Chapter 5

CO-CONSTRUCTING MEANING THROUGH DIAGRAM-MEDIATED ELECTRONIC DISCUSSION

The aim of this research is to provide suggestions for computer support to enhance collaborative learning through argumentative discussion. We focus on small groups of academic students engaged in electronic discussion using the Belvédère environment, a networked software system for synchronous chat discussion and argumentative diagram construction. We are specifically interested in the relationship between chat discussion and argumentative diagram construction. Our approach is to characterise chat discussions on focused argumentation and constructive contributions and to analyse the diagrams on organisation and selected information from the chat discussion. The results show a complex interplay between chat discussion, diagram construction and student groups’ characteristics, which partly overlaps with some earlier findings (Veerman, Andriessen & Kanselaar, 2000). We discuss our results in the light of guiding the development of support for effective student interaction.

5.1 Introduction

Computer-supported collaborative argumentation (CSCA) is concerned with problems such as how computer-mediated situations for argumentative interaction should be designed in order to support learning. For some it has been well attested that under certain conditions, specific forms of communicative interactions can be vehicles for learning (e.g. Baker, De Vries & Lund, 1999). Such 'epistemic' interactions focus on meanings of terms and concepts in a domain, and characteristically involve argumentation and explanation (Ohlsson, 1995; Baker & Bielaczyc, 1995; Baker, 1999). In CSCA, one of the conditions relates to the role of the communication interface and the learning environment. The main issue is how the communication interface should be designed in order to provoke and support epistemic interactions to facilitate learning and problem solving with computers (Veerman & Treasure-Jones, 1999). Research on interface design has taught us that such questions cannot be easily answered by systematically varying interface characteristics. Indeed, the affordances of an interface design interact with aspects such as the knowledge domain, the task, types of instruction, the type of learners and the mode of communication (Veerman, Andriessen & Kanselaar, submitted). This is why we prefer to talk about an environment, instead of a system or an interface.

Baker et al. (1999) propose three general conditions favouring the production of epistemic interactions, two of which concern the interface. First of all, to focus discussion, the interface should display the ideas under discussion as well as students’ opinions with respect to them (e.g. Suthers & Weiner, 1995). Secondly, the effort to produce a message and to manage the communication should be minimised (see also Baker & Lund, 1996). Finally, the topic of discussion should be debatable (Golder & Pouit, 1999), and participants should have well elaborated views and clearly expressed and mutually recognised opposed attitudes with respect to the subject of debate. It should be noted that with respect to learning, the third constraint presents a paradox: a characteristic of the knowledge of students engaged in debates for learning purposes is that it is not always well elaborated. With respect to the second condition, despite serious attempts to design an interface befitting their requirements, Baker et al. (1999) still report a high degree of effort by students needed for interaction management.
The current work concerns the first condition. We present a study on the relationship between synchronous chat discussion and argumentative diagram construction using the Belvédère environment, a networked software system that supports these facilities (Suthers & Weiner, 1995). We focus on students collaboratively trying to reach understanding and insight into concepts relevant to a design problem at stake. Specifically, our focus is on meaning co-construction through epistemic interaction. The term 'co-construction' implies that new meaning or understanding does not necessarily arise as a function of individual activities but may be constructed in interaction, particularly during argumentation (Baker, 1996; Baker, 1999). We aim to characterise and evaluate students’ discussions in terms of interaction and argumentation, collaborative learning and use of the environment.

The remainder of the article comprises two sections. In the first section, the Belvédère environment is described on its pedagogical affordances, also in reference to an earlier Belvédère study we conducted. Then, the educational context is described and subsequently, the main research variables are presented. These variables are explained in close relationship to the so-called NetMeeting study, a study we carried out in the same line of research. However, the NetMeeting system was only used as a basic tool for synchronous chat discussion and not for argumentative diagram construction. In the second section, the present Belvédère experiment is discussed. The method of analysis is presented before describing the results in detail. Finally, some conclusions are drawn and perspectives are offered for future research.

5.2 Background issues

5.2.1 The Belvédère environment and its pedagogical affordances

The Belvédère environment is a synchronous networked software system developed by Dan Suthers and others at the Learning Research and Development Center at the University of Pittsburgh (Suthers & Weiner, 1995; Learning Research and Development Center, 1996; Suthers, 1998). Belvédère was originally developed as a tool for secondary school students (age 12 - 15) to reconstruct scientific arguments by constructing argumentative diagrams on the basis of scientific information. To communicate, each student has a text-based chat box in which multi-line messages can be created and sent. Messages, coupled with the writer’s name, are displayed in a shared chat history. Students can only add data into the diagram by using a predefined set of text boxes ('hypothesis',

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'data', 'unspecified') and links ('against', 'for', 'and'). Boxes and links with different functions have different shapes or colours. These are shown in the menu bar of Figure 5.1.

Figure 5.1. The Belvédère system.

In this contribution, we examine the idea (not necessarily the opinion of its developer) that Belvédère forms an appropriate and dedicated interface for organising and understanding argument in collaborative learning tasks. Literature on graphical representation and comprehension generally shows that such representations foster comprehension when they support a focus by transparency on salient and important features of a task (Ghyselink & Tardieu, 1999; Reimann, 1999). In its most basic form, an argument can be seen as an organised structure of a claim and evidence oriented for and against the claim. This structure is essentially not linear (McCutchen, 1987; Adam, 1992; Coirier, Andriessen & Chanquoy, 1999). Hence, linear interfaces may not be optimal for supporting and representing such a structure. In addition, linearisation is considered to be one of the most important problems for coherent argumentative text production. To put an argument onto paper, strategic mental effort is required, and considerable linguistic competence needed (Coirier, Andriessen & Chanquoy, 1999). Hence, non-linear representation of argumentation might facilitate learning and understanding, because it
may be easier to construct than a linear argument, thereby leaving more room for attention to other aspects of a learning assignment. In addition, a diagram as a representation of argumentation may be easier to understand and serve as a better source for further debate than linear text. The diagram could be particularly supportive if it is used in a manner closely linked to the chat and serves to trigger discussion about arguments that are still unclear, or not yet stated, discussed or justified (Veerman & Treasure-Jones, 1999). The diagram construction tool, therefore, may help students to organise their argument and to keep track of the main issues under discussion.

