Changing face-to-face communication
Diggelen, Wouter van

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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2011

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):

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8 Computer-Mediated Communication and Task Performance

The envisioned collaborative tools aim to support groups who carry out a problem-solving discussion in the classroom. The tools mediate part of the group communication. It is expected that the tools create the proper conditions for groups to learn. This is not self-evident because the groups already communicate verbally. They can talk with each other but should also use a collaborative tool as a medium for communication. The two opportunities for face-to-face communication – verbal and computer mediated – raise the question which communicative functions should be computer mediated. Design guideline 2 addresses this issue. The distinction between task-related and social-emotional communication is used as a criterion “to split” the communication between the two media. Design guideline 2 states that the computer-mediated communication must contribute to effective task performance. This guideline provides us with a general direction. In chapter 6, we further elaborated on the requirement that the computer-mediated communication should mirror effective task performance. The collaborative tool should support the groups so that they will carry out their learning task effectively. Group learning is most likely to occur when the students share knowledge about the task and when they elaborate on the knowledge that is shared (Hogan, Nastasi & Pressley, 2000). We developed two additional guidelines – design guidelines 7 and 8 – that are based on the two criteria for a constructive dialogue. These two criteria emphasize coherence and elaboration. Table 8.1 describes the two design guidelines that should stimulate groups to carry out a coherent discussion that is oriented at knowledge elaborations.

In this chapter, we present a study that further elaborates on design guideline 7 and 8 that aim to establish a proper fit between the characteristics of the collaborative tool and the communicative demands set by the learning task. The study addresses
research questions 4 that can be stated as follows:

\[ Q4: \text{How do the structures of the medium organize the computer-mediated part of the communication?} \]

### 8.1 Computer Support for Task-related Communication

The task-related communication is considered as the gist of group learning, difficulties with regard to the task-related communication will have a direct effect on the learning achievements. It does not mean that the other functions of communication are less important. Task-related communication should be balanced by communication that is directed towards the relationship between group members. Social-emotional communication is crucial for the group's well being. The quality of these expressive

<table>
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<th>Design guideline</th>
<th>Description</th>
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<tr>
<td>7</td>
<td>A mediated discussion should be based on global principle of coherence. The use of “connections” enable students to respond to a previous contribution that does not directly precede in time. Users can relate contributions based on a general structure of meaning instead of a purely temporal structure. It is expected that the students experience more “cognitive freedom” with they discuss a topic based on a global structure of coherence.</td>
</tr>
<tr>
<td>8</td>
<td>It is expected that a notation system that structures the communicative acts that students can display in the shared workspace stimulates the occurrence of certain behaviors or cognitions that are beneficial for group learning. A structured-communication notation system displays a limited range of acts that serve semantic guidelines during a problem-solving discussion. With a post-hoc notation system students label a contribution after it has been placed in the shared workspace. It triggers student to reflect on the content of the discussion.</td>
</tr>
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</table>

*Table 8.1: The guidelines that are associated with task performance.*
interactions in groups may be very important in influencing the attitudinal and affective consequences of being in a group (Guzzo & Shea, 1992).

The collaborative tools support the task-related interactions because they are directly related to learning (Draskovic et al., 2004). The tools should stimulate groups to carry out their task-related communication in the shared digital workplace. Design guidelines 7 and 8 (Table 8.1) point out how the task-related communication should look like. These guidelines refer to two criteria for a constructive dialogue: 1) the sequence of task-related communication should be coherent, and 2) the task-related communication should display patterns of knowledge elaboration.

**Coherence**

Communication is more than a collection of random sentences (Knott & Sanders, 1998). Groups have to organize their individual talk into a coherent whole. A speaker must relate his or her contribution to what has been said previously so that a meaningful discussion emerges (Pavitt & Kline Johnson, 1999). Design guideline 7 addresses this issue of coherence. The guideline states that the use of connections enables students to respond to contributions that do not directly precede in time. It “overrules” the principle of adjacency pair or “nextness” that is the leading principle to relate successive verbal contributions during a verbal discussion. Design guideline 7 offers an alternative structure to organize communicative exchanges into a coherent whole. Students can directly react on all the contributions that have been put forward in the shared workspace. This provides students with more freedom of expression; they are no longer confined to a temporal order where topics follow each other.

