment of the information flow may improve online collaborative learning: for example, students may use multiple tools simultaneously to enrich their communication, or they may use an awareness tool that provides them with detailed information about their performance. The aim of these interventions is to broaden the range of cognitions and behaviors that are necessary for collaborative learning. They seem to reflect 'a return' to the richness of face-to-face communication. Still, it remains unclear if online collaboration can *and* should mirror its face-to-face counterpart. Research into computer supported collaborative work (CSCW) seems to indicate otherwise (Olson & Olson, 2000; Kiesler & Cummings, 2002).

We will argue that the partial orientation on online collaborative learning may limit our understanding of the potentials of computer support. We would like to stress that most learning still takes place in classrooms where the students are located near each other and collaborate face-to-face. Ignoring these face-to-face classroom situations would deprive the CSCL community of a promising direction for research and development. We will present an exploratory study to indicate that collaborative technologies may also be beneficial in situations where the students are co-allocated (1).

Problem-solving discussions in the classroom

Small-group learning has traditionally been studied in classroom settings where students meet face-to-face to solve problems. (for an overview, see e.g., Cohen, 1994; Webb & Palincsar, 1996; Slavin, Hurley & Chamberlain, 2003). Small-group learning is often conceptualized as a *problem-solving discussion* between a group of students. Problem-solving discussions generally consist of several interrelated phases that are directed towards the resolution of a particular problem. Problem-solving discussions can be dynamic, difficult to grasp and hard to manage. Students who solve a problem collaboratively have to manage different kinds of processes. On a general level, two processes can be identified: students have to *solve the problem* and they must *maintain a satisfying level of collaboration*. These two processes are associated with two distinct types of interactions, i.e. task-related and social-emotional interactions (Bales, 1950).

Solving the problem: task-related interactions

The first requirement – solving the problems –requires a lot from the cognitive abilities of the students, especially in the case of ill-structured or ill-defined problems. These types of problems don't fulfill the rational, goal-directed strategies that are associated with cognitive analysis of human problem solving. They refer to situations where it isn't clear at the beginning what the problem exactly is *and* which actions may lead to the solution of the problem. The cognitive processes that underlie the problem-solving activities of the group are difficult to model and open to different interpretations. Solving these problems requires the application of multiple perspectives and mutual knowledge. Different perspectives and mutual knowledge create opportunities for higher-order thinking (Schwartz, 1995). The group processes that relate to 'solving the problem' emerge from the *task-related interactions* within the group. They are used to explicate the task processes in groups. It enables group members to share and use knowledge and information that are directly related to task performance (Propp, 1999).

Group well-being: social-emotional interactions

A second complicated factor has to do with maintaining a satisfying level of collaboration. When students collaborate they have to maintain durable relationships and acceptable levels of participation. Interactions that are associated with these aspects of the group performance can be typified as *social-emotional interactions*. These interactions are primarily directed towards the relationship between group members. They affect student's perception of the other group members and the relationships they form (Propp, 1999). The minimal number of categories of social-emotional interactions would include control and affection (Hare, 1960).

Facilitating collaborative learning

A shift from online towards face-to-face collaborative learning brings along a shift in the kind of interactions that should be mediated by the computer. Online collaborative learning seems to reflect an attitude of *'more support is better'*, i.e. a richer information flow between the students is seen as a guarantee for collaboration and learning. In contrast, the starting point for face-to-face collaborative learning is fundamentally different: students can already communicate *without* the support of computers. This observation draws the attention to those interactions that can be facilitated by the collaborative technology *and* that would improve learning. It seems that "*less but specific support*" is the leading principle. When the students work with the collaborative tool, their interactions will be distributed between the two modes of communication, i.e. an oral, face-to-face and an electronic, computer mediated part. At least two questions have to be addressed when collaborative technologies are introduced this setting:

- What are the characteristics of an effective face-to-face problem-solving discussion in the classroom?
- How can a collaborative technology, that mediates part of the communication between the students, improve a face-to-face discussion?

