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4 Designing Argumentation Tools for Collaborative Learning

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4.1 Introduction

The focus of education has shifted towards working actively, constructively and collaboratively, as this is believed to enhance learning. The studies discussed here deals with the influence of different CMC (Computer Mediated Communication) tools on argumentation processes during collaboration. The purpose of our research is to investigate the effect of computer supported environments and its tools on the final product through differences in the participants' collaboration processes. In this chapter we will concentrate on students collaboratively taking part in argumentation via CMC systems. Computer environments that support collaborative writing can emphasize both the constructivist and collaborative aspects through its active and interactive nature.

4.2 Argumentation and Collaboration in CMC Systems

One of the main principles of constructivist learning theory is the negotiated construction of knowledge through dialogue. Such learning through negotiation can consist of testing understanding and ideas against each other as a mechanism for enriching, interweaving and expanding understanding of particular phenomena. Active engagement in collaborative argumentation during problem solving fits this principle by giving prominence to conflict and query as mechanisms for enriching, combining and expanding understanding of problems that have to be solved (Savery & Duffy, 1995).

After all, as Von Glaserfeld (1989) has noted, other people are the greatest source of alternative views to challenge our current views and hence to serve as the source of cognitive conflict that stimulates learning.

Knowledge is actively constructed, connected to the individual's cognitive repertoire and to a broader, often team-based and interdisciplinary context in which learning activities take place (Salomon, 1997). Constructivism seems to be influenced not only by a Piagetian perspective on individual cognitive development through socio-cognitive conflict, but also by the socio-cultural approach emphasising the process of interactive knowledge construction in which appropriation of meaning through negotiation plays a central role (Greeno, 1997). From a constructivist perspective, collaborative argumentation during problem solving can be regarded as an activity encouraging learning through mechanisms such as externalising knowledge and opinions, self-explanation, reflecting on each other's information and reconstructing knowledge through critical discussion (Kanselaar, de Jong, Andriessen, & Goodyear, 2000; Kanselaar, & Erkens, 1996).

We consider an argument to be a structured connection of claims, evidence and rebuttals. A minimal argument is a claim for which at least doubt or disbelief is expressed (van Eemeren, Grootendorst & Snoeck Henkemans, 1995). Such doubt or disbelief can be expressed by an individual (if working alone) or by a partner in an argumentative dialogue. In response to such doubts a complex structure may be produced potentially including features such as chaining of arguments, qualifications, contraindications, counter-arguments and rebuttals. Hence the argument is the product, the structure linking claims, the evidence or rebuttals. The process by which the argument is produced we refer to as argumentation.

Our interest lies in argumentation structures that are built by groups of students involved in collaborative problem solving and writing. During problem solving we expect students to make various claims about the domain and the potential solutions. It is possible that during the problem solving no doubt is expressed regarding claims and solutions and hence no argument emerges in the dialogue. However, such a situation seems unlikely and we believe would not produce the best solution to the problem. Certainly if the students have not produced reasons to support the claims and solutions during the problem solving process itself then we have no reason to believe that they will be able to produce such reasons at a later date. Therefore we believe that students should be encouraged to use argumentation processes to build argument structures during problem solving.

We will concentrate on students collaborating via computer mediated communication (CMC) systems. Communicative tools give access to collaborating partners through Computer Mediated Communication (CMC) facilities like chat and discussion forums, but also to other resources, such as external experts, or information sources on the Internet. In this respect, the program functions as a communication medium (Henri, 1995). The collaborative aspect is mainly realized by offering computerized tools that can be helpful for collaborating students in solving the task at hand (e.g., the CSILE program of Scardamalia, Bereiter & Lamon, 1994; the Belvédère program of Suthers, Weiner, Connelly & Paolucci, 1995). These tools are generally one of two types: task related or communicative. Task related tools support task performance and the problem solving process (Roschelle & Teasley, 1995; Salomon, 1993; Teasley & Roschelle, 1993). Programs that integrate both tool types are generally known as groupware: they are designed to support collaborative group work by sharing tools and resources between group members, and by offering communication opportunities within the group and with the external world.

This chapter addresses how argumentation processes can be supported in electronic environments. We studied students actively engaged in collaborative argumentation in order to solve open-ended problems such as writing argumentative texts, constructing hypotheses or designing computer-based learning programs. These types of problems are characterised by the existence of justifiable beliefs and multiple acceptable viewpoints, as described by Baker (1992), Andriessen, Baker, & Suthers (in press). In working on problems together, students first have to establish a (partially) shared focus, which can be changed, maintained or refined during the problem solving process (Roschelle, 1992). The focus determines the concentration on thematic parts (sub-problems) of the problem to be solved. Subsequently, information relevant to the sub-problem must be generated and gathered from mental or material resources. The next phase is to critically check its strength (Is the information true?) and relevance (Is the information appropriate?) before integrating it in the problem-solving process (for instance by assimilating new information in a writing assignment). Finally, after discussing alternative solutions the strongest and most relevant one must be chosen (Erkens, 1997).

4.2.1 Interface Design for Argumentation

To provoke and support argumentation in CMC systems, interaction can be structured at the interface. Dependent on task characteristics, students can be provided with dialogue markers, sentence openers and turn taking control (Veerman & Andriessen, 1997; Veerman, 2000; Veerman, Andriessen, & Kanselaar, 2000). These options might improve shared understanding, focus maintenance or critical assessment of new information. Additional options for free text interaction could stimulate elaboration whereas careful use of turn-taking control and dialogue rules could guide the interaction without constraining it. In addition, graphic representation of arguments might support exploration of multiple perspectives and identification of misconceptions and gaps.