Design guideline 7 cannot be set apart from other structural features of the collaborative tool. The different characteristics of the tool make it possible to organize a discussion based on a global structure of coherence. These characteristics are:

- the permanence of contributions in the shared workspace,
- a shared workspace divided into functional spaces,
- a division of the shared workspace based on an information structures that is associated with relevant aspects of the problem or the task, and
- connections as a means to relate contributions.
A global structure of coherence seems to be a more proper method for organizing the communication that uses parallel access as floor control mechanism. It offers the group a structure that helps them to organize their parallel talk into a coherent whole.

**Elaboration**

Design guideline 8 states that a notation system stimulates the elaboration of knowledge shared by the group. A notation system offers student semantic guidance; it displays a limited number of suggestions for the kind of statements that the students can put forward in the shared workspace. The study that is discussed in this chapter analyzes the effects of a notation system that contains two options: question and comment. It is supposed that “asking a question” and “making a comment” would stimulate a constructive dialogue between the students. Asking a question and giving a comment have the function to elicit a specific response; they encourage students to elaborate on a contribution. A question is more explicit in triggering such a response. A comment expresses an opinion or attitude that, on its turn, stimulates further elaboration. As a response, students might give examples to explain an idea, provide evidence for a statement or give reasons as grounds for a conclusion. The function of asking a question is to elicit a verbal response from those to whom the question is addressed (Keatsley, 1976). Questions may serve several functions that depend on the context of the interaction (Hargie & Dickson, 2004). For example, a question might encourage students to elaborate further on a statement. Research indicates that students who were instructed to ask high-level thought-provoking questions elicited more knowledge-construction responses. These questions lead to explanations, inferences, speculations, and other such elaborated responses, which have a direct positive effect on individual achievement. Questions encourage students to elaborate on existing knowledge, which, on its turn, facilitates the acquisition of that knowledge (King, 1999; King, Staffieri & Adelgais, 1998; King, 1994).

**8.2 The Learning Environment**

The research has been carried out at the secondary school with 5th grade students who attended a Dutch language course. These students followed a series of six lessons that had as central theme “Respectful discourse in the classroom”. The learning goal of the lessons was to develop the argumentative skills of the students. The students had to
develop well-founded solutions that would encourage a respectful discourse. Small-group discussion was considered as an appropriate and useful method for practicing argumentation. The 21 students worked in small groups of two or three persons. They had to formulate a solution for the social issue, share their solution with their group members and discuss the assumptions and implications of their solutions.

We studied the effects of design guidelines 7 and 8 in a study where the students used the Digalo tool to discuss a problem. Insights obtained from this study should provide us with valuable insights about the effects of these design guidelines on the task-related communication.

**The Learning Task**

The central theme of the lessons was “Respectful discourse in the classroom”. During the first lesson, the teacher introduced the topic and explained to the students which products they had to deliver for evaluation. The students had to deliver two products:

- A policy note for the school’s board of directors. The policy note should contain an advice about how to promote a respectful discourse in the classroom. The policy note should be a group product.
- An argumentative text, written individually.

As preparation, the students watched two short videos about the topic. One video about a school program that aimed to solve conflicts between pupils through mediation, and one video about a discussion between students, teachers, experts and politicians about respect.

