Changing face-to-face communication

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Summary

Collaborative learning is a valuable means for learning that can be characterized by active involvement of the learners. Collaborative learning – as it is presented in this thesis – consists of a group discussion between a *small number* of students. These discussions are directed towards the exploration of a particular subject or the resolution of a problem. Learning from this perspective can be seen as a continuing effort to improve on existing knowledge through an engagement in a discourse that advances mutual understanding (Bereiter, Scardamalia, Cassells & Hewitt, 1997).

Bringing students together does not automatically lead to a productive discussion that promotes learning. Sfard and Kieran (2001), for example, concluded that the merits of collaborative learning could not be taken for granted due to *ineffective communication patterns*. These communication patterns inhibit the free expression of ideas and the further exploration of these ideas. In this thesis, we argue that these ineffective patterns are closely related to the medium within which they occur. Such a medium for communication provides specific opportunities for expressing ideas and for the coupling of these ideas into a meaningful whole. The medium prescribes the content and sequence of communication in a specific manner (Cushman & Kovacic, 1994).

The objective of the research that is described in this thesis is to develop two collaborative tools to support face-to-face group discussions. The computer tools offer the students an alternative medium for communication. It is worth to notice that the computer-mediated communication is *not* contrasted with verbal communication. Rather both forms occur *simultaneously* in a face-to-face setting where students are co-located and communicate directly with each other. The collaborative tools provide the groups with a digital medium that stimulates a constructive dialogue between students. This brings us to the following four research questions:

Q1: *What are the criteria for a constructive dialogue in terms of requisite patterns of communication?*

Q2: Which communication patterns during a verbal face-to-face discussion prevent students from carrying out a constructive dialogue?

Q3: How do the structural features of the medium relate to the ineffective communication patterns?

Q4: How do the envisioned collaborative tools change the group communication for the better?

Understanding through Design

The four research questions reflect a problem-solving paradigm that considers the design process as a means to advance scientific understanding. One of the most noticeable outcomes of such a process is a concrete artifact – a product developed by humans – that offers a solution for a problem. Another result of the design process – less tangible but of equal importance – is increased understanding, or what Winograd and Flores (1986) referred to as "the interaction between understanding and creation". Exactly this latter outcome comprises the essence of the *Design-based research approach* that guides the research. This approach can be typified as a modeling mode of inquiry in which theory, operationalization, and data patterns are treated simultaneously (Poole, McPhee & Canary, 2002).

Hypotheses in the Design-based research approach serve a specific goal. We follow the philosopher Popper (1999) who stated that the solution of a problem might be compared to an expectation, and hence to a hypothesis or a theory. The hypotheses that we formulated offer a solution for a communication problem, they are anchored in a theoretical model, and will be implemented in a collaborative tool. The approach can be further characterized by a regular evaluation of the tool and, if necessary, a refinement of hypotheses so that the tool better fits the context of use.

Rationale for a Design: Systems and Functions.

In this thesis, we argue that the Design-based research approach relates to a distinct social ontology, and hence with a particular explanatory framework. We adopt a S*ystems perspective* that sees reality as consisting of functional entities or systems that are related. The group is viewed as a *purposeful* system that can be described on various levels of complexity. This opens up explanations in terms of coordination processes and function. These *functional descriptions* call for a "concrete and detailed account of the mechanisms, which operate to perform a designated function" (Merton, 1967). In our case, we focus on the communication and examine:

– which functions the communication fulfills for the group, and
– how the group organizes individual utterances into a coherent and meaningful whole.