Veerman & Treasure-Jones (1999) studied how to *provoke* and *support* argumentation in electronic collaborative problem-solving situations, considering the cognitive processes of critical information checking, argument elaboration and the taking of multiple perspectives. In addition, maintenance of focus was discussed as an important factor in effective argumentation and collaborative problem solving. Five studies on different CMC systems were reviewed, which were all designed for educational tasks and in which argumentation was emphasised as a method for collaborative problem solving or an end goal for learning. The selected CMC systems demonstrated a range of approaches to structuring interaction at the user interface in order to support communication, and more specifically, argumentation (e.g. turn-taking control, menu-based dialogue buttons, and graphical argument structures). In discussing the success of the systems at provoking and supporting argumentation, characteristics of the task, instruction and structured interaction were considered. The review revealed that structuring interaction at the interface does not necessarily *provoke* argumentation. Rather, the initiation of argument seems to be related to task characteristics, such as the use of competitive task design. However, providing a combination of structured and unstructured interaction modes may *support* argumentative processes. In communication windows (chat boxes), combining free text entry with well designed argument moves or sentence openers can stimulate students to critically check information. In task windows constructing argumentative diagrams can improve the exploration of multiple perspective taking and argument elaboration. However, some task characteristics can also enhance such processes. Therefore, task features and structured interaction at the user-interface must be considered in close relationship to each other in order to support argumentation in CSCL situations. In addition, offering support for focus maintenance was proposed as an important factor.

4.2.2 Argumentation in NetMeeting, Belvédère and Allaire Forums

In line with this research, three experimental studies were subsequently organised that examined student groups' academic discussions mediated by the synchronous CMC systems NetMeeting and Belvédère, and the asynchronous system Allaire Forums (Veerman, 2000).

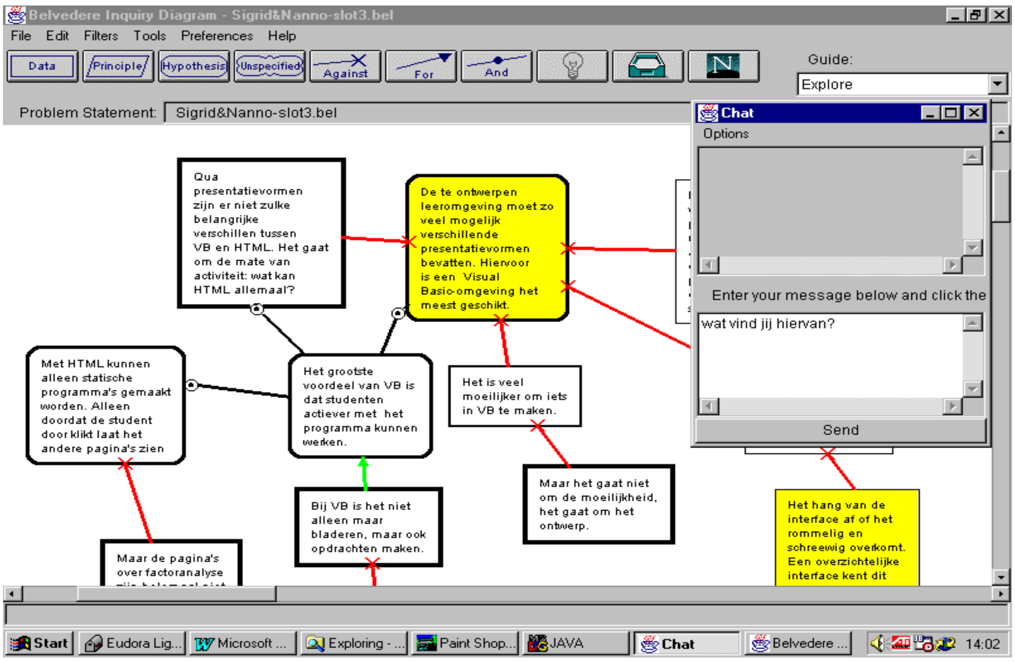

Figure 4.1: Screendump of the Belvédère system

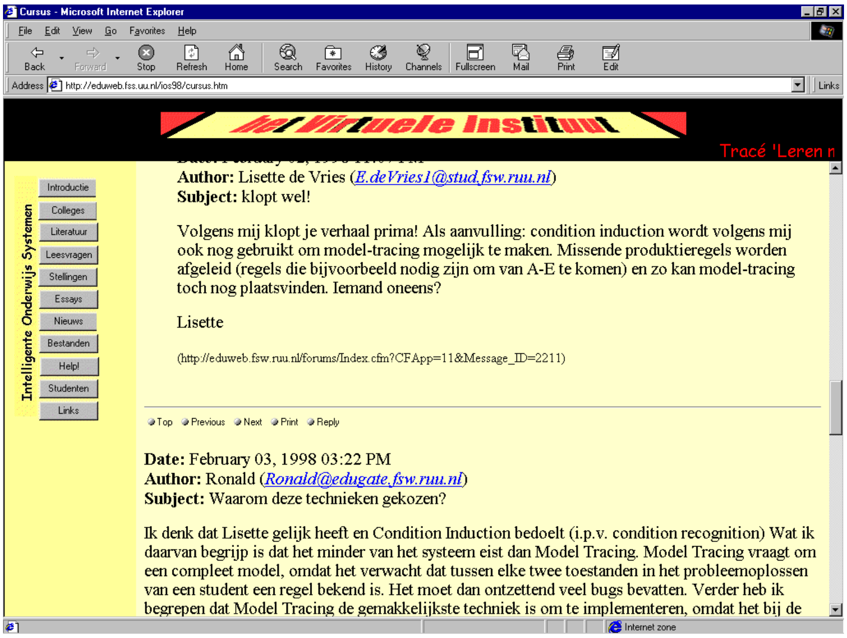

Figure 4.2: Screendump of a discussion 'thread' in Allaire Forums

All discussions were analysed and compared on the factors of focusing, argumentation and the production of constructive activities, a measure that was used to define collaborative learning-in-process. In addition, various forms of pedagogical support were considered, provided by humans or the user-interface.

The results can be summarised under the following three headings:

1. The results showed, first of all, that a study of collaborative learning from electronic discussions requires analyses of focus in relationship to argumentation. Constructive discussions were particularly focused on the meaning of concepts, and included focus shifts back and forth between the application of concepts, while information was critically checked.
2. Second, 'indirect' forms of argumentation in particular were shown to be effective (i.e. checks, mainly by verification questions), in contrast to 'direct' forms of argumentation (challenges, counter-argumentation). The more information was checked, the more constructive activities were produced. Absent effects of the 'direct' forms of argumentation were explained by the use of the following paradox: to engage in critical debate, students should have well-established views on subjects and be able to mutually recognise opposed knowledge and attitudes - (Baker, De Vries & Lund, 1999). However, a characteristic of the knowledge of students engaged in debates for collaborative learning purposes is that these views are not always well elaborated, since they are subject to the learning process.