The students carried out a number of collaborative activities before they start writing the policy note. During the second and third lesson, the students worked in small groups on two assignments that should advance their argumentative skills. The second lesson consisted of an argumentative discussion that the students had to carry out with the support of the Digalo tool. This activity was similar to the one discussed in chapter 7. Each group had to formulate a proposition like: “The teacher is responsible for respectful discourse in the classroom”. During the argumentative discussion, the group members formulated arguments in favor or against the proposition. They did not have to take a position; it was important that their arguments covered various perspectives of student, teacher and parent. During the third lesson, the students had to...
develop solutions that would promote a respectful discourse in the classroom. This activity served as a preparation for lesson four, where the students were expected to write a policy note for the school’s board of directors. That policy note should contain a set of solutions. During the remaining lessons, the groups had to write the policy note. In this policy note, the students have to offer an advice to the board of directors.

The study that is discussed in this chapter is about lesson 3 where students used the Digalo tool to formulate and discuss solutions. Student had to propose a solution for the social problem and discuss their proposals with the group members.

The Digalo

Students formulated and discussed their proposals with the support of the Digalo tool. The Digalo tool offers the students a number of meaningful areas that support the coordination and organization of the communicative exchanges in the shared workspace. The shared workspace was divided into three areas that have a distinct meaning; each area is associated with a specific solution (Figure 8.1). Each student was allocated to such an area to put forward their solution. The students were instructed to take some time to formulate their proposal in their own area before they start to elaborate on the various proposals suggested by fellow group members.

![Figure 8.1: Meaningful areas.](image)

The Digalo had a notation system to stimulate knowledge elaboration. The students were presented with three options to label their contribution: 1) solution, 2) question and 3) comment (Figure 8.2). Students had to choose one of these labels before they put forward a contribution in the shared workspace. They could use the label
“Solution” to submit a solution, and the other two labels to elaborate on the proposed solutions.

**Instructions**

At the beginning of the discussion, the students were encouraged to work in their own area and to take some time to formulate a solution. These solutions might serve as the starting point for a discussion during which the group assessed their solutions critically. By dividing the shared workspace into separate quadrants, where each quadrant contains one solution from a specific student, we provided the students with a meaningful structure or representation aid that directs the communication in the shared workspace.

**8.3 Analysis I: The Content of the Computer-mediated Interactions**

There are at least two ways to look at the communication. One can look at the content and analyze what has been put forward by the students or one can focus at the process and analyze the sequence of communicative acts of the various group members. In this study we did both. First, we analyzed the content to understand what kind of reasoning went on in the shared environment of the Digalo tool. Secondly, we analyzed how the individual actions in the digital workspace were organized into a pattern of related communicative acts.
Coding Scheme

Various authors developed coding systems to analyze computer-mediated communication (e.g. Henri, 1992; Newman, Johnson, Webb & Cochrane, 1997; Pena-Shaff and Nicholls, 2004). Henri (1992) was one of the first researchers who developed a framework for analyzing computer-mediated interactions between students. She identified five dimensions of the learning process:

– **Participation**: The participation dimension gives an overview of student participation indicated by the number of messages or statements made by the students.

– **Interaction**: The interaction dimension makes a distinction between explicit and implicit interactions. Explicit interactions are statements that refer specifically to one or more messages while implicit interactions do not specifically mention the connection.

– **Social**: The social dimension contains all statements that are not related to the formal content of the subject matter.

– **Cognitive**: The cognitive dimension is used to evaluate reasoning which uses critical thought. Critical thought is measured by criteria that distinguish surface processing from in-depth processing.

– **Metacognitive**: The metacognitive dimension is divided into metacognitive knowledge and skills. Metacognitive knowledge refers to declarative knowledge concerning the person, the task, and the strategies. Metacognitive skills have to do with procedural knowledge relating to evaluation, planning, regulation and self-awareness.