Input into the Belvédère diagram construction tool is constrained by a labelled set of argument boxes and links. Students, nevertheless, are free to fill in boxes with any information they like. A general expectation is that students will be cued by the labelled argument boxes and links, which correspond to the input of arguments that can be oriented and organised for and against a claim (Kozma, 1991). In other words, they will use the tool to represent the content of arguments and not procedural matters. A first study with the Belvédère system confirmed this expectation (Veerman, Andriessen & Kanselaar, submitted). The study took place in the context of an academic course on Computer Based Learning (CBL). Small groups of students were instructed to use the Belvédère system for a discussion about learning goals and pedagogical aspects concerning the design of a CBL program. The students produced 14 dialogues and corresponding diagrams (7 pairs * 2 assignments). The number of statements and arguments expressed (pro and contra) in both the chat discussions and the corresponding diagrams were measured and compared. The results showed that the diagrams contained a higher proportion of content information (statements, arguments, elaborations) and a better balance between positively and negatively oriented arguments.

The Belvédère environment may enhance the process of collaborative learning through diagram-mediated argumentative discussion. The diagram construction tool may support students in organising their arguments and keeping track of the discussion by representing (discussed) information. This may trigger new discussion in the chat, about issues raised by the organised representation, maybe in the form of elaboration of discussed content or as arguments that have not yet been discussed or justified. In addition, use of a diagram may affect task approaches, in the sense that the argumentative orientation of the discussion may be fostered, displayed by a focus on meaning negotiation. The question whether such support fosters a focus on important features of a task should be
reformulated in this light. In this research we discuss data pertaining to some of the conditions under which meaning negotiation may emerge. The main question can be generally formulated as: *What is the relationship between ongoing chat discussion and the produced argumentative diagrams?* The next paragraphs serve to explain the manner we wish to attack this question.

### 5.2.2 Educational context

The participants in our experiments are undergraduate students in Educational Technology. In this academic area, students have to deal with open-ended, ill-structured, vague, abstract and complex concepts or problems. Conceptual understanding and problem solutions may legitimately vary with prior knowledge, general opinions and personal beliefs and values (Petraglia, 1997). While the main thrust of the curriculum can still be taken as transmission-based (Andriessen & Sandberg, 1999), there are attempts at introducing more open tasks, such as writing and discussion, including collaborative learning and the use of electronic means.

In collaborative learning, students can externalise and discuss the meaning of concepts and problems to compare and contrast different ways of understanding or handling them. This can be particularly effective when students encounter conflicts and manage to produce a shared meaning or problem solution through negotiation. Argumentation may trigger students to rethink their understanding of a problem and to revise conceptual knowledge, beliefs and values (e.g. Piaget, 1977; Doise & Mugny, 1984; Baker, 1996; Erkens, 1997; Savery & Duffy, 1996; Petraglia, 1997). The educational objective of using the electronic collaborative learning tasks that we focus on is for students to co-construct meaning in order to promote understanding and insight into conceptual knowledge, not to learn argumentation or debate strategies. Our research focuses on creating the appropriate environments to foster such collaborative learning, especially through argumentative discussion.

Not all collaborative assignments lead to argumentation and not all argumentative discussions foster learning (Baker, 1996; Veerman, Andriessen & Kanselaar, submitted). To understand and support students’ argumentative discussions so as to facilitate learning, we have to be more detailed than that. The problem is, where to look and what to look for. Full insight into collaborative learning tasks is a long-term goal to strive for, but at this
moment, we have to look for interesting observations in large amounts of data. In our research we have established a limited set of variables, which seem to be important in this respect (Veerman, Andriessen & Kanselaar, 2000). These variables are derived from collaborative learning research, and will be discussed in the next sections.

To understand the role of argumentation in the process of collaborative learning in electronic situations requires characterising sequences of interaction as to their relation to the learning and task goals. In open tasks, such as writing or discussion about meaning, it is hard to characterise learning as the result of completion of a single assignment. Approaches to discourse analysis do not seem to support the openness and complexity of our educational setting and the unpredictable unfolding of the discussion itself. Many approaches require well defined concepts or problems that can be divided and subdivided until an 'atomic' level has been reached (e.g. Katz, O'Donnel & Kay, 1999). Others are content-free but based on formal dialogue classifications, such as speech act pairs (e.g. Question/Answer; Argument/Counter-argument), or strict dialogue rules (e.g. Moore, 1993). Flexible systems, such as the DISCOUNT scheme (Pilkington, 1999), aim at levels and categories to describe properties of dialogue in detail.

For our purpose, the examination of the relationship of argumentation to collaborative learning in Belvédère discussions and diagrams, we present a limited approach with respect to the number of selected variables and categories. This does not allow us to model the dialogue as a whole, but may give us the opportunity to characterise the relationships between the variables. The variables we choose are based on previous research. Another restriction of the research should be noted: we do not want to tutor our students. Hence, we are not looking for correct answers or flawed arguments on the part of the students but we focus on the collaborative learning processes themselves.

5.2.3 Research variables

In this section, our main research variables are presented in close relationship to an earlier study, in which we assessed collaborative learning through argumentation by using the NetMeeting system (Veerman, Andriessen & Kanselaar, 2000). NetMeeting is a networked software system, allowing synchronous chat and sharing of applications between several users over the Internet. The NetMeeting study was integrated into an academic course on Educational Technology and aimed at students’ development of reaching insight and
understanding in the 'Conversational Framework', a theoretical model for analysing tutor-student interaction (Laurillard, 1993). In this study, 20 student pairs were given a 45-60 minute discussion task, in which they were instructed to analyse a protocol of a tutoring session according to the 'Conversational Framework'. Student pairs were peer coached 'reflectively' (aimed at triggering justifications), 'structured' (aimed at counter-argumentation and multiple perspective taking) or not at all.

The analysis we undertook aimed at discovering to what extent effective chat discussions were related to argumentation and collaborative learning activities in these circumstances. In addition, we wanted to find out what effects the coached support would have in this respect. We looked for variables relating task approach to collaborative learning activities and argumentative moves in dialogues. As far as we know, such a combination of variables has not yet been studied explicitly. Based on research on collaborative learning and argumentation (Baker, 1996; Baker, 1999; Erkens, 1997) we analysed the NetMeeting discussions on the variables of (1) focusing, (2) checks, challenges and counter-arguments and (3) the constructive activities produced. In the next sections, each of these variables will be elaborated.