3. Third, the discussions mainly contained additions, explanations and evaluations. Summaries or information transformations hardly occurred. This was due to the cognitive effort required, but also to an incomplete, intuitive and personalised understanding of information under discussion (Kuhn, 1991). To transform information, there must be a certain level of (shared) understanding. In the studies considering task characteristics, students' preparation activities, prior knowledge and time available for discussion, obtaining (deeper) understanding may have been the highest goal achievable. Reaching new insights may have been just the next step, for instance, when students were sufficiently prepared and had established a mutual framework for interpreting each other's information in order to engage in critical, hefty discussions (Coirier, Andriessen & Chanquoy, 1999).

4.2.3 Synchronous and Asynchronous Discussions

Discussions mediated by the synchronous CMC systems NetMeeting and Belvédère and the asynchronous CMC system Allaire Forums, appeared to have different characteristics concerning focusing, argumentation and the production of constructive activities. Relatively speaking, the synchronous discussions in NetMeeting and Belvédère included more 'direct' forms of argumentation (challenges, counter-argumentation), more focus shifts to non-task related issues, and they were less constructive than the asynchronous discussions in Allaire Forums. The asynchronous discussions were only 'indirectly' argumentative (including information checks), they maintained a more conceptually oriented focus and contained more constructive activities. To maintain a conceptually oriented focus and to co-ordinate interactions appears to be particularly related to the asynchronous and synchronous modes of communication. In synchronous discussions students engage in a fast flow of communication. Real-time pressures them (psychologically) to read and respond to each other's contributions within seconds or at most minutes. Focus shifts to non-task related aspects or technical issues easily cause students to lose track of an argument or to lose the overview of the main issues under discussion. In asynchronous discussions students may take hours, days, weeks, and sometimes even longer to read, write and think about contributions that triggered their interest, instead of seconds or minutes. More time may afford re-reading and reflection, keeping track of the line of discussion and treating non-task related interactions or technical disturbances for what they are: temporary, peripheral interruptions.

4.2.4 Support in CMC Systems

In all three studies human or interface support primarily aimed at promoting argumentative processes. However, no effects were found from human 'structure' coaches who supported the taking of multiple perspectives and counter-argumentation. 'Reflective' support increased the number of check questions asked, which later turned out to be powerful in relationship to the production of constructive activities. Graphical support on the Belvédère interface triggered students to produce more counter-arguments, a 'direct' form of argumentation. However, counter-argumentation was not related to effective student discussions. Then again, the Belvédère discussions were relatively more often conceptually oriented and constructive than the NetMeeting discussions. Perhaps the separate window for argumentative diagram construction particularly facilitated focus maintenance, and subsequently stimulated the production of constructive activities. It may be possible, however, that a tool for regular concept mapping[1] might have been just as effective as the diagram construction tool (Van Boxtel, 2000). It is not known (yet) to what extent the beneficiary effect is due to particular constructs of the Belvédère system.

To refer back to one of the earlier points mentioned, relatively speaking the asynchronous discussions in Allaire Forums were more often conceptually oriented and constructive than the synchronous Belvédère and NetMeeting discussions. The NetMeeting discussions were most often focused on finishing the task. However, in clustering the discussions on the factors of focusing, argumentation and constructive activities, some discussions in Allaire Forums were also found to be less effective; some Belvédère discussions were completely product-oriented and a few NetMeeting discussions were even found to be highly conceptually oriented and constructive. This indicates that in addition to features of the electronic systems and task characteristics, effective discussions also relate to individual group differences, such as task approaches, preparation activities or collaboration strategies, and to factors of the broader educational context.

4.3 The TC3 Environment

In addition to the studies described above with university students and well-known software applications, we will elaborate on a study in upper secondary schools with a new environment. In the COSAR project (Erkens, Prangsma, Jaspers, & Kanselaar, 2002) we developed the groupware program TC3 (Text Composer, Computer supported & Collaborative) with which the students carry out the main writing task. This environment is based on an earlier tool called CTP – Collaborative Text Production (Andriessen, Erkens, Overeem, & Jaspers, 1996), and it combines a shared text editor, a chat facility, and private access to a notepad and to information sources to encourage collaborative distance writing. The participants worked in pairs within TC3, each partner working at his/her own computer, and wherever possible partners were seated separately in different classrooms.

The main screen of the program displays several private and shared windows. The basic environment, shown in Figure 4.3, contains four main windows:

- The upper half of the screen is private and the lower half is shared.
- INFORMATION (upper right window): This private window contains tabs for the assignment, sources and TC3 operating instructions. Sources are

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1 Concept mapping homepage: http://www.to.utwente.nl/user/ism/lanzing/cm_home.htm

divided evenly between the students. Each partner has 3 or 5 different sources plus one – fairly factual – common source. The content of the sources cannot be copied or pasted.

- NOTES (upper left window): A private notepad where the student can make non-shared notes.
- CHAT (lower left, 3 small windows): The student adds his/her chat message in the bottom box: every letter typed is immediately sent to the partner via the network, so that both boxes are WYSIWIS: What You See Is What I See. The middle box shows the incoming messages from the partner. The scrollable upper chat box contains the discussion history.
- SHARED TEXT (lower right window): A simple text editor (also WYSIWIS) in which the shared text is written while taking turns.