Newman et al. (1997) combines Henri’s (1992) framework with Garrison’s (1992) model of critical thinking that considers critical thinking as a sequential problem solving process with five stages: problem identification, problem definition, problem exploration, problem applicability and problem integration. Pena-Shaff and Nicholls (2004) developed an extensive category system to analyze knowledge construction that assesses sophisticated cognitive skills such as clarification, conflict, assertion, judgment and reflection that appear to be most directly related to the process of knowledge construction.
<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specify</td>
<td>Qspe</td>
<td>Encourage respondents to examine an idea in more detail by drawing attention to a neglected aspect of the idea.</td>
<td>How are the pupils chosen?</td>
</tr>
<tr>
<td>Inference</td>
<td>Qinf</td>
<td>Encourage respondents to examine an idea in more detail by drawing attention to a neglected aspect of the idea.</td>
<td>Source?</td>
</tr>
<tr>
<td>Judgement and evaluation</td>
<td>Qjud</td>
<td>Encourage respondents to give an opinion, make value-judgements or judge the relevance of solutions.</td>
<td>What is this for a measurement?</td>
</tr>
<tr>
<td>Application</td>
<td>Qapp</td>
<td>Encourage respondents to provide examples, i.e. concrete or specific instances of an idea or thought.</td>
<td>Would you be an eligible mediator?</td>
</tr>
<tr>
<td>Comparison and contrast</td>
<td>Qcom</td>
<td>Encourage respondents to consider similarities and differences between situations.</td>
<td>Does the parent at present have no faith in teachers?</td>
</tr>
<tr>
<td>Conflict</td>
<td>Qcfl</td>
<td>Encourage respondents to consider alternative or opposite point of views or positions.</td>
<td>Are not the pupils who don’t have any respect the cause of the problem instead of unmotivated teachers?</td>
</tr>
<tr>
<td>Specify</td>
<td>Cspe</td>
<td>Provide a more detailed analysis or a clarification of ideas and thoughts</td>
<td>[…] this is an agreement that the whole school makes, all teachers and pupils.</td>
</tr>
<tr>
<td>Inference</td>
<td>Cinf</td>
<td>Provide evidence, arguments or reasons, reach conclusions or make predictions</td>
<td>It is the same as in court. One witness doesn’t mean much, several witnesses do.</td>
</tr>
<tr>
<td>Judgement and evaluation</td>
<td>Cjud</td>
<td>Express an opinion, make value-judgements or judge the relevance of solutions, listing advantages and disadvantages</td>
<td>Two pupils talking to each other doesn’t seem a good idea to me.</td>
</tr>
<tr>
<td>Application</td>
<td>Capp</td>
<td>Using examples, i.e. concrete and specific instances of an idea or thought</td>
<td>The rules are: don’t swear, scold and don’t talk simultaneously.</td>
</tr>
<tr>
<td>Comparison and contrast</td>
<td>Ccom</td>
<td>Compare two situations to present similarities and differences, identify assumptions</td>
<td>Not all teachers are trained how to handle pupils with problems, they have just learned how to teach.</td>
</tr>
<tr>
<td>Conflict</td>
<td>Ccfl</td>
<td>Defending one’s point of view or position by argumentation or further elaboration</td>
<td>The problems do not have to do with the home situation of the pupil but are be caused by […]</td>
</tr>
</tbody>
</table>

Table 8.2: Coding scheme for Digalo-mediated communicative acts.
It was difficult to use an existing coding framework for the analysis of the actions and interactions within the Digalo environment. For example, the frameworks discussed above were developed for asynchronous computer-mediated communication. Furthermore, they are associated with cognitive acquisition-oriented perspective that assesses knowledge construction as an individual activity, fed by a social context (Veldhuis-Diermanse, 2002). No existing coding framework matched with the data, so we decided to develop our own classification scheme (Table 8.2).

To analyze the content of the discussion we focus on the sequence of related pairs where an utterance is followed by a response. An obvious action-response example is a “question-answer” relationship. However, an utterance can also elicit a response in a less straightforward manner. For example, a comment that expresses an opinion can trigger a response in the form of a further elaboration of the initial statement. It means that we only coded the student’s actions that are a part of an interaction sequence because these actions are indicative for the co-construction. The diagrams that represent a sequence of related actions were used to (re)organize the data for coding (see Figure 8.5).