5.2.3.1 Focus

Focusing refers to the way the participants maintain the same topic in their dialogue. In collaborative learning, students have to initiate and maintain a shared focus on the task at hand. In order to achieve this, they generally have to agree on their interpretations of the overall learning goal, descriptions of the current problem-state, and available problem-solving actions (Roschelle & Teasley, 1995). Shifting focus, defined as failures to maintain a shared focus during the discussion, can result in less effective learning (Baker & Bielaczyc, 1995; Erkens, 1997).

Defining exactly what kind of focus should be shared and maintained is determined by the learning and task goals, as set by instructors or by the students themselves. In the NetMeeting study, students were supposed to reach insight and understanding of theories and concepts while discussing conceptual information in order to solve problems as set by the task. We identified three types of focus categories and two types of focus shifts:

(F1) focus on understanding the meaning of concepts (semantic level)
(F2) focus on the application of concepts (pragmatic level)
(F3) focus on task strategy or non-task related issues (procedural level)
(F4) focus shifts between conceptual issues (F1 + F2) and task-strategy / non-task related issues (F3)
(F5) focus shifts between understanding the meaning of concepts (F1) and the application of concepts (F2)

5.2.3.2 Argumentation

Critical assessment of each other’s knowledge and inferences is considered by many to be a characteristic of effective collaboration and learning (Petty & Cacioppo, 1986; Erkens, 1997; Buckingham Shum, MacLean, Bellotti & Hammond, 1997). Through argumentation, strengths, weaknesses and the understanding of information can be questioned and discussed. For our purposes, we are not (yet) interested in the effects of argumentation, as changes in beliefs or acceptance of positions. Our concern is the incidence of argumentation, when and how often it happens in terms of task focus, and whether or not it is related to learning activities.

In the NetMeeting study, we first selected all messages that were focused on understanding the meaning and the application of concepts (F1 and F2). Considering several approaches in the field of analysing Educational Dialogue (including analyses of Dialogue Games, Exchange Structures and Communicative Acts; see Pilkington, Treasure-Jones & Kneser, 1999), we subsequently categorised each of these messages as a general dialogue move (D), such as a ‘statement’ or ‘other’ (acceptances, conclusions etc.), or as one of the following argumentative dialogue moves:

(Da1) checks
(Da2) challenges
(Da3) counter-arguments

Checks were verification questions aimed at reaching understanding (e.g. "Do I understand it correctly..."); "Do you mean that...", "What do you mean by..."). Challenges were questions that expressed at least doubt and aimed at provoking justifications (e.g. "How do you know that..."); "Why do you think that..."). Counter-arguments expressed disagreement (e.g. "I don’t agree...", "I think it is the opposite/something else..."). Statements could include opinions, ideas, new claims etc. However, they were not aimed at expressing doubt or disagreement.
It should be noted that focusing and argumentation could be seen as co-ordination processes in discourse essentially dealing with content matters. The incidence and the nature of these co-ordination mechanisms are contingent on characteristics of the knowledge being constructed. Our concern here is still with the incidence of such activities, not their content.

5.2.3.3 Constructive activities

Learning can be the result of sudden insights, brought about by prolonged reflection, problem solving or passive leisure. The learning results in open tasks depend to a great extent on prior knowledge, beliefs and values of the learner and what is expected to be learned. It is hard to precisely assess this knowledge beforehand. In addition, because of the unpredictable nature of discussions, reliable post-tests are even more difficult to conceive. This does not mean that this is impossible, simply that the domain should be well researched and may have to be restricted on content before adequate tests can be developed. Interesting examples of such studies for the analysis of writing tasks can be found in Alamargot (1997) and Dansac and Alamargot (1999).

To examine collaborative learning, the option we put forward is to look at what happens with knowledge during the dialogue. Knowledge-building discourse can be viewed as an externalised and collective information network that is dynamic and in which content can grow or change by explicit constructive activities, such as additions of information, explanations, evaluations, summaries and transformations. Additions contain new information that cannot be linked to earlier chat messages. Explanations are linked to earlier chat messages, and for example differentiated, specified, categorised, or made clear by examples. Evaluations are (personally) justified considerations of the strength or relevance of already added or explained information. Information transformations are based upon evaluations and lead to new insights or directions for further discussion. In summaries, already stated information is (re)organised in such a way that selected points of the discussions are put in relation to each other and reflect the main content of the discussion. Some researchers speculate that in knowledge-building discourse ‘explaining’ is the major constructive activity (Scardamalia & Bereiter, 1994; p.274). We regard the production of constructive activities as signals of potential support for collaborative learning-in-process as they appear to be connected with knowledge-building discourse to co-construct meaning.
In the NetMeeting study, students tried to co-construct meaning by knowledge-building discourse in which they could produce constructive activities. Chat messages that focused on the meaning or application of concepts, therefore, were subsequently analysed on the production of constructive activities in addition to argument analyses (see Table 5.1).

Table 5.1. Categories of focusing, argumentation and constructive activities

<table>
<thead>
<tr>
<th>Focus</th>
<th>Dialogue moves, including argumentation (F1 &amp; F2)</th>
<th>Constructive activities (F1 &amp; F2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1: Meaning of concepts</td>
<td>D : statement, other</td>
<td>CA1: addition</td>
</tr>
<tr>
<td>F2: Application of concepts</td>
<td>Da1: check question</td>
<td>CA2: explanation</td>
</tr>
<tr>
<td></td>
<td>Da2: challenge</td>
<td>CA3: evaluation</td>
</tr>
<tr>
<td></td>
<td>Da3: counter-argument</td>
<td>CA4: summary</td>
</tr>
<tr>
<td>F3: Task strategy / non-task related issues</td>
<td>---</td>
<td>CA5: transformation</td>
</tr>
<tr>
<td>F4: Shifts between the meaning and application of concepts</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>F5: Shifts between conceptually oriented discussion (F1 &amp; F2) and task strategy / non-task related issues (F3)</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

In Figure 5.2, an example is shown of a NetMeeting chat discussion in which single messages (11-20) are analysed on respectively focusing, dialogue moves (including argumentation) and constructive activities. In this example, two students (S1, S2) are engaged in a chat discussion in order to analyse a protocol of a tutoring session. They try to analyse utterances by using the ‘Conversational Framework’. The framework offers a scheme with 12 categories that can be used for labelling single utterances. An instructed peer coach provides support on collaborative argumentation in order to enhance collaborative learning processes (T). Text and explanations are given below the analysed fragment in Figure 5.2.
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Figure 5.2. A NetMeeting chat discussion analysed on focus, argumentation and constructive activities.