A Constructive Dialogue

Several studies about collaborative learning looked at the group communication (e.g. Gillies, 2004; Barron, 2003; Kneser & Ploetzner, 2001; Hogan, Nastasi & Pressley, 2000; Keefer, Zeitz & Resnick, 2000). These studies make it clear that the *quality* of interaction has implications for learning (Barron, 2003). In the thesis, we further elaborated on what quality exactly means and present four criteria for a constructive dialogue in terms of requisite communication. *First,* the communication must be oriented at effective task performance because learning achievement is associated with how well students communicate about the task. Task-related communication leads to cognitive activities often referred to as knowledge elaboration, which, in turn, facilitates the acquisition of that knowledge (Draskovic, Holdrinet, Bulte, Bolhuis and Leeuwe, 2004). *Secondly,* the group has to maintain acceptable levels of participation so that all its members are able to share their knowledge. Equal participation is a fundamental element of well-performing student groups (Lindblom-Ylänne, Pihlajamäki & Kotkas, 2003). *Thirdly,* the group members must organize their individual talk into a coherent whole. Research indicated that successful groups carried out more coherent discussions where they linked proposals to the prior conversation (Barron, 2003; Kneser & Ploetzner, 2001). *Finally,* discussions of successful groups can be characterized by frequent knowledge elaborations (Barron, 2003; Kneser & Ploetzner, 2001; Hogan, Nastasi & Pressley, 2000). These elaborations resemble a coherent sequence in the sense that several speakers make substantive statements that build on or clarify prior statement.

Ineffective Communication Patterns

The teachers that participated in our studies reported that a discussion was sometimes controlled by one or more dominant students. These students talked a lot while the other students hardly got the opportunity to share their ideas with the group. This does not only work out badly for individual students, it also hampers the learning potentials of the group. Bales (2002) considered this form of interpersonal dominance as one of the basic problems of a group that manifests itself by behaviors like repeatedly taking

the turn, interruptions and simultaneous speech. These disruptive behaviors are an intentional violation of the *turn-taking rule* that rests on the rule that only one group member talks at the same time.

Another consequence of the turn-taking principle is *product blocking*. Product blocking occurs when individuals need to wait to verbalize an idea because of some procedural limitation (Isakesen, 1998). Group members, who are prohibited to verbalize their ideas on the moment they occur, forget or suppress them so that the process of idea generation stagnates or it is disrupted because of blocking (Nijstad, 2000).

Design Guidelines

The two ineffective communication patterns – interpersonal dominance and product blocking – formed the rationale for the tool design. It is expected that these behaviors do not occur when the group members organize their communicative exchanges according to the principle of "parallel access" instead of turn taking.

With *parallel access*, all the group members can access a shared workspace simultaneously. They do not have to wait for their turn but they can immediately share an idea with the group. The transition from turn taking to parallel access is a basic property of the collaborative tools. The users of these tools cannot interfere directly when other users express their thought into words. They type an idea in a private window rather than expressing it verbally.

The general guideline of parallel access does not suffice. That guideline describes the process of digital communication only in rudimentary terms. The implementation of parallel access triggered further research that aimed to come up with a tool that is specifically suited to support face-to-face group discussions. This resulted in eight design guidelines:

1. The support closely matches the characteristics of effective task performance.
2. Associate a medium with a specific communicative function.
3. Ensure joint attention by concentrating the digital communication in *one* collaborative tool.
4. Use parallel access as floor-control mechanism for access to the digital discussion.
5. Use functional spaces to stimulate overview and coherence.
6. Associate the functional spaces with a relevant macro structure that is related to the problem or the task.

7. Establish global coherence by using connections that enables users to respond to a contribution in the shared workspace.
8. Use a notation system to stimulate elaboration.

Functional design

The eight design guidelines were translated into a number of *services.* These services describe a set of tangible actions that the user can perform with the collaborative tool. They lay down the external behavior of a tool from the user's point of view (Davis, 1990).

The tool design resulted in two collaborative tools – a Graphical tool and a Threaded-discussion tool – to support particular collaborative learning activities. Both tools are based on the eight design guidelines and offer the users the ability:

- To divide the shared workspace into functional spaces, i.e. categories for the threaded-discussion tool and meaningful areas for the graphical tool.
- To arrange a discussion according to different levels of complexity: categories and threads for the Threaded-discussion tool and meaningful areas and sequences of related text objects for the Graphical tool.
- Graphically link ideas that are related.
- To label contributions according to a pre-defined notation system.