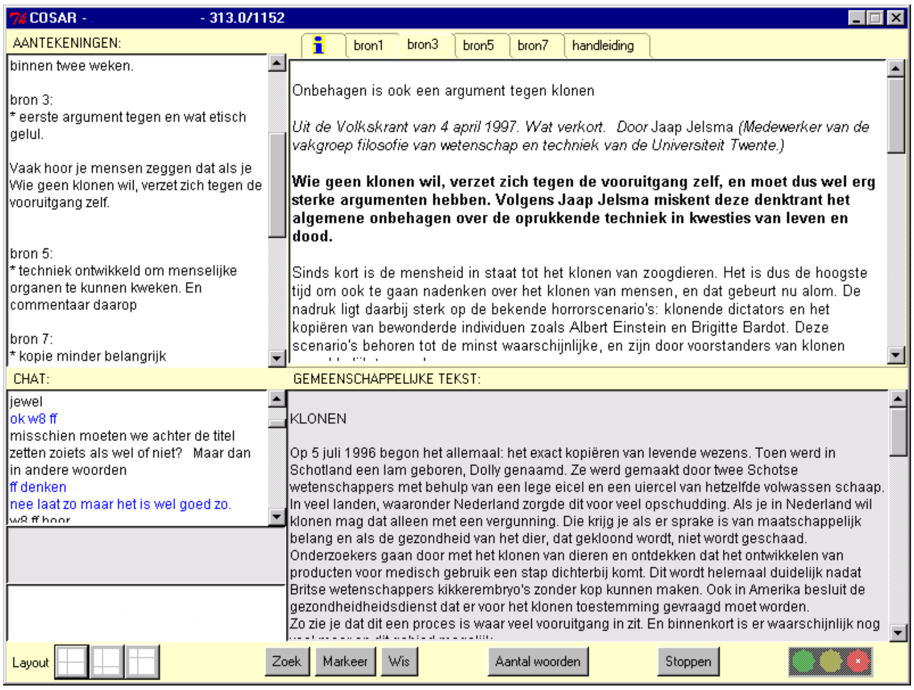

Figure 4.3: The layout of the interface of the TC3-basic environment

Text from the private notes, chat, chat history and shared text can be exchanged through standard copy and paste functions. To allow the participants to adjust their focus between their private work and the collaboration, three layout buttons were added in the left-hand corner: the middle layout button enlarges the private windows, the rightmost button enlarges the shared windows, and the leftmost layout button restores the basic layout. The buttons search; mark and delete (*zoek*, *markeer* and *wis*) can be used to mark and unmark text in the source windows and to search through the marked texts. The number of words (*aantal woorden*) button allows the participants to count the number of words in the shared text editor at any given moment. The stop (*stoppen*) button will end the session. The traffic light button serves as the turn taking device necessary to take turns in writing in the shared text editor.

In addition, two planning modules were developed in the TC3 program for the experimental conditions: the Diagram and the Outline. The Diagram (see Figure 4.4) is a tool for generating, organizing and relating information units in a graphical knowledge structure comparable to Belvédère (Suthers, Weiner, Connelly, & Paolucci, 1995; Suthers, & Hundhausen, 2001). The tool was conceptualized to the students as a graphical summary of the information in the argumentative essay. Students were told that the information contained in the Diagram had to faithfully represent the information in the final version of their essay. We hoped that this requirement would help students to notice inconsistencies, gaps, and other imperfections in their texts, and encourage them to review and revise. In the Diagram, several types of text boxes can be used: information (Informatie), position (Standpunt), argument pro (Voorargument), support (Onderbouwing), argument contra (Tegenargument), refutation (Weerlegging), and conclusion (Conclusie). Two types of connectors were available to link the text boxes: arrows and lines. The Diagram can be used to visualize the argumentative structure of the position taken.

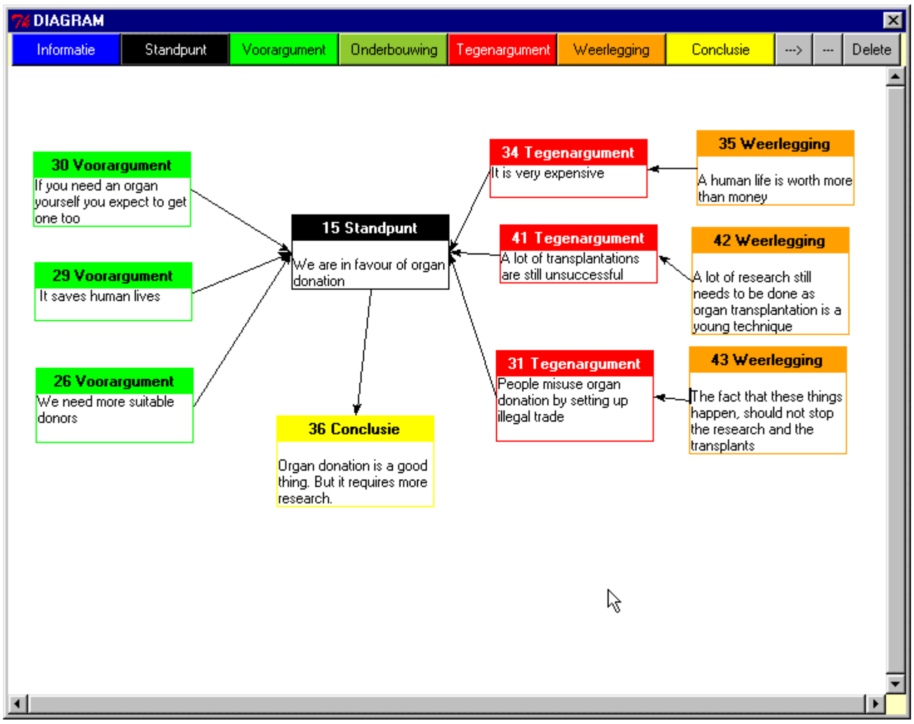

Figure 4.4: The Diagram Window in the TC3 program

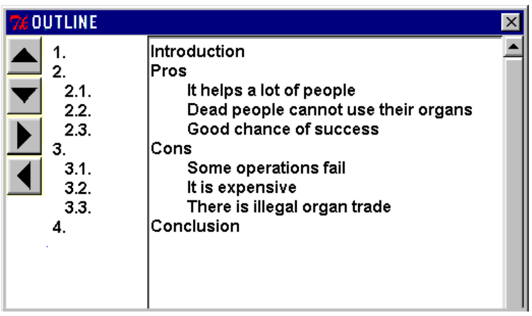

Figure 4.5: The Outline window in the TC3 program

The Outline (see Figure 4.5) is a tool in the TC3 program for generating and organizing information units as an outline of consecutive subjects in the text. The Outline tool was designed to support planning and organization of the linear structure of the texts. The tool was designed to allow students to construct an overview or hierarchical structure of the text to be written, to help in determining the order of content in the text. In addition, the Outline tool has the didactic function of making the user aware of characteristics of good textual structure, thus allowing the user to learn to write better texts. The Outline has a maximum of four automatically outline numbered levels. Both planning windows are WYSIWIS.