In the NetMeeting study, students engaged in a fast flow of communication, in which they produced multiple messages per minute. They argumentatively checked, challenged and countered each other’s information and produced constructive activities.

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(mainly additions and evaluations). Argumentation, related to a focus on the meaning of concepts, proved to be important for the production of constructive activities.

To what extent epistemic interactions were related to argumentation and collaborative learning activities was further explored by executing a cluster analysis. Student pairs’ discussions were grouped on the interplay between focus, argumentation and constructive activities. The cluster analysis revealed that student pairs could be characterised as either (a) Conceptualisers: student pairs that engaged in meaning-oriented discussion; (b) Achievers: student pairs that engaged in product-oriented discussion, focusing on the application of concepts and aiming at finishing the task, or (c) Conceptual Achievers: student pairs that used a mix of meaning-oriented and application-oriented talk. Compared to product-oriented discussions, meaningful discussions could be characterised by focus shifts between the meaning and the application of concepts, argumentation and constructive activities. Thus, epistemic interactions appear to be particularly related to conceptually oriented argumentation and the production of constructive activities.

Conceptually oriented student pairs (a + c) did not profit from support offered by instructed peer students, however, the Achievers (b) did when 'reflective' support was aimed at checking information on strength and relevance. Finally, we concluded that the 1995 version of NetMeeting (2.0) was not an ideal system for synchronous discussion since many student groups encountered synchronisation problems. To establish an argument, students had to discuss information in the same communication interface as in which they had to discuss technical problems, planning issues and co-ordination aspects with respect to the task assignment. Conceptually oriented discussions were significantly interfered with focus shifts towards such types of task-strategy related interactions, which hindered the students to keep track of their discussion and to structure and organise their arguments.

In the present study, the Belvédère chat discussions are comparably analysed to the NetMeeting chats. Focusing, argumentation and the production of constructive activities showed to be functional variables in relationship to epistemic interaction, collaborative learning and the optimal use of the electronic system. The Belvédère environment, however, additionally provides students with a graphical tool for argumentative diagram construction. Therefore, additional diagram analyses are conducted and, three more variables are added: student groups’ preparation time, judgement of the usefulness of the
Belvédère sessions and group size. These variables are particularly of interest for next year’s implementation of the Belvédère sessions in our educational program: to plan when and how to prepare, group and engage students in the Belvédère discussion. For practical purposes, we use the results to look for some individual group differences affecting the production of constructive activities. The research questions are:

1. How can chat discussions, produced by student groups during argumentative diagram construction, be characterised in terms of focus, argumentation and the production of constructive activities?
2. How can argumentative diagrams, produced by student groups during chat discussion, be characterised in terms of organisation and to the correspondence of information from the chat discussion?
3. What is the relationship between ongoing chat discussion and the produced argumentative diagrams?
4. What is the relationship between student preparation time on the one hand and the chat discussions and constructed diagrams on the other hand?
5. What is the relationship between students’ group size on the one hand (2 or 3 students) and the chat discussions and constructed diagrams on the other hand?

5.3 Method

5.3.1 Subjects and method

In 1998, we integrated the Belvédère study in a regular eight-week undergraduate course on Computer-based learning (CBL), which involved 20 undergraduate students. They all had reached a comparable level in Educational Technology. During the introductory meeting of the course, the students formed eight small groups of their own choosing (4 * 2 students; 4 * 3 students).

Prior to the study, the first week assignment for all student groups was to construct learning goals for an educational computer program. All student groups could choose their own theme, nevertheless, they were asked to aim their program at the population of students and tutors within Educational Sciences. After a brainstorm session in week 2, student groups presented their ideas to the tutor in a face-to-face session. Ideas were evaluated on strength and relevance by discussing the students’ assumptions. Then, the student groups defined the learning goals and were subsequently asked to produce
conflicting claims on two pedagogical aspects (1) what pedagogical strategies to use in order to reach the learning goals and (2) how to sequence learning activities. In week 3, the next step was to discuss these claims in organised Belvédère sessions (60 - 90 minutes per session). Thus, each student group produced argumentative diagrams that were subsequently submitted as final products to the tutor. In week 4, these were used as input for face-to-face tutoring sessions in which student groups had to defend their conceptual plan before proceeding with a more detailed design.

Before entering the Belvédère sessions, the students received basic instruction and exercises on the technical use of Bélvèdere. A list of ground rules for critical argumentation was distributed, such as “be critical but co-operative”, “detect feigned or flawed argumentation” or “ask questions to verify information you are in doubt with”. We based these ground rules on Grice’s co-operative principles for communication (as discussed in Levinson, 1983), pragmatic ground rules for exploratory talk (Wegerif, Mercer & Dawes, 1998) and pragmatic discussion rules and fallacies (Van Eemeren, Grootendorst & Snoeck Henkemans, 1995), and see also the guidelines in Veerman, Andriessen & Kanselaar (submitted; 2000).

The eight student groups produced 13 chat discussions and 13 diagrams in total, which were automatically logged on the computer. Two student groups only engaged in one Belvédère session whereas another group chose a theme for which the second claim was not relevant (‘how to sequence learning activities’). Questionnaires were used both to evaluate the time students invested on the subject the week before they engaged in the Belvédère sessions and to assess the students’ judgement of the usefulness of the electronic discussions. The students stated their opinion (using a 5-point Likert scale from full agreement to full disagreement) on eight statements about task focusing, multiple perspective taking, raising new ideas and decision-making.

5.3.2 Data analyses

Chat discussions and diagrams produced were automatically logged as text files and pictures on the computer. Names were logged per message. Chat discussions were subsequently analysed on focusing, argumentation and constructive activities. Diagrams were analysed on thematic organisation and on the overlap of selected information from the chat discussion. Both chat discussions and constructed diagrams were then separately
grouped by a K-Means cluster analysis to iteratively identify and classify relatively homogeneous groups of chats and diagrams before relationships were further explored (Everitt, 1974). Finally, we gathered student groups’ preparation times, post-hoc evaluations and group size and related them to the clustered chats and diagrams. Below, we explain these analyses in greater depth.

5.3.2.1 Chat discussion analysis

First, all chat discussions were analysed on the focus of messages. Compared to the NetMeeting study, this time students not only had to co-ordinate their text-based discussion but also the building of a diagram. The following focus categories reflected this: (1) technical / off-task talk, (2) planning talk and (3) thematic talk.