We identified six categories of actions that can be associated with the in-depth elaboration of knowledge (see King, 1994; Hargie and Dickson, 2004; Pena-Shaff and Nicholls, 2004). These categories are analysis, inference, judgment, evaluation, application, comparison and contras, and conflict. These categories where associated with the two labels of the notation system – question and comment – that should trigger elaboration. This results in 12 categories. Each sentence that students put forward in the Digalo – and that is a part of sequence or related responses – was coded by two coders (interrater reliability 0.9). We choose for the sentence as unit for analysis because students sometimes change theme within a contribution. For example, they ask a question but also comment upon the question. Sentences that were divided by the words “but” or “for” were considered as two separate sentences because these words also reflected a change in focus.

**Results**

Table 8.3 gives the amount of sentence for each category of the coding scheme. It is noteworthy to notice that all students’ utterances were task-related. There were no statements that could be typified as social-emotional. Figure 8.3 presents the percentages of sentences identified in each category. If we look at “questioning” as a communicative act for in-depth elaboration that we may conclude that students mainly
asked “specifying questions” (18% of all statements) that encouraged respondents to examine an idea in more detail. The comments that students gave are more diverse: students have more detailed account of their ideas (18 % Cspe), they provided reasons, evidence or arguments on which they based their ideas or thoughts (22% Cinf) or they expressed an opinion or made value judgments (22% Cjud).

One can conclude that the students used the Digalo to remove uncertainty within the student groups that is caused by ignorance or imprecision of a shared interpretation of the situation. The communication was directed at acquiring new information that enables them to form a more precise interpretation of the proposal.

<table>
<thead>
<tr>
<th></th>
<th>Qspe</th>
<th>Qinf</th>
<th>Qjud</th>
<th>Qapp</th>
<th>Qcom</th>
<th>Qcfl</th>
<th>Cspe</th>
<th>Cinf</th>
<th>Cjud</th>
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<td>48</td>
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</table>

Table 8.3: Number of statements indicating knowledge construction.

Figure 8.3: Frequencies for different types of task-related messages.
Discussion

The Digalo tool in combination with verbal interaction led to a specific kind of problem-solving discussion. Only the task-related interactions were mediated by the tool. The utterances expressed in the Digalo concerned the topical content of the discussion. This in contrast to the findings with regard to 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 verbally. In our study, the students sat next to each other. We observed that the students also communicated verbally; for example, they asked for help, discussed their planning or decided when to end the Digalo discussion. It seems that the communication mediated by the tool only concerned messages with respect to the content. An analysis of the recorded face-to-face discussions revealed that this mode of communication was used infrequently. Students could be silent for 2 to 3 minutes. When they did communicate verbally, their utterances referred to:

– social-emotional aspects of the collaboration, for example asking for help, tension release by telling a joke, giving positive feedback, keeping group members focused on the task;

– planning of the activities, for example discussing the assignment;

– regulative aspects of the collaboration, for example discussing rules for computer-mediated interactions.

8.4 Analysis II: The Sequence of Task-related Interactions

In this paragraph, we examine the patterns of related communicative acts that emerge in the shared digital workspace. We describe how the groups organize their communicative exchanges digitally. The analysis takes into account the structural features of the Digalo that give rise to certain rules for regulating the communication. These structural features are: 1) parallel access as floor-control mechanism, 2) permanence of contributions, 3) a shared workspace divided into functional spaces, 4) a predefined information structures (meaningful areas) to organize the computer-mediated communication, and 5) the ability to link contributions to indicate a relationship between the two. These characteristics help users to organize their
individual messages into a coherent and meaningful discussion.

**Communication patterns**

A first look at the diagrams that the groups created revealed that all students started to work in their own area where they put forward a solution. Furthermore, their fellow group members elaborated on these solutions by asking questions and giving comments. Most groups created a coherent diagram based on the meaningful areas – the Grid – that were presented to them. It triggered the students to use spatial grouping as a leading principle for organizing their contributions.