4.3.1 Hypotheses and Experimental Design

The effects of the organizer (Diagram) were expected to be related mostly to the consistency and completeness of the knowledge structure in the text (Veerman & Andriessen, 1997). The effects of the lineariser (Outline) were expected to be related mostly to the persuasiveness of the argumentation and the adequate use of language in the shape of connectives and anaphora (Chanquoy, 1996). We expected these effects to take place especially when both organization and linearization were supported, and explicit attention was being paid to translating the conceptual structure into the linear text. The main indicators of this would be increasing attention to the opposite position, and the use of counterarguments. A help facility, the Advisor, gave advice on how to use the Diagram and Outline tools.

In order to compare the effects of the planning tools on the process of collaborative argumentative writing a (quasi) experiment was set up varying the different combinations of planning tools. The effect of the tools on collaborative writing were investigated in the experimental conditions shown in Table 4.1.

The participants were 290 Dutch students aged 16 to 18 from six secondary schools. 145 randomly assigned pairs were asked to write an argumentative text of about 600 to 1000 words defending a position on cloning or organ donation. The shared text had to be based on information sources given within the groupware program.

All communication and activities during the collaboration were logged automatically in a chat and activity protocol. It is possible to replay a whole session with all the keyboard input, including typing errors, deletions, mouse clicks, etc. on the basis of the log file.

Table 4.1: Experimental design

	Condition	Tools
C	Control	TC3 basic
D	Diagram	Basic + Organizer
DA	Diagram Advisor	Basic + Organizer + Advisor
DO	Diagram Outline	Basic + Organizer + Lineariser
DOA	Diagram Outline Advisor	Basic + Organizer + Lineariser + Advisor
O	Outline	Basic + Lineariser
OA	Outline Advisor	Basic + Lineariser + Advisor

4.3.2 Writing in a Shared Space

The main task in this study was a collaborative writing task. The assignment was to write an argumentative text on cloning or organ donation. For organ donation each partner had five private sources plus one common source, so there were eleven sources in total. The sources were taken from the Internet sites of Dutch newspapers. The assignment was to convince the Minister of Health, Welfare and Sport of the position they had taken. For cloning the partners each had three sources and one common source, so there were seven sources in total. In all groups, partners were seated in separate computer rooms, to encourage them to communicate only through TC3.

The assignment was completed in two to six sessions with an average total duration of 3.9 hours.

4.3.3 MEPA: a Tool for Multiple Episode Protocol Analysis

We use the program MEPA to analyze all the data the students produce in the TC3 environment. The purpose of MEPA[2] (Multiple Episode Protocol Analysis), a program for protocol analysis, is to offer a flexible environment for creating protocols from verbal and non-verbal observational data, and annotating, coding and analyzing these.

The program is multifunctional in the sense that it allows for development of both the coding and protocolling systems within the same program, as well as direct analysis and exploration of the coded verbal and non-verbal data using several built-in quantitative and qualitative methods of analysis. In its current version, MEPA can execute frequency and time-interval analyses; construct cross-tables with associative measures; perform lag-sequential analysis, interrater reliability, visual, word frequency and word context analyses; and carry out selecting, sorting and search processes. Also, some aids for inductive pattern recognition have been implemented. MEPA uses a multidimensional data structure, allowing protocol data to be coded on multiple dimensions or variables. To minimize the work associated with coding protocols and to maximize coding reliability, MEPA contains a module that can be used to program

[2] MEPA was developed as a general program for protocol analysis and is being used in several research projects at Utrecht University, as well as abroad. For further information, please contact G. Erkens (G.Erkens@fss.uu.nl).

complex structured if-then rules for automatic coding. Figure 4.6 shows a screen dump of the MEPA program.

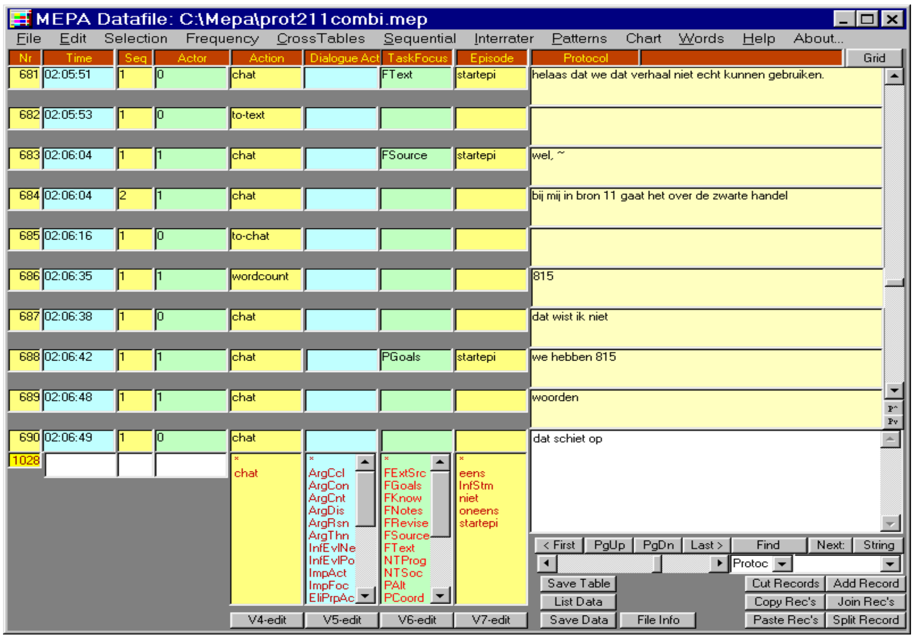

Figure 4.6: MEPA program for protocol analyses

4.3.4 Analysis of the Argumentative Texts

Each of the 145 student pairs produced one text, and these were analyzed on several dimensions. As a preparation for the final assessment, the texts were imported into MEPA, with a single sentence – defined by a period – per line. The sentences with potentially multiple argumentative functions were split into smaller units using an automatic splitting filter, so that the constituents of sentences such as “Cloning is good, but it can also have side effects” could be properly coded as position and argument contra. The sentences were split automatically where necessary on the basis of argumentative and organizational markers, such as but, however, although, therefore, unless. Before coding, the experimenters manually divided the final texts into segments, largely based on the existing paragraph structure. The final argumentative texts were scored on five variables.