Technical talk contained talk about the electronic connection established, about beeps and bleeps, about how to draw diagrams, boxes and links etc. Off-task talk contained talk about the weather but also about the Belvédère system on a meta level ("I am going to use this tool in my classroom, great!", “I do not see the use of such a program”). Off-task talk hardly occurred, therefore, the categories of technical talk and off-task were merged. Planning talk included discussion about how to start, continue or close the task, about discussion roles (for or against the statement), about time management and about proposals to put information into the diagram. Thematic talk included discussion in relation to the claim and statements and was divided into two categories: a focus on the meaning of concepts and a focus on the application of concepts. Focus shifts were all analysed in relationship to thematic talk, and included shifts back and forth between sections of:

1. Thematic talk and planning talk
2. Thematic talk and technical / off-task talk
3. Thematic talk focused on the meaning of concepts and a focus on the application of concepts
Messages focused on thematic talk (3) were subsequently analysed in more detail on types of (a) dialogue moves, including argumentation (statements, checks, challenges and counter-arguments) and on the presence of (b) constructive activities. Dialogue moves included an additional category called 'others', in which small numbers of acceptances, conclusions etc. were put that could not be coded as one of the main categories. Constructive activities only included messages in which information was added, explained, or evaluated since summaries and transformations hardly occurred.

5.3.2.2  

**Diagram analysis**

All diagrams were analysed on the number of themes (different issues that students talked about), statements and links, the organisation of thematic information and on information put into the boxes that overlapped with the content of chat messages. The number of themes was defined as the number of boxes that directly started from the claim. The number of statements included all boxes except the main claim and links were counted. We analysed the organisation of thematic information as follows.

Each information box is (in) directly linked to the claim. The minimal number of steps to go from an information box towards the claim is 1. An information box that is 2, 3 or 4 steps away is always linked to a box that is just one step nearer to the claim. At each step in the diagram \{1,2,3...n\}, we can measure the balance between positively and negatively oriented information boxes in relation to the claim by division. Zero balance means that students oriented their arguments only for or only against the claim. A balance of 1 means that students oriented as many arguments for as against the claim. The higher the number between 0 and 1, the better balanced an argument is (see Figure 5.1). Finally, the diagrams were analysed on overlapping information. Overlap between information that was expressed in the chat messages and put into information boxes was coded as a dichotomous variable: overlap / no overlap. Overlap was coded if (a) an information box literally overlapped with a chat message, (b) an information box partly overlapped with a chat message but kept the same subject and meaning, (c) an information box contained a paraphrased chat message but kept the same meaning.
5.4 Results

We analysed 13 chat discussions and 13 argumentative diagrams. Inter-judge reliability showed a Cohen’s kappa of 0.74 for the focus variable, a kappa of 0.83 for statements and argumentative moves, and a kappa of 0.78 for constructive activities (Cohen, 1968). There was a perfect agreement on organisation measurements; the kappa for overlapping information was 0.82. In qualitative data analysis, a Cohen’s kappa between .61 - .80 can be considered as ‘substantial’; a kappa between .81 - 1.00 is ‘almost perfect’ (Heuvelmans & Sanders, 1993; p. 450).

5.4.1 Chat discussions: results

As shown in Table 5.2, of all messages sent in the chat discussions (mean = 99 messages) a small majority was focused on technical / off-task issues and planning aspects (mean = 29 respectively 28 messages). The rest were thematic (mean = 42 messages), of which more messages were focused on the meaning of concepts than on the application (mean = 24 versus 18 messages).

Most focus shifts occurred between thematic talk and planning talk (mean = 12 shifts). More than half of the thematic messages were coded as argumentative moves (mostly checks, then counter-arguments, then challenges). Half of the thematic messages could also be coded as types of constructive activities (mean = 20; mostly additions, then evaluations, then explanations). Constructive activities comprised about 20% of the total number of messages sent in the chat discussions; however, it is 48% of all thematic messages sent.

Before executing a K-Means Cluster Analysis, we deleted three categories (counter-arguments, ‘others’ and focus shifts between concepts and planning) because of a high skewness (≥ ± 1) and kurtosis (≥ ± 1.5). The cluster analysis then iteratively classified the 13 chat discussions into three final clusters. We additionally requested descriptives and an analysis of variance F statistics to reveal information about each variable’s contribution to the separation of the clusters.

As shown in Table 5.2, first of all it is obvious that significant differences between the three clusters are partly due to the total number of (thematic) chat messages sent. Nevertheless, the clusters can additionally be described and explained on specific
characteristics. In Cluster 1, two chat discussions are classified. These chats are characterised by a high frequency of thematic messages (mean = 87), which are focused almost twice as much on the meaning of concepts than on the application of concepts (mean = 56 messages versus 31). Most focus shifts occur between thematic talk and technical issues (mean = 20 technical shifts versus 11 conceptual shifts). Within thematic discussion, checks are made almost twice as much as challenges (mean = 19 versus 10 messages). The production of constructive activities is high (mean = 38 messages), but only for additions and evaluations (mean = 16 and 17). No summaries or transformations occurred. We label the chat discussions in this first cluster as meaning-oriented: elaborated and mainly focused on the meaning of concepts. An example of a meaning-oriented chat discussion fragment is shown in Figure 5.3.

Table 5.2. Descriptives and cluster analysis of the 13 chat discussions.

<table>
<thead>
<tr>
<th>Chats (N=13)</th>
<th>Mean</th>
<th>s.d.</th>
<th>'Meaning-oriented' Mean Cluster1 (n=2)</th>
<th>'Pragmatic' Mean Cluster2 (n=6)</th>
<th>'Product-oriented' Mean Cluster3 (n=5)</th>
<th>ANOVA (F)</th>
<th>P-value</th>
</tr>
</thead>
</table>

| All messages sent | 99   | 50  | 168                                    | 117                             | 49                                    | 20.47    | .00    |
| Thematic messages sent | 42   | 29  | 87                                     | 49                              | 14                                    | 26.68    | .00    |

Focused messages (all messages)
- Technical and off-task issues | 29   | 18  | 43                                     | 37                              | 13                                    | 4.75     | .04    |
- Planning aspects | 28   | 16  | 38                                     | 31                              | 22                                    | 0.82     | .47    |
- Thematic talk: meaning of concepts | 24   | 20  | 56                                     | 29                              | 4                                     | 31.11    | .00    |
- Thematic talk: application of concepts in relation to the claim | 18   | 12  | 31                                     | 20                              | 10                                    | 3.36     | .08    |