The *Graphical tool* allows students to make abstract representations of a problem. The tool restricts the communication to a distinct and limited number of classes (Stenning & Oberlander, 1995). The tool has a user interface that represents concepts and their relationships in a two-dimensional workspace. The tool displays small text objects (shapes) that represent a concept or an idea and lines or arrows (links) to represent a relationship between two concepts. The tool has a number of representational aids that help students to represent their ideas in a meaningful and coherent manner.

The Graphical tool seems to be less useful to represent the richness of a problem-solving discussion that addresses various topics. Conversely, the *Threaded-discussion tool* has a workspace where students can discuss a problem extensively. The tool enables students to share, discuss and organize their ideas in a systematic manner. The tool has a stratified structure to represent different levels of complexity that represent different levels of elaboration.

Parallel Access

The first study that is discussed in the thesis, examines the effects of parallel access. Parallel access was implemented in a Graphical tool. The tool supported an argumentative discussion between a small group of students. Initial findings revealed that the number of contributions expanded quickly. The students spent a lot of time organizing these contributions into a meaningful whole. Some groups came up with comprehensible diagrams that looked organized while other groups failed to achieve this.

An analysis of the diagrams revealed that *spatial grouping* led to more coherence between contributions. The groups who did not apply the spatial character of the workspace came up with less structured diagrams. This insight served as inspiration for the development of design guidelines 5 and 6. These guidelines aimed to solve the *coordination problem* that users experience when they access a digital workspace simultaneously.

Design guideline 5 is grounded in the hypothesis that states that students are better able to coordinate their actions when the shared workspace is divided into *functional spaces*. Design guideline 6 indicates that these functional spaces must have a distinct meaning.

We evaluated the two design guidelines in a study with two conditions. In one condition, the shared workspace was divided into a number of meaningful areas while in the other condition the groups did not have such a representational aid. Results indicate that the use of meaningful areas that relate to the learning task reduced the coordination problem: students spent less time organizing their contributions *and* they put forward substantial more contributions in the digital workspace.

Task Performance

In the second study, we elaborated on design guideline 7 and 8 that further define effective task performance. The aim of the study is to establish a proper fit between the use of collaborative tool and the communicative demands set by the learning task. It was expected that the representational aids encourage students to elaborate on the knowledge that they share in the digital workspace.

An analyses of the content of the *digital* discussion revealed that the communication in the digital workspace was purely about the task. Students share new

information to form more precise interpretations. The communication removed the uncertainty that was caused by ignorance or imprecision of a shared interpretation.

An analyses of the interaction sequences showed that several discussion lines existed in parallel and remained active for a long period. These discussion lines can be considered as *focused* discussions that deal with a specific topic. These discussion lines are situated in different areas of the shared workspace. An analysis of students' pattern of participation revealed that they constantly switched between discussions lines. Students "jumped" from one focused discussion to another; added a contribution to the discussion and moved forward on to the next topic.

A Diagnostic reasoning discussion

The third study investigates the effects of a collaborative tool on the communication and learning. The students that participated in the study worked together in small groups. They carried out a diagnostic reasoning discussion during which they analyzed a patient's health condition to formulate a care plan. Three aspects of the support were addressed by the study:

1. The instructional strategy that aims to establish a good match between the learning task and the computer support.
2. If the digital part of the communication is really a discussion.
3. How a face-to-face discussion that has a digital and verbal component looks like in practice.

While the collaborative tools stay more or less the same over different contexts, its use will vary. Teachers can use a collaborative tool in many ways that can be more or less appropriate to the learning task. Just introducing the collaborative tools in the classroom is not sufficient. In our case, the introduction of the collaborative tools is accompanied with an instructional strategy that makes the computer support suitable for a specific learning situation. An instructional strategy specifies how the students learn effectively. It consists of a lesson plan that directs student's learning towards the achievement of the learning goals. After each lesson, the instructional strategy was evaluated with the teacher. This led to a number of adaptations that mainly had to do with improving the coherence between the various activities.