Effective face-to-face discussions

We will use the distinction between task-related and social-emotional interactions as a criterion for qualifying group discussions and to identify requirements for computer support. It is assumed that the students may benefit from a clear distinction between task-related and social-emotional interactions. Task-related interactions are associated with learning. It leads to cognitive activities often referred to as knowledge elaborations, which, in turn, are responsible for knowledge acquisition (Draskovic, Holdrinet, Bulte, Bolhuis & Leeuwe, 2004). This would imply that the students should be encouraged to perform their task-related interactions within the shared workspace of the collaborative tool. It is hypothesized that this could be achieved by a design that closely matches the characteristics of effective task performance. Students will use the tool purely for task-related communication when the characteristics of the tool facilitate the problem solving.

Computer mediated interactions

One type of task-related interaction that has been associated with learning is "asking questions". The aim of asking a question is to elicit a verbal response from those to whom the question is addressed (Keatsley, 1976). Students may be encouraged to elaborate on existing knowledge when they ask questions. Knowledge elaboration, on its turn, facilitates the acquisition of that knowledge (King, 1994). It is hypothesized that both 'asking questions' and 'making comments' would stimulate a constructive problem-solving discussion between the students. Asking question and giving comments may encourage the students to elaborate further on a topic by exhibiting behaviors like giving examples to explain an idea; providing evidence for a statement or giving reasons as grounds for a conclusion. Both communicative acts have the function to elicit a response. A question is more explicit in triggering a response. Making a comment expresses of a reaction that, on it turn, may trigger a response from the 'listener'.

To summarize, we identify to following principles and hypotheses with regard to computer supported collaborative learning in the classroom:

- The task-related interactions will lead to knowledge elaborations.
- Students will use the collaborative tool for task-related interactions when this tool is designed in such a way that it closely matches the conditions for effective task performance.

- A collaborative tool that stimulates task-related interactions like ‘asking questions’ and ‘making comments’ would stimulate a constructive problem-solving discussion.

These principles and hypotheses are “translated” into the collaborative tool as design principles. These design principles will be evaluated in practice. The evaluation of these principles implies a test of the principles and hypotheses that underlie the design. It means that we can draw conclusions about these principles and hypothesis through the evaluation of the design. The design activities, in our study, are a natural continuation of the theory development activities. The principles and hypothesis that we discussed are made applicable for evaluation through the design.

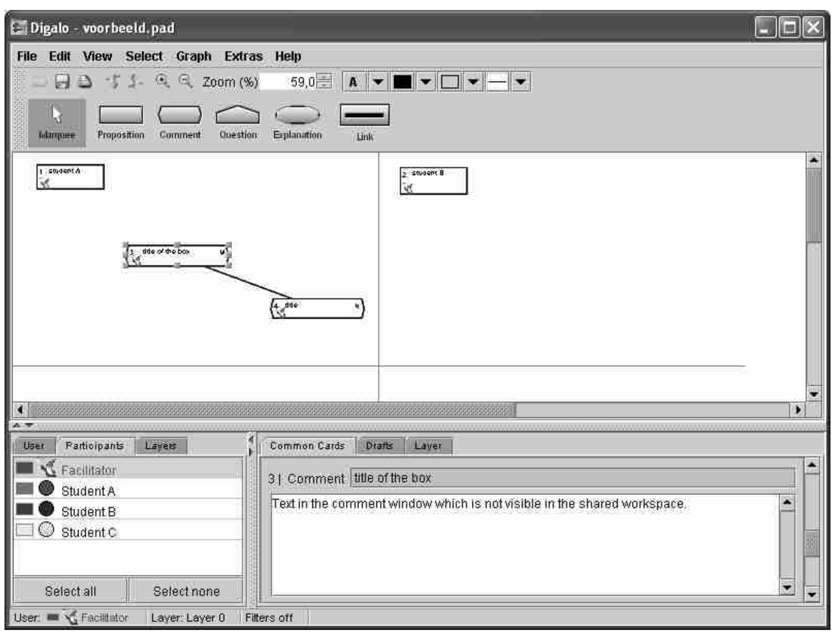
Design research

Our research approach is in accordance with the “design research” approach. Design research combines theory-driven design with empirical educational research. The approach entails both ‘engineering’ particular forms of learning *and* systematically studying those forms of learning within the context defined by the means of supporting them (Cobb, Confrey, diSessa, Lehrer & Schauble, 2003). It explicitly exploits the design process as an opportunity to advance researchers’ understanding of learning processes (Edelson, 2002).