Table 4.2: Description of text quality measures

Variable	Description
Textual structure	The formal structure of the text as defined by introduction, body, and conclusion.
Segment argumentation	The quality of the argumentation within the paragraphs.
Overall argumentation	The quality of the main line of argumentation in the text.
Audience focus	The presentation towards the reader and the level of formality of the text.
Mean text score	The mean of the four scores above.

4.3.5 Analyses of the Chats

The chat protocols were not analyzed at a propositional level like the argumentative texts, but rather at an episode level based on the task oriented collaboration process.

The chat protocols were manually divided into episodes of different Task act categories. Whenever the focus of the discussion changed within a particular type of Task act, a new episode was started as well. In addition, MEPA automatically coded a new episode whenever the partners had not used the chat window for more than 59 seconds.

4.4 Results

4.4.1 Structural Characteristics of the Chat Dialogue

This section[3] contains a description of the results for the structural characteristics of the dialogue in terms of communicative functions and dialogue patterns within the collaboration dialogues, and the relationship between these features and the final product, the argumentative text. Table 4.4 shows the distribution for the five communicative functions for the Control group and for each experimental condition.

The distribution for all groups together shows that Informatives occur most frequently (37,66%), followed by Responsives (24,06%). Argumentatives make out an encouraging 10% of the communicative functions, and Imperatives are the least frequent with 7,93%.

Compared to the other conditions, the Control group uses significantly fewer Argumentatives, especially in comparison to the Diagram, Diagram-Advisor and Outline conditions. Imperatives are more frequent in the Diagram-Outline-Advisor condition, but less frequent in the Diagram and Diagram-Advisor conditions. The Diagram-Outline-Advisor condition also used fewer Informatives, and the Outline-Advisor group used relatively few Responsives.

Table 4.3: Communicative functions and Dialogue acts in chat discussions

[3] Thanks to Floor Scheltens who assisted in the data analyses.

Communicative function	Dialogue act	Specification	Explanation
Argumentatives	Reason		Ground
	Contra		Counterargument
Argumentative task focus	Conditional		Condition
	Then		Consequence
	Disjunctive		Disjunctive
	Conclusion		Conclusion
Responsives	Confirmation		Confirmation of information
	Deny		Refutation of information
Reaction, or response to an elicitative	Acceptation		Acceptation of information, without confirming or refuting the information
	Reply	Confirm	Affirmative response
		Deny	Negative response
		Accept	Accepting response
		Statement	Response including a statement
		Performative	Response containing an action performed by saying it
Informatives	Performative		Action performed by saying it
	Evaluation	Neutral	Neutral evaluation
Transfer of information		Positive	Positive evaluation
		Negative	Negative evaluation
	Statement		Statement
		Action	Announcement of actions
		Social	Social statement
		Nonsense	Nonsense statement
	Task		Task information
Elicitatives	Question	Verify	Yes/no question
		Set	Set question/ multiple choice
Questions or utterances		Open	Open question
requiring a response	Proposal	Action	Proposal for action
Imperatives		Action	Order for action
Commanding utterances		Focus	Order for attention

Table 4.4 shows the mean percentages of the main Dialogue acts. The distributions within the communicative functions (see Table 4.3 for specific categories) are very similar for all conditions, so we will only discuss the total sample here. Within the Argumentatives, the relatively most frequent Dialogue act is Contra: counterarguments (4%). This is a nice surprise, as relatively novice writers are usually thought to use counterarguments quite sparsely (Veerman, 2000). The verifying question is relatively most frequent in the Elicitatives (10%), followed by proposals (6%) and open questions (5%). Urging the partner to take action or fulfill a task is the more frequent Imperative with 5%, although asking for attention follows closely behind at 3%. Task information is exchanged relatively often (Statement Info 26%), while evaluative informatives are used less frequently (4%). Finally, within Responsives the most frequent Dialogue acts are Confirmation (13%) and plain replies (Reply Statement 4%).

Table 4.4: Distribution of communicative function in the chat dialogues in percentages

	Total	C	D	DA	DO	DOA	O	OA
	Mean	M	M	M	M	M	M	M
Argumentatives	9.80	8.98	10.74	10.51	9.72	9.03	10.70	9.04
Elicitatives	20.55	20.46	21.26	20.39	20.92	19.30	20.11	21.30
Imperatives	7.93	8.06	6.40	6.36	7.68	10.74	9.18	9.18
Informatives	37.66	38.65	36.04	38.28	37.93	33.94	36.50	40.22
Responsives	24.06	23.84	25.56	24.45	23.75	26.99	23.51	20.26
Total number of contributions	425.37	421.15	312.59	441.81	518.00	460.27	401.72	385.91
N (dyads)	145	39	17	26	23	11	18	11

Note: Standard deviations of the variables were between 1.82 and 6.11. See Table 4.3 for a description of the categories in the first column and Table 4.1 for a description of the conditions.

4.4.2 Transitions Between Dialogue Acts

Figure 4.7 and Figure 4.8 show the transition diagrams made by the MEPA program for the Control and the Diagram condition. We will discuss the other transition diagrams too, but they are not shown here. The transition diagrams result from lag-sequential analyses (Wampold, 1992). In lag-sequential analysis the number of transitions of one event to the next (lag = 1) are tested for significance with regard to the expected number of transitions of that type based on the distribution of probability. In the diagrams, only the significant transitions are shown, with the width of the arrows indicating the level of significance. A large number of different transitions in the diagrams points towards unstructured dialogues: the fewer arrows, the more structured the dialogues were for that condition. A relatively high number of autocorrelations – indicated by the circular arrows – also indicates relatively unstructured dialogues. For readability reasons, a number of categories from Table 4.3 were merged in these analyses.

The Control group with only the TC3 basic environment, shown in Figure 4.7, differs from the experimental conditions with extra tools: this group shows a lot more different significant transitions between the Dialogue acts. The Control group displays relatively more different patterns than the experimental groups, and 8 out of 19 of its Dialogue acts show autocorrelations, which means that the dialogue is less structured in the Control group. Possibly, the planning tools in the experimental groups stimulate structuring of the dialogue.