Focus shifts (between sections of messages sent)
- Shifts between thematic talk (meaning + application) and planning aspects* | 12   | 11  | --                                     | --                              | --                                    | --       | --     |
- Shifts between thematic talk (meaning + application) and technical / off-task issues | 9    | 7   | 20                                     | 10                              | 3                                     | 10.06    | .00    |
- Focus shift between the meaning of concepts and the application of concepts | 6    | 6   | 11                                     | 9                               | 2                                     | 4.07     | .05    |

Dialogue moves (thematic messages)
- Statements | 16   | 11  | 31                                     | 20                              | 7                                     | 10.83    | .00    |
- Checks | 9    | 7   | 19                                     | 11                              | 2                                     | 22.01    | .00    |
- Challenges | 4    | 4   | 10                                     | 6                               | 1                                     | 6.89     | .01    |
- Counters* | 8    | 7   | --                                     | --                              | --                                    | --       | --     |
- Others* | 5    | 4   | --                                     | --                              | --                                    | --       | --     |

Constructive activities (thematic messages)
- Addition of information | 9    | 5   | 16                                     | 11                              | 5                                     | 8.60     | .01    |
- Explanation of information | 3    | 3   | 5                                      | 5                               | 1                                     | 4.78     | .04    |
- Evaluation of information | 8    | 6   | 17                                     | 9                               | 4                                     | 6.24     | .02    |

* Skewness > ±1 and/or kurtosis > ± 1.5: category will not be used in the cluster analysis
Chapter 5

Agents 1 + n
[Goals, beliefs, prior knowledge, task approach]

<table>
<thead>
<tr>
<th>Message</th>
<th>Agent</th>
<th>Focus (F)</th>
<th>Dialogue Moves (D &amp; DA)</th>
<th>Constructive Activities (CA)</th>
<th>Overlap diagram?</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>S2</td>
<td></td>
<td>counter</td>
<td>evaluation</td>
<td>--</td>
</tr>
<tr>
<td>22</td>
<td>S1</td>
<td></td>
<td>counter</td>
<td>evaluation</td>
<td>yes</td>
</tr>
<tr>
<td>23</td>
<td>S2</td>
<td></td>
<td>statement</td>
<td>evaluation</td>
<td>yes</td>
</tr>
<tr>
<td>24</td>
<td>S1</td>
<td></td>
<td>challenge</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>25</td>
<td>S2</td>
<td></td>
<td>check</td>
<td>evaluation</td>
<td>yes</td>
</tr>
<tr>
<td>26</td>
<td>S1</td>
<td></td>
<td>statement</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>27</td>
<td>S1</td>
<td></td>
<td>statement</td>
<td>evaluation</td>
<td>yes</td>
</tr>
<tr>
<td>28</td>
<td>S1</td>
<td></td>
<td>statement</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>29</td>
<td>S2</td>
<td></td>
<td>counter</td>
<td>evaluation</td>
<td>yes</td>
</tr>
<tr>
<td>30</td>
<td>S1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20. (...)  
21. Nonsense, in real life well-organised discussions about developmental issues also exists. For example, you discuss policy issues to develop policy. That’s is not just for fun.  
22. Discussions organised to develop policy are organised. Discussions between people about policy without the goal to develop policy; that is what I am focusing on. In other discussion types, there are moderators, such as a chairman.  
23. Ok, that is right, but in education there are also learning situations about certain themes. Mostly, such discussions are not moderated. I think it is also not wishful to have someone who regulates the discussion.  
24. Such as?  
25. Discussions about certain claims a tutor provides. Can’t you think of such situations?  
26. But what kind of learning effects are we then talking about? We don’t come to an overview very often, do we?  
27. Unless the tutor provides us with an overview, but then he is a kind of a moderator.  
28. Think about the electronic claims we discussed a couple of weeks ago through the Internet. I did not have the feeling I learned a lot. Discussions can be organised to confront people with different points of view. It is not necessary to reach always consensus.  
29. But to get an overview does not have to be the goal. Discussions can be organised to confront people with each other’s different points of view because the moderator can give an overview of different perspectives.  
30. But a moderator is needed to confront people with each other’s different points of view because the moderator can give an overview of different perspectives.  
31. (...)  

Figure 5.3. Example of a meaning-oriented chat discussion fragment.
In Figure 5.3 two students discuss their self-defined claim “Every discussion needs a moderator”. They focus on the meaning of concepts and partly on application. All messages are thematically oriented in the context of the claim. Messages categorised as focused on application explicitly support the claim. In Figure 5.3, text and explanations are given.

Considering the distribution of messages across the categories of focusing, argumentation and constructive activities, the chat discussions in cluster 2 (n = 6) look quite similar to cluster 1. The main difference is that chat discussions in cluster 2 contain less thematic messages (mean = 49). In addition, messages tend to focus on the application of concepts as well as on the meaning of concepts (mean = 29 versus 20 messages). The difference in balance between these two categories is not as high as in cluster 1. We label the chat discussions in this second cluster as pragmatic: focused on both the meaning and application of concepts in order to finish the task.

The third cluster of chat discussions (n = 5) clearly differs from the other two since there is hardly any thematic discussion. Chat discussions are mainly focused on planning aspects (e.g. how to construct a diagram together) and on technical issues. The few thematic messages (mean = 14) are mainly focused on the application of concepts, hardly on the meaning of concepts (mean = 10 versus 4 messages). We label these chat discussions as product-oriented: not aimed at a process of conceptual discussion but at finishing the task. An example of such a discussion fragment is shown in Figure 5.4, in which three students discuss their self-defined claim “The department needs a website”. The discussion is mainly focused on planning and technical issues in relation to diagram construction. In Figure 5.4, text and explanations are given.
Agents 1 + n

<table>
<thead>
<tr>
<th>Message</th>
<th>Agent</th>
<th>Focus (F)</th>
<th>Dialogue Moves (D &amp; DA)</th>
<th>Constructive Activities (CA)</th>
<th>Overlap diagram?</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>S3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>92</td>
<td>S2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>93</td>
<td>S3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>94</td>
<td>S3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>95</td>
<td>S1</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<tr>
<td>96</td>
<td>S3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>97</td>
<td>S1</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>98</td>
<td>S2</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>99</td>
<td>S3</td>
<td>statement +</td>
<td>addition</td>
<td>yes</td>
<td>--</td>
</tr>
<tr>
<td>00</td>
<td>S3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Before executing a K-Means Cluster Analysis, we deleted one variable (number of themes) and three categories (balance step 2, 3 and 4) because of a high skewness ($> \pm 1$) and kurtosis ($> \pm 1.5$). A cluster analysis then iteratively classified the 13 diagrams into
three final clusters. We additionally requested descriptives and an analysis of variance F statistics to reveal information about each variable’s contribution to the separation of the clusters.