For our research we used a graphical shared-workspace tool: the Digalo. We expected that the Digalo would stimulate task-related interactions that will lead to knowledge elaboration. We used the two communicative acts – i.e. asking questions and making comments – as a starting point for our design. They were implemented in the notation system of the Digalo.

Digalo: The graphical shared-workspace tool

The Digalo tool provides its users with a shared workspace based on a concept-mapping interface (Figure 2). Users can put forward contributions simultaneously into a shared workspace by using a predefined notation system. They can also relate associated contributions by drawing a link between these contributions.



<u>Figure 2.</u> User interface of the Digalo tool

A notation system consists of a set of labels or contribution cards that represents certain communicative acts. The notation system that the students used in our study consists of three labels: 1) proposal, 2) question, and 3) comment. A student has to select a label before she types in a text and places that text in the shared workspace. Different types of contributions could be identified in the shared workspace by their shape. The student may want to type in more text than the shape could contain. In that case could the student can type in additional text in the comment window. The additional text becomes visible when a student selects a contribution – i.e. shape – in the shared workspace.

Methodology

The research that we discuss in this paper has been carried out at a secondary school with a class of 5th grade students of a Dutch language course. The class consists of 19 students, divided over groups of two or three members. The seven groups had to write a paper for the school's board of directors. The paper should contain an advice about how to promote a respectful discourse in the classroom. The policy note was a group product. The pedagogical objectives associated with the assignment were:

- developing discussion skills with an emphasis on analytical and argumentative skills,
- developing collaborative skills,
- developing writing skills.

Our study discusses the third lesson of a sequence of 6 lessons where the students worked on the assignments. The third lesson consisted of two activities: 1) each student had to formulate a proposal about how the school should improve a respectful discourse and 2) the students should discuss the proposals with their group members. Each group of students formulated and discussed their proposal with the support of the Digalo. The students sat near each other so that they could communicate face-to-face.

Micro analysis of the Digalo mediated actions

We have two sources of data for analysis: 1) audio recordings of verbal interaction during the discussion, and 2) the Digalo mediated actions of the students that were recorded by the tool. Our analysis of the Digalo mediated actions were divided into two parts. First, we identified the sequences of related communicative acts. We used graphical characteristics of the diagram to identify the interaction sequences. Second, we coded the individual communicative acts of the students. We develop a coding schema that focused on the task-related interactions.

Interaction sequences

We focus our analysis on the interaction sequence that consists of related communicative actions from several students. A sequence consists of minimal three related actions. Weick (1979) defines such a sequence as a double interact. An action by actor A evokes a specific response in actor B, which is then responded to by actor A (Weick, 1979). The minimal amount of actions to make up a sequence consists of *at least three related* contributions from at least two different students. The diagrams that represent the problem solving discussion of the students are used to (re)organize the contributions for coding. To identify the interaction sequences we used two of the three organizing principles – link and spatial grouping – that the students used to organize their diagrams (van Diggelen, Overdijk & Andriessen, 2004). The linking principle refers to the possibility to draw a link between related contributions. The spatial grouping principle underlines that contributions that are displayed in close proximity from each other, are related.

Individual communicative acts

We identified six different categories of actions that can be associated with the in-depth elaboration of knowledge (Hargie & Dickson, 2004; King, 1994; Pena-Shaff & Nicholls, 2004). The six categories were associated with the two types of contributions within the Digalo environment – question and comment – that stimulate elaboration (see Table 1):

- Specify,
- Inference,
- Judgment and evaluation,
- Application,
- Comparison and contrast,
- Conflict.

A final category consists of non-task communication. Each sentence that was put forward in Digalo – *and* is part of an interaction sequence – was coded by two coders (interrater reliability 0.9). We choose the sentence as basic unit of analysis because a contribution generally consisted of several sentences and students sometimes addressed several topics in one contribution. The contributions that were linked with other contributions were organized into a sequence of related contributions. These sequences were presented to the raters. Each contribution was then analyzed on the level of sentences.