The second topic that was addressed in the study had to do with the utility of the collaborative tools. Utility refers to how well the students are able to carry out a

discussion digitally. The students reported that they could express their ideas in writing and were aware of what other group members shared. The students also mentioned that there were frequent interactions within the shared digital workspace.

The third topic had to do with the two media for communication: verbal speech that is paralleled by digital communication. Participation during the verbal part of the discussion varied substantially: in almost every group, there was at least one student who hardy said anything. The communication in the digital workspace revealed a different kind of pattern: all the group members contributed substantially to the digital discussion. There was an even pattern of participation in the digital workspace. The willingness to participate was irrespectively of the behavior during the verbal discussion. Group members who hardly said anything, frequently communicated digitally.

There is a complex interplay between the verbal and computer-mediated part of the communication. The permanence of the contributions in the digital workspace made constant reflection possible. Students frequently reacted on the statements that they read in the digital workspace. This was done digitally but also verbally. Verbal communication helped the group members to align the views with regard to the differences that became visible in the digital workspace.

Changing communication

Group discussions can be characterized by multiparty talk that is episodic in nature (Schwartzman, 1989). The episodic character implies that the utterances of individual group members are only loosely coupled. Coherence, order and meaning between successive statements cannot be taken for granted. Groups have to follow certain rules for *coupling* to make their individual expressions into a coherent and meaningful whole. A central premise of this thesis is that each medium for communication provides specific rules for coupling. These rules do not only determine what can be expressed and how, it *also* affects the behavior of the group.

In our case, we compared parallel access as floor control mechanism for digital communication *with* turn taking that can be associated with verbal speech. Findings indicate that parallel access leads to participation that is more or less equal: dominant group members have fewer opportunities to influence the digital part of the discussion so that the other group members are better able to share their thoughts with the group. Parallel access changed the discussion in several ways: students worked at their own

pace, they could freely choose a topic of immediate interest, and they expressed their thoughts without being interrupted.

Turn taking as floor control mechanism is closely associated with adjacency pair or "nextness" as unit for sequence construction (Schegloff, 2007). Adjacency pair means that a statement receives its meaning in relation to a statement that directly precedes in time. Adjacency pair as a rule for coherence works less well for parallel access because there is no clear time frame. Consequently, the shared digital workspace became crowded with contributions that lacked a clear relationship. To solve this coordination problem we developed some additional guidelines:

- a shared digital workspace that is divided into functional spaces,
- functional spaces that are based on a macro structure that represents relevant aspects of the problem or the task, and
- the possibility to link a new contribution to a contribution that is already present in the shared workspace.

The three guidelines enable users to organize their digital discussion based on a global model of coherence. Global coherence refers to a *macro structure* that is based on topics or themes in a discourse (van Dijk, 1985). Such a structure was implemented in the collaborative tools as a representational aid, i.e. categories for the Threaded- discussion tool or meaningful areas for the Graphical tool. These macro structures changed the digital part of the discussion. Several discussion lines occurred in parallel that remained active during the whole time. These discussion lines addressed specific topics that had a direct relation with the macro structure, i.e. with the problem or task. It seems that the macro structure broadens up the discussion, i.e. they gave the students more freedom to follow their own lines of thinking and to share their thoughts with the group.

The collaborative tools keep the discussion open. As a result, the students become more aware of their differences in thinking. The tension between the individual and the group, between unhampered thinking and conformity to the group becomes more explicit. There is also a current in the opposite direction towards *conformity* that is visible in the verbal part of the communication. Differences in thinking are discussed verbally. The group members align their cognitive models verbally.

The medium for communication does not only determine how thoughts are expressed and joined together into a meaningful story. The medium also stimulates certain behaviors while it suppresses other behaviors. This becomes clearly visible in a face-to-face setting where a digital medium for communication is places next to human speech. The research that is described in this thesis shows that the digital medium changes the dynamics of a group in such a way that students are better able to collaborate, to share knowledge and to elaborate on the knowledge that is shared.