Table 5.3. Descriptives and cluster analysis of the 13 constructed diagrams.

<table>
<thead>
<tr>
<th>Diagrams (N=13)</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Generative Mean</th>
<th>Deliberative Mean</th>
<th>Adaptive Mean</th>
<th>ANOV A (F)</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>cluster1 (n=2)</td>
<td>Cluster2 (n=6)</td>
<td>Cluster3 (n=5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum of statements made (except the claim)</td>
<td>15.46</td>
<td>9.54</td>
<td>33</td>
<td>16</td>
<td>9</td>
<td>14.72</td>
<td>0.00</td>
</tr>
<tr>
<td>Themes*</td>
<td>6.00</td>
<td>2.12</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Levels</td>
<td>2.62</td>
<td>1.12</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4.88</td>
<td>0.03</td>
</tr>
<tr>
<td>Links</td>
<td>20.62</td>
<td>11.22</td>
<td>39</td>
<td>22</td>
<td>11</td>
<td>12.61</td>
<td>0.00</td>
</tr>
<tr>
<td>Organisation of information 1 (positive : negative statements per level)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance level 1 (N=13)</td>
<td>0.55</td>
<td>0.36</td>
<td>0.50</td>
<td>0.66</td>
<td>0.43</td>
<td>0.55</td>
<td>0.59</td>
</tr>
<tr>
<td>Balance level 2 (N=11)*</td>
<td>0.33</td>
<td>0.28</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Balance level 3 (N=6)*</td>
<td>0.29</td>
<td>0.27</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Balance level 4 (N=4)*</td>
<td>0.78</td>
<td>0.15</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Overlapping information (percentage)</td>
<td>57.73</td>
<td>31.28</td>
<td>1.50</td>
<td>54.17</td>
<td>84.50</td>
<td>28.44</td>
<td>0.00</td>
</tr>
</tbody>
</table>

As shown in Table 5.3, two diagrams are classified in cluster 1. These diagrams can be characterised by a high number of information boxes and links (mean = 33 respectively 39), a high number of steps (mean = 4) and hardly any overlapping information (2%). This means that almost all information put into the diagram boxes is new (98%) and not mentioned in or selected from the chat discussions. We label this cluster as a group of generative diagrams, containing a large amount of information that is generated and expressed directly into the diagram window. A typical example is shown in Figure 5.5a.

Diagrams in the second cluster (n = 6) contain just half as many information boxes and links as the diagrams in cluster 1 (mean = 16 respectively 22). The mean number of steps is 3. The information boxes overlap with the chat messages for 54%. In these diagrams, overlapping information is combined with generated information directly expressed in the information boxes. We label this cluster as deliberative diagrams, containing moderately organised information boxes that overlap with chat messages on the one hand, and are newly generated on the other hand.
Diagrams in the third cluster (n = 5) are characterised by the low number of information boxes, steps and links (mean = 9 boxes, 2 steps and 11 links). However, they include a huge amount of overlapping information (85%). We label this cluster as adaptive diagrams in which a small number of chat messages is selected and organised into the diagram window. A typical example is shown in Figure 5.5b.

![Figure 5.5. Typical examples of a generative diagram (left: 5a) and an adaptive diagram (right: 5b).](image)

### 5.4.3 Chat discussions in relation to the constructed diagrams: results

To explore the relationship between chat discussions and constructed diagrams, we linked the clustered chat discussions to the clustered diagrams. Crosstabs showed no significant relationships (see Table 5.4). However, we can see that meaning-oriented and pragmatic chat discussions only relate to adaptive and deliberative diagrams. On the other hand, product-oriented discussions mainly relate to deliberative and generative diagrams (4 out of 5 times).
Table 5.4. Clustered chat discussions linked to clustered diagrams.

<table>
<thead>
<tr>
<th>Diagrams:</th>
<th>Meaning-oriented</th>
<th>Pragmatic</th>
<th>Product-oriented</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>- observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- expected</td>
<td>0.8</td>
<td>2.3</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Deliberative</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>- observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- expected</td>
<td>0.9</td>
<td>2.8</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Generative</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>- observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- expected</td>
<td>0.3</td>
<td>0.9</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Total N</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>N = 13</td>
</tr>
</tbody>
</table>

χ²(df=4) = 3.99; p = 0.41

For each of the clusters distinguished, we took a closer look at overlapping information between chats and diagrams. We traced overlapping information from the diagram boxes back into the chat discussions, and explored it on being (a) only stated, (b) argued about (c) argued about at multiple points in the discussion. In Figure 5.6 and Figure 5.7, two examples show some of the possible (contrasting) relationships between chats and diagrams.

Our exploration on the overlap of information indicated that overlapping information was most thoroughly discussed in meaning-oriented chat discussions and occurred most often in adaptive diagrams (see Table 5.2 and Table 5.3). In product-oriented discussions, information was sometimes stated but not discussed, as was also the case in generative diagrams. Across chats and diagrams, correlation measurements showed that overlapping information in the diagrams was significantly related to the number of constructive activities produced during the chat discussions (r = 0.63; p < 0.05).
Figure 5.6. Example of an attached diagram to a meaning-oriented chat discussion about the claim “Each discussion needs a moderator.”
Figure 5.7. Example of a detached diagram to a product-oriented chat discussion about the claim “The department needs a website”.

<table>
<thead>
<tr>
<th>Message</th>
<th>Agent</th>
<th>Focus (F)</th>
<th>Dialogue Moves</th>
<th>Constructive</th>
<th>Overlap (D &amp; Da)</th>
<th>Activities (CA)</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>S3</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>92</td>
<td>S2</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>93</td>
<td>S3</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>94</td>
<td>S3</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>95</td>
<td>S1</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>96</td>
<td>S3</td>
<td>...</td>
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<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>97</td>
<td>S1</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>98</td>
<td>S2</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>99</td>
<td>S3</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>00</td>
<td>S5</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Legend:
- Thematic talk: focus on the meaning
- Thematic talk: focus on application
- Planning talk
- Technical & off-task talk
5.4.4 Student group variables

We used student groups’ evaluations to look for explanations of the approaches found in chat discussion and diagram construction. We included the students’ estimation of their time investment in the subject just before they engaged in the Belvédère sessions and their judgement of the usefulness of the electronic discussions. We also looked at effects of group size (2 or 3 students).