Table 1: Coding scheme

Communicate act		**Code**	**Description**
Question *Evoke a response to provide unknown information or to rethink a previous action or response*	Specify	Qspe	Encourage respondents to examine an idea in more detail by drawing attention to a neglected aspect of the idea.
	Inference	Qinf	Encourage respondents to give evidence, arguments or reasons (causes and consequences) or to reach a conclusion based on evidence, arguments or reasons.
	Judgment and evaluation	Qjud	Encourage respondents to give an opinion, make value-judgments or judge the relevance of solutions.
	Application	Qapp	Encourage respondents to provide examples, i.e. concrete or specific instances of an idea or thought
	Comparison and contrast	Qcom	Encourage respondents to consider similarities and differences between situations.
	Conflict	Qconfl	Encourage respondents to consider alternative or opposite point of views or positions.
Comment *Express an opinion or a response*	Specify	Cspe	Provide a more detailed analysis or a clarification of ideas and thoughts
	Inference	Cinf	Provide evidence, arguments or reasons, reach conclusions or make predictions
	Judgment and evaluation	Cjud	Express an opinion, make value-judgments or judge the relevance of solutions, listing advantages and disadvantages
	Application	Capp	Using examples, i.e. concrete and specific instances of an idea or thought
	Comparison and contrast	Ccom	Compare two situations to present similarities and differences, identify assumptions
	Conflict	Cconfl	Defending one's point of view or position by argumentation or further elaboration
Others		O	non-task communication

Results

The aim of our analysis it to explore how the interactions between the students split up in an oral and a computer- mediated part. With regard to the computer-mediated part we also want to explore how the characteristics of the tool affect the interactions within the tool. Two characteristics will be highlighted: the notation system and the ability to relate associated contributions into a sequence of communicative acts.

The interplay between face-to-face and computer mediated interactions

The Digalo tool in combination with face-to-face interaction led to a typical kind of problem-solving discussion. All the task-related interactions were mediated by the tool. All utterances expressed in the Digalo concerned the topical content of the discussion. This in contrast to research findings with regard to research of online collaborative learning, where a considerable amount of the messages is of a social-emotional or meta-cognitive nature (e.g. Pena-Shaff and Nicholls, 2004; Hara, Bonk and Angeli, 2000). This difference in findings may be due to the fact that in our research the students were co-located and could also communicate orally.

Analysis of the recorded face-to-face discussions reveals that this mode of communication was used infrequently. Students could be silent for 2 to 3 minutes. When they did communicate orally, their utterances referred to:

- socio-emotional aspects of the collaboration, e.g. asking for help, tension release by telling a joke, giving positive feedback, keeping group members focused on the task;
- planning of the activities, e.g. discussing the assignment;
- regulative aspects of the collaboration, e.g. discussing rules for computer-mediated interactions.

We may conclude that the face-to-face communication involved more than only social-emotional expressions. It also contained procedural messages that encompass the establishment and maintenance of procedures and rules for arriving at a solution and goal-related expressions that pertain to establishment and monitoring of group goals and values (see e.g. Poole and Hirokawa, 1996).

Notation system

Figure 3 gives the percentages of utterances for each category of the coding scheme (see table 1) that represent different aspects of 'in-depth elaboration' of knowledge. The students mainly asked "specifying questions" (18% of all statements) that encourage respondents to examine an idea in more detail. The comments that the students made are more diverse: students gave a more detailed account of their ideas (18 % Cspe), they gave reasons, evidence or arguments on which they base their ideas or thoughts (22% Cinf) or they expressed an opinion or made value judgments (22% Cjud). The 'comment' label was used more frequently than 'question' label during the students' interaction in the Digalo, despite the fact that a question is more explicit in triggering a response from a group member.