All transition diagrams show one typical pattern in particular: the arrows from open questions (EliQstOpn) and verifying questions (EliQstVer) to statement replies (ResRplStm). Although the obvious answer to a verifying question would be a denying or accepting reply (ResDen or ResAcc) in all seven conditions verifying questions are relatively often answered with an elaborated statement.

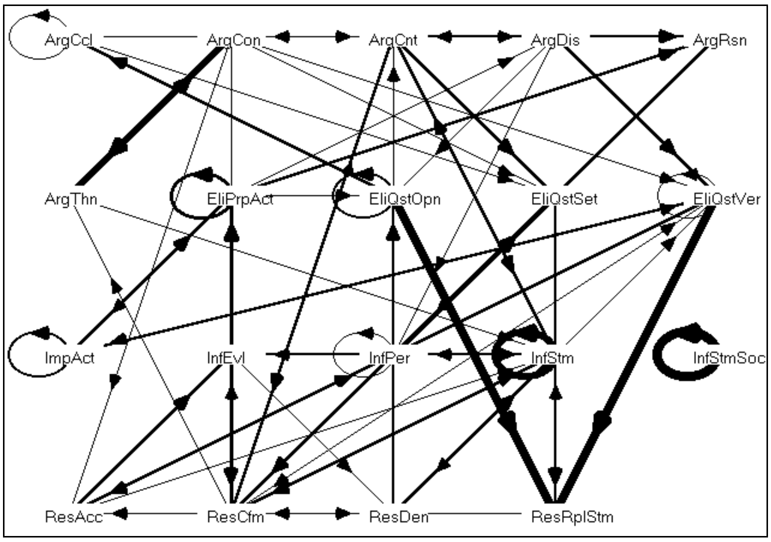

Figure 4.7: Transition diagram for the Control group

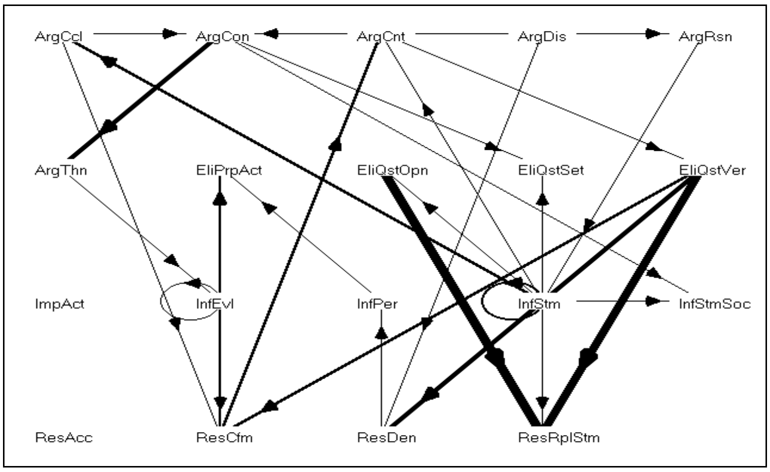

Figure 4.8: Transition diagram for the Diagram condition

Another characteristic pattern is the strong presence of argumentative sequences throughout the conditions (see upper half in Figure 4.8). Only the Diagram-Advisor condition differs on this point, as it shows fewer transitions between argumentatives than any other condition. The Diagram-Advisor condition generally differs from the other experimental conditions in its transitions. There are more significant transitions and these transitions are different from the ones that occur in the other experimental groups. For example, argumentative conclusions (ArgCcl) are followed significantly by social statements (InfStmSoc), conditionals (ArgCon) are followed significantly by imperative actions (ImpAct), and there are relatively many transitions to accepting responsives like *mmm* or *oh* (ResAcc). Just like the Control group, the Diagram-Advisor condition contains a relatively large number of autocorrelations.

The transition between 'if'-argumentatives (ArgCon) and 'then'-argumentatives (ArgThn) is not significant for the Outline and Outline-Advisor conditions, whereas the transition *is* significant in the Control group and the conditions with the Diagram. Possibly, the diagram stimulates the use of if-then patterns, whereas the Outline suppresses these patterns.

4.4.3 Relation of Dialogue Structure and CMC-tools with Text Quality

Four out of five measures for dialogue structure in the chats show some significant correlations with the quality of the final text (Table 4.5). The Elicitatives correlate positively with most of the text scores, while the Informatives are predominantly negatively correlated. This suggests that asking questions and making proposals leads to a productive argumentative writing process, whereas exchanging neutral information brings about the opposite. This assumption is supported by the more detailed analyses of the subtypes of Dialogue acts: these show that the main contributors to the negative correlations for Informatives are the nonsense statements and the social talk. The Argumentatives and Imperatives each correlate positively with only one text quality measure. The Responsives do not correlate with text quality at all.

Table 4.5: Correlations between communicative functions and final text scores

	Textual structure	Segment argumentation	Overall argumentation	Audience focus	Mean text score
Argumentatives	-.01	-.01	.13*	.05	.06
Elicitatives	.00	.17**	.12*	.21**	.18**
Imperatives	.14*	.01	.01	-.09	.02
Informatives	-.06	-.10	-.24**	-.13*	-.19**
Responsives	-.03	-.02	.10	.01	.02

Note: * $p < .05$; ** $p < .01$.

We also tested for the effects of dialogue structure in the chats and conditions with different tools on the quality of the final text. To check the possibility that condition and communicative function affect text quality independently of each other, we tested the model presented in Figure 4.9.

Table 4.6 shows the directions of the effects of condition and communicative function on text quality. In these regression analyses all communicative function measures and all conditions were entered in the regression with the quality measures as dependent variables. Independent of the dialogue activity (communicative function), the Diagram-Advisor condition negatively influences textual structure, whereas the Diagram-Outline-Advisor condition has a positive effect. Adding a third planning aid –

the Outline – seems to enhance the structural quality of the final text (either directly or through some unidentified factor).