None of the variables showed a relationship to the clustered chat discussions. However, in relationship to the clustered diagrams significant differences were found considering the variables of time investment ($F_{(2,10)} = 13.88; p < 0.00$) and judgement of the discussion ($F_{(2,10)} = 6.54; p < 0.05$). Generative diagrams were produced by student groups that invested the highest amount of time in preparation activities (mean = 8.0 hours) and judged their sessions below average as ‘not very effective’ (mean score = 2.0). Deliberate diagrams were produced by student groups that invested the lowest amount of time for preparation activities (mean = 2.3 hours) and judged their sessions as ‘effective’ (mean score = 3.3). Adaptive diagrams were constructed by student groups that invested a medium amount of time (mean = 3.3 hours) and judged their sessions also as ‘effective’ (mean score = 3.2).

To summarise, we analysed 13 chat discussions and corresponding diagrams, produced by eight student groups in the Belvédère environment. The chat discussions were analysed on the variables of focusing, argumentation and constructive activities; diagrams were analysed on organised arguments and information that overlapped with the chat discussion. Despite the fact that about half of the messages in the chat discussions was focused on technical/off-task talk and planning talk, the other half was thematically focused and aimed stronger at the meaning of concepts than at their application. Most focus shifts were found between technical/off-task talk, planning issues and thematic talk. Thematic messages mostly contained statements, then checks, counter-arguments and then challenges. About half of these messages could be coded as constructive activities. The chat discussions could be clustered into three groups, which were labelled as (a) meaning-oriented, (b) pragmatic and (c) product-oriented discussions. Meaning-oriented discussions
contained most thematically focused talk on the meaning of concepts, argumentation and constructive activities. The Belvédère diagrams could be clustered into groups of (a) adaptive, (b) deliberative and (c) generative diagrams. Adaptive diagrams were small and contained most overlapping information. The results suggested that meaning-oriented chat discussions primarily relate to adaptive and deliberative diagrams and that product-oriented chats relate to generative diagrams. Considering students’ task preparation, time investment appears to be an important factor for student satisfaction as well as for diagram construction.

5.5 Conclusions and discussion

The present work concerns the issue of diagram-mediated argumentative discussion in electronic environments. We studied how small student groups co-constructed meaning during electronic chat discussion in which they had to justify claims in relation to a to be designed Computer-based learning (CBL) program. Students engaged in electronic discussion by using the Belvédère environment, a networked software system for synchronous chat discussion and argumentative diagram construction. We were specifically interested in describing and evaluating the relationship between chat discussion and argumentative diagram construction. We conducted the research in line with an earlier study about the NetMeeting system, a software system for synchronous basic chat discussion (Veerman, Andriessen & Kanselaar, 2000). Although tasks and assignments differed, considering the chat analyses on focusing, argumentation and the production of constructive activities, some comparisons can be made.

The Belvédère study points out that the interplay between chat discussion, diagram construction and students’ group characteristics is not straightforward and difficult to understand. First of all, the results showed that student groups spent half of their messages to technical issues and planning aspects, mainly considering the co-ordination of actions in order to construct a diagram. The other half was aimed at thematic talk, and was subsequently coded on talk about the meaning and application of concepts, argumentation and the production of constructive activities. Through argumentation, information could be critically assessed by checks, challenges or counter-arguments. Constructive activities were messages in which thematic information was added, explained, evaluated, summarised or transformed. These messages were regarded as signals of collaborative
learning-in-process as they appear to be connected with knowledge-building discourse to co-construct meaning.

Overall, the Belvédère chat discussions contained thematic messages that were focused on the meaning of concepts or on their application. Most focus shifts were found between technical/ off-task talk, planning issues and thematic talk. Thematic messages mostly contained statements, then checks, counter-arguments and then challenges. About half of these messages could be coded as constructive activities. The chat discussions could be subsequently clustered into three groups, which we labelled as: (a) meaning-oriented, (b) pragmatic and (c) product-oriented discussions. Meaning-oriented chat discussions were most elaborated, focused mainly on the meaning of concepts and included particularly checks and constructive activities. Pragmatic discussions focused on both the meaning and application of concepts, included less arguments and constructive activities, and aimed stronger at finishing the task. Product-oriented discussions aimed mainly at finishing the task.

The Belvédère diagrams could also be clustered and were characterised as (a) adaptive, (b) deliberative and (c) generative diagrams. Adaptive diagrams were small and mainly contained an overlap of information from the chat discussion. Generative diagrams were three to four times as large and, on the contrary, hardly contained any overlapping information. Deliberative diagrams fell in between: they were moderately big and contained information that partly overlapped with the chat discussions and was partly new.

To benefit from the Belvédère environment, students had to link their chat discussions closely to their diagrams. A significant relationship was found between the amount of overlapping information between chats and diagrams, and constructive activities produced. However, student groups varied in linking information between chats and diagrams. This appeared to depend heavily on student groups’ task approaches and preparation activities.

Considering students’ task preparation, time investment also appears to be an important factor for student satisfaction as well as for diagram construction. Weakly prepared students revealed to find the Belvédère sessions useful and produced pragmatic and adaptive diagrams. In contrast, well prepared students were not satisfied and produced generative diagrams. Perhaps the well prepared students had not enough open-ended, vague, abstract or complex issues left for discussion - which would simply leave the Belvédère task to filling in blank diagram boxes.
Considering the interplay between focus, argumentation and constructive activities, the Belvédère chats were more strongly focused on the meaning of concepts, more information was countered and a higher percentage of information was found to be constructive than in the NetMeeting discussions. The NetMeeting discussions could be clustered on similar variables but contained more product-oriented discussions (12 out of 20) than the Belvédère study (5 out of 13). In both studies, epistemic interactions appeared to be related to a meaning-oriented focus in combination with argumentation (in particular information checking) and the production of constructive activities.

Comparable to the NetMeeting system, student groups needed a high amount of effort to co-ordinate their communication. About half of their messages were focused on and shifted focus to technical issues, off-task talk and planning talk. However, the Belvédère environment provided students with separate windows for linear chat discussion