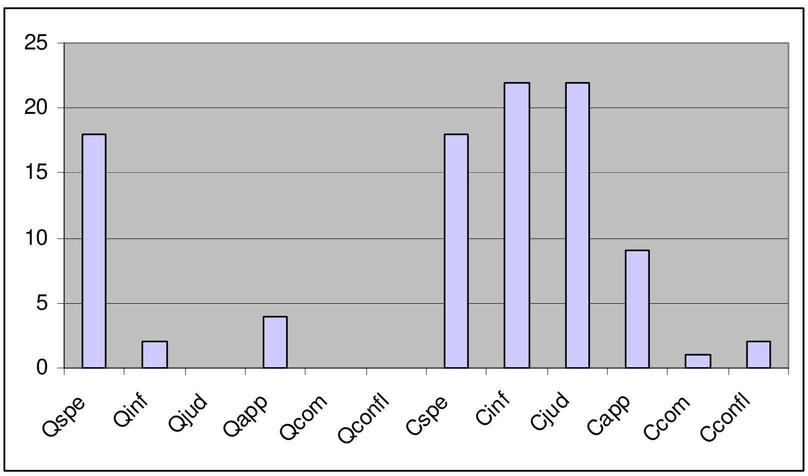


Figure 3. Percentage of 'in-depth elaboration' of knowledge indicators

One can conclude that the Digalo environment was mainly used to remove uncertainty, caused by ignorance or imprecision of a shared interpretation of the situation. The majority of the students' task-related interactions were directed towards acquiring new information that helps the group to form an interpretation of the situation. There were hardly any communicative acts that would reveal a conflict in interpretation. An analysis of the interaction sequences of the 7 groups revealed three episodes of conflict. Conflict *can* be made visible in the Digalo environment, although – in this case – it never leads to a process of negotiation within *or* outside the tool.

Interaction sequence

Our analysis of the Digalo diagrams indicates that the 7 groups produced 37 sequences. Table 2 displays the length of the sequences, i.e. the number of related contributions that make up a sequence. The length of a sequence is an indication of how extensively the students elaborated on an idea.

Table 2: The length of the sequences

	No. of contributions within a sequence								
		3	4	5	6	7	8	9	10
No. of sequences		14	9	7	2	0	2	0	3

The interaction sequences in the Digalo emerged in a parallel order. They can be considered as "discussions in a discussion". We named these sequences discussion lines. Figure 4 gives a graphical representation of group 4 that constructed six discussion lines in parallel (2.1, 2.2., 2.3, 2.4, 2.5, 2.6). The number of – parallel – discussion lines for the seven groups varied between two and six. Groups of two students produced less discussion lines than groups of three students.

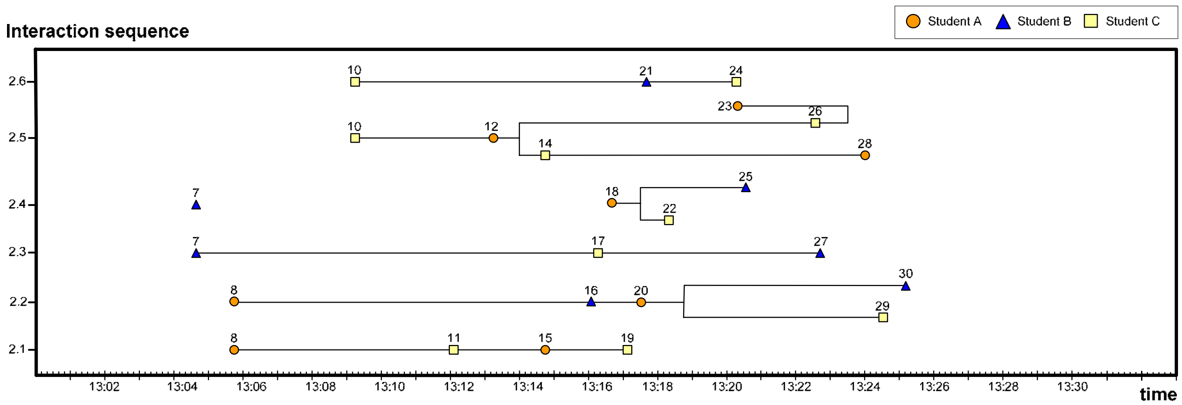


Figure 4. Interaction sequences of group 2

A graphical analysis of the students' behaviour in the shared workspace revealed that the students constantly switched between discussions lines (see Figure 5). The students "jump" from one discussion line to another; adding a contribution to a discussion line and then moving on to the next discussion line. In contrast to oral, face-to-face discussions, students seemed less constrained to one dominant course of action when they discussed a topic in the Digalo environment.