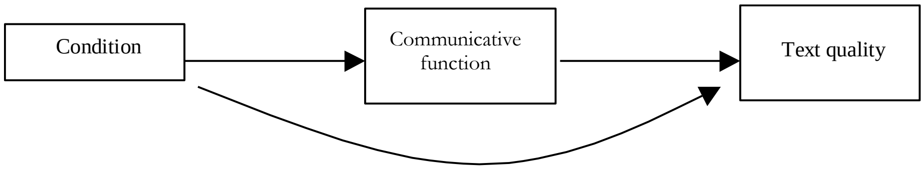

Figure 4.9: Effect of the conditions and of the dialogue structure of the chats on text quality

Elicitatives have a positive effect on audience focus and on quality of the argumentation at the segment level. Informatives have a negative effect on the argumentative quality of the text as a whole. In addition, a lower percentage of Informatives in the chat goes together with higher overall text quality. Collaboration with an argumentatively and structurally good result requires little informing, but does require frequent argumentation, asking accurate questions, responding to the partner, and use of imperatives.

Table 4.6: Relation of communicative function and experimental condition with text quality

	Textual structure	Segment argumentation	Overall argumentation	Audience focus	Mean score
Argumentative					
Elicitative		+		+	
Imperative					
Informative			-		-
Responsive					
D					
O					
DO					
DA	-	-			
OA					
DOA	+				

This model hypothesizes that the experimental condition affects text quality through the dialogue, but also directly, independent of the communicative function of the chat.

4.5 Discussion and Conclusion

Education can be viewed as an ongoing process of argumentation (Petraglia, 1997). It is the process of discovering and generating acceptable arguments and lines of reasoning underlying scientific assumptions and bodies of knowledge. In collaborative learning, students can negotiate different perspectives by externalising and articulating them, and learn from each other's insights and different understandings. Thus, through negotiation processes, including argumentation, they can reconstruct and co-construct knowledge in relationship to specific learning goals.

The present research suggests that the role of argumentation needs to be reconsidered. Across studies, 'direct' forms of argumentation (challenges, counter-argumentation) did not relate well to the production of constructive activities, a measure to define learning-in-process. This may be explained by the paradox that students should have a well-established understanding of knowledge in order to take firm positions. However, their knowledge is under discussion and subject to the learning process itself. Therefore, offering support to students to challenge and counter each other's information may not be the most fruitful approach. However, information checking was shown to be important, which was regarded as an 'indirect' form of argumentation. The more information was checked, the more constructive activities were produced. Students can be provoked to critically check each other's information through instruction and task design.

With regard to computerised learning environments, the research indicates that students particularly need facilitation by means of tools and explicit instruction in co-ordinating electronic and text-based communication, and in keeping track of the main issues while producing networked-based discussions. Technical disturbances and a loss of thematic focus easily occur, especially in synchronous CMC systems, and have a negative effect on collaborative learning processes. Additional tools to keep a (graphical) overview of the issues at hand can be helpful, such as the diagram construction tool provided by the Belvédère system and the TC3 program.

In research by Erkens (1997), focusing, checking and argumentation were revealed as essential factors in collaborative learning processes. In addition, parallel studies aimed at argumentation, epistemic interactions and grounding processes contributed to gaining more understanding of the mechanisms that can support collaborative learning through (electronic) dialogue. We presented some results of a couple of studies in this chapter to explore those relations more in depth.

We found that the Diagram, Outline and Diagram-Advisor conditions all have a positive affect on the number of Argumentatives. This suggests that the moderate availability of extra tools has a positive influence on the number of arguments in the chat, and also on some aspects of the quality of the argumentative text.

The transition patterns show that the experimental groups are more structured in their direct communication than the Control group. This suggests that the planning tools (Diagram, Outline, Advisor) stimulate a more structured dialogue. The same difference in the structure of dialogues can be observed when comparing high scoring and low scoring dyads. This leads us to conclude that the experimental condition (extra tools) has a direct effect on text quality, but also through the communicative function in the chat dialogues.

Some of the results in the last study (Erkens, Prangsma, Jaspers, & Kanselaar, 2002) are not simple to interpret.

The analyses of chat dialogues about the Diagrams suggest that for some participants this tool did not serve as a basis for discussion or a tool for idea generation, as it was intended, but rather functioned as a visual representation. The correspondence of arguments between Diagram and the final text reveals a discrepancy between the two: only about a third of the arguments are found both in the final text and the Diagram. Although the use of wholly original arguments seems to be slightly positively related to text quality, these are hardly used, and most of the arguments are taken directly from the given sources.

With respect to these results, the study of Veerman (2000) can be mentioned in which students used the Belvédère environment to chat electronically and to visualize their discussion about a computer-based design by the use of an argumentative diagram construction tool. It showed that the students only gained from the Belvédère environment, when they linked their chat discussions closely to their diagrams. A significant relationship was found between the amount of overlapping information between chats and diagrams, and the amount of constructive activities produced (Veerman, 2000). However, student groups varied in linking information between chats and diagrams. This appeared to depend heavily on student groups' task approaches and preparation activities.

We also found that using the private – hence non-collaborative -– notes window (the upper left window in Figure 4.3) is detrimental to the quality of the collaborative product. This confirms our idea that collaboration is necessary on all subtasks, including planning, idea generation, coordination and information processing.

We also found that explicit argumentation on content, coordination, and metacognitive strategies is related positively to text quality, whereas argumentation on technical aspects of the task and on non-task related topics is related negatively to text quality. The relation between non-task chat and text quality is negative throughout the groups, although the relation is the most clear for the Control group.

When we compare the Diagram (Figure 4.4) with the Outline (Figure 4.5), the Outline tool was more successful. Availability and proper use of this planning tool have a positive effect on the dialogue structure, and on the coordination processes of focusing and argumentation, as well as on text quality. The Diagram often functions as a visual representation, and not as a basis for discussion or a tool for idea generation. When a diagram reflects the discussion itself, it can be a valuable starting point for writing the text, and of benefit to textual structure. Students don't have much experience with the use of Diagram tools. Perhaps a different approach to the task instruction – for example by giving the students time to practice using the complex Diagram tool – could encourage the students to use the tool as it was intended, and thus lead to different results.

Much is possible in electronic learning environments, but so far not enough is known about the relationships between collaborative learning, argumentation and educational technology. This research has shown that such relationships are neither simple nor very predictable. Hence, much more research is needed that examines the role of (interactive) mechanisms such as argumentation and focusing in relationship to features of CSCL situations.

4.6 Acknowledgements

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