**Time to Think**

We divided the shared workspace into a number of meaningful areas. Each area in the two-dimensional workspace represented a solution of one of the group members. At the beginning of the session, students were instructed to put forward a solution in their own area. The teacher stressed that the students should take ample time to formulate a solution. They were encouraged to work in their own area before they would participate in the group discussion. Table 8.4 represents the time between the moment that the students started to work in the shared workspace and the moment they participated in the discussion. On the average students worked individually during the first 10 minutes ($M=10:10\text{ min.}/\text{sec.}, SE=3:38\text{ min.}/\text{sec.}$). During that period, students

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<td></td>
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<td></td>
<td></td>
<td>01:29</td>
<td>15:46</td>
<td>14:17</td>
<td>5</td>
</tr>
</tbody>
</table>

*Table 8.4: Time to formulate a proposal at the beginning of the session.*
did not interact with each other in the shared workspace. Table 8.4 shows that the
groups differed from each other for the time they needed to work individually on a
solution. Group members within a group also showed some variation. For example, in
the case of group 1 and 2 there is a difference of 8 minutes between the moment that
the first and the last student participated in the group discussion. This would indicate
that the students felt hardly any pressure to participate in the discussion when other
students did so.

The number of sentences that students used to write down a proposal indicates
how detailed the description is. Within the groups, there is little variation between the
number of sentences that the students produced. While some group members took
more time to formulate a solution, the detailedness of the solutions did not differ
much.

The Pattern of Related Communicative Acts

The analysis focuses on sequence of related communicative acts that might be a sign for
knowledge elaboration. 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 (so far this is an interact), which is then responded to by
actor A (this complete sequence is a double interact). We broaden this definition to a
group of at least three students. The minimal amount of actions to make up a sequence
consists of at least 3 related contributions within the shared workspace. Furthermore,
the successive contributions are made by two different group members (see Figure 8.4).
To identify the interaction sequences we used two of the three organizing principles –
link and spatial grouping – that students used to organize their contributions (see
chapter 7).

The seven groups produced 37 double interacts. Four times two successive
contributions were made by the same student. Group 6 is responsible for three of these
“successive contributions made by the same student”. Table 8.5 displays the length of

"actor A ________ actor B ________ actor A ________ ...

actor A ________ actor B ________ actor C ________ ...

Figure 8.4: Actions that make up a meaningful sequence."
the sequences as the number of communicative acts – i.e. contributions or messages – made within the sequence. Most sequences are relatively short; they contain three to five contributions. Three sequences contain 10 related contributions.

They seven groups produced 6 single interacts, i.e. interaction sequences that only contain two related contributions. These single interacts were excluded from further analysis (12.5 % of all contributions). It is worth to notice that the fast majority messages in the shared workspace were part of a sequence of related messages of several students. It means that the digital workspace with its functional spaces is really a medium for communication.

We took the proposed solution as a criterion to formulate meaningful areas in the shared workspace. Each quadrant in the shared workspace contained a solution. Table 8.6 shows the number of contributions for each functional area (quadrant). All the members of the groups 1, 2 and 6 formulated proposals that were discussed by the group. Only two of the three members of the groups 3 and 4 formulated a solution. These two solutions were discussed by all the group members. Groups 4 and 7 only had two group members. These groups also entered into a discussion but put forward a smaller amount of contributions.

<table>
<thead>
<tr>
<th>No. of related contributions within a sequence</th>
<th>No. of sequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

*Table 8.5: The “length” of a sequence.*
Chapter 8

Interaction Sequences

Figure 8.5 shows a graphical representation of the sequence of related contributions. These figures display the contributions on a time axis; the contributions that are related are represented on the same horizontal level. The first contribution is the proposed solution. A line between two contributions indicates a link between the two contributions. The absence a line means that the students used the principle of spatial grouping to signify relatedness.