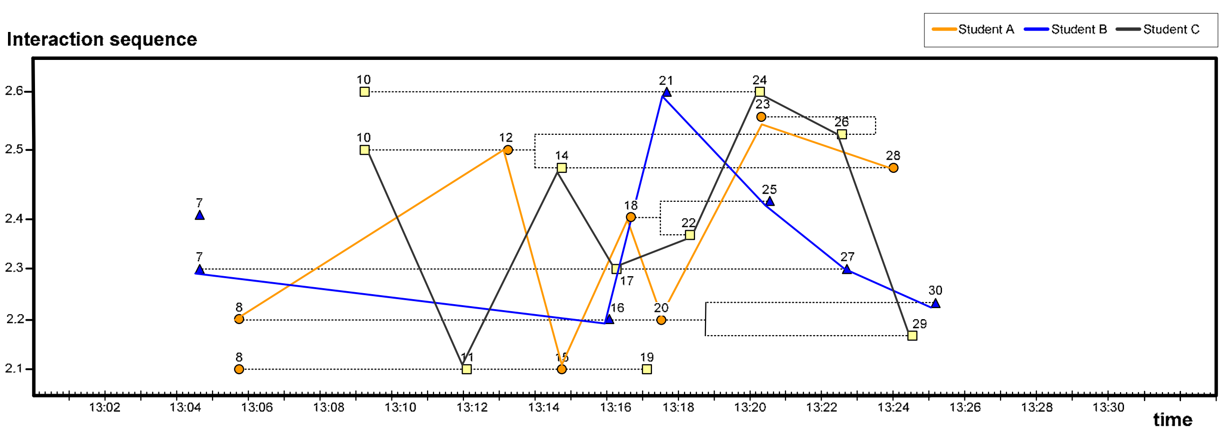


Figure 5. A spatial analysis of group 2 - jumping between discussion lines

Discussion

Computer supported collaborative learning *in* the classroom have received relatively little attention within the CSCL community. Still, it seems to be a distinct situation for research that can be set apart from the other collaborative learning situations. For example, the interactions patterns that we observed in our study differed fundamentally from the ones that are generally observed during online collaboration – e.g. a clear division of task-related and socio-emotional interactions – and during the purely face-to-face collaboration, e.g. the occurrence of parallel discussion lines. These differences seem inherent for the specific learning situation that was the focus of our study. The use of collaborative technologies for face-to-face collaborative learning seems to be a promising new direction for CSCL research. The different forms of communication may trigger different learning mechanisms and outcomes. Furthermore, a combination of computer-mediated and face-to-face communication create opportunities to optimize both means of interaction in order to maximize collaboration and learning.

The combination of both face-to-face and computer mediated communication raises new research questions that can only be addressed to its full detail in that specific research setting. A more fundamental issue would, for example, be the question: 'what are the key characteristics of face-to-face learning situation?' Olson and Olson (2000) identify several characteristics of face-to-face interactions in a situation of close proximity like rapid feedback, multiple channels, personal information, nuanced information, shared local context, informal 'hall' time before and after, co-reference, individual control, implicit cues and spatiality of reference. Still, it remains unclear if, when and how these characteristics influence collaboration and learning. Answering this question may lead to new insights that have important implications for both: online and face-to-face collaborative learning.

The use of collaborative technology may also change our perception of the 'traditional' face-to-face discussions I the classroom. Some characteristics of these discussions may change fundamentally. A good example may be the floor control mechanism. Verbal interactions in a traditional discussion are based on turn taking where participants interact by taking turns. Our observations of the interactions in the Digalo tool indicates that some of the 'limitations' of turn taking may be may neutralized by the tool. A shared workspace that is based on simultaneous access and the possibility to link related contributions enables the students to organize their discussion in a logical order that reflects their reasoning, instead of organizing their discussion in a temporal order and where meaning is based on adjacency of contributions like in a verbal discussion or a chat tool.

Endnotes

(1) This study is part of a larger research project – the LEAD project – that aims to develop and study collaborative technology for face-to-face problem-solving discussions in the classroom. The LEAD project is partially funded within the Sixth Framework Program of the EC. Information about the LEAD project can be found on: http://www.lead2learning.org.

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