Figure 8.5 shows that most interactions sequences occurred parallel in time. These interaction sequences can be considered as focused discussions within in a general discussion. These focused discussions were named discussion lines. Group 2, for example, constructed six discussion lines in parallel (2.1, 2.2, 2.3, 2.4, 2.5, 2.6).

The digital workspace represent the history of their discussion, the contributions remained visible throughout the session. It was easy for group members to return to something that has been “said” earlier. The groups created a number of focused discussions – within the general discussion – that remained active.

The number of discussion lines for the seven groups varied between two and six. Groups of two students produced less discussion lines than groups of three students. The greater part of the sequences – 96 % of all sequences – had a typical pattern: a group member put forward a solution; another group member reacted on that proposal after which the group member who had put forward the solution gave a reaction. It seems that the “owner” of the solution keeps track of the questions or comments raised by other group members. Subsequently, these questions and comments triggered a reaction from the owner of the solution. These findings combined with the results of the first analyzes suggest that the groups display short sequences of knowledge elaborations.

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
<th>Group 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>6</td>
<td>10</td>
<td>13</td>
<td>4</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>22</td>
<td>19</td>
<td>18</td>
<td>7</td>
<td>34</td>
<td>12</td>
</tr>
</tbody>
</table>

*Table 8.6: Number of contributions that are part of a sequence.*
Figure 8.5: Sequence of related contributions.
Spatial behavior

In the previous paragraph, we already noticed that several discussion lines existed in parallel and that these discussion lines remained active for a long period. The discussion lines are situated within the different meaningful areas of the shared workspace. It means that students moved through the different areas of the workspace to contribute to the different focused discussions. This spatial behavior is displayed in Figure 8.6.

An analysis of students’ pattern of participation revealed that they constantly switched between discussions lines. Students “jumped” from one quadrant to another; added a contribution to the discussion within that quadrant and moved on to the next discussion. Students were less constrained to one course of action. They easily changed the subject of the discussion by moving to another discussion line. This in contrast to oral, face-to-face discussions, where only one topic is prominent for all group members. It seems that a general structure – i.e. meaningful areas that represent relevant aspects of the problem space – helps students to represent their discussion according to a global model of coherence. The parallel discussion lines that represent different topics do not make a discussion scattered. Although students frequently switched between topics; they still responded to what has been put forward earlier.
Figure 8.6: Spatial behavior in the shared workspace.
Discussion

In this chapter, we presented a study that examined the communication patterns in the shared digital workspace. The goal of the study was to find out if students would use the collaborative tool to communicate about the task. Furthermore, we were interested in how the computer-mediated part of the communication would look like whereby we focused on the relationship between characteristics of the tool and the communication patterns they give rise to.

The notation system of the Graphical tool made the students aware of the possibility to ask questions or to give comments. These two options stimulated further elaboration of the proposed solutions. Students put forward their solutions without any interference of the other students. Their solutions remained visible during the whole discussion. This kept the discussion open; the group explored the various directions, i.e. the different solutions that the members put forward at the beginning of the discussion. The computer support has a similarity to structured group interventions like the Devil’s advocate (Janis, 1982) or the Stepladder technique (Rogelberg, Barnes-Farrell & Lowe, 1992), in the sense that these techniques aim to prevent groups from “a premature adoption of a preferred solution” (Nemeth, Brown & Rogers, 2001).

The sequence of communicative acts within the digital workspace looked quite different from the way verbal talk is organized. Groups no longer organized their discussion based on the principle that only one member speaks at the same time. Instead, group members put forward their ideas without any delay and they can directly respond to all the statements made by their fellow group members. It gave the students a sense of “cognitive freedom”; they followed their own line of thinking and they directly shared their ideas with the group. In the next chapter, we further elaborate on this issue by taking into account the relationship between verbal and computer-mediated part of the face-to-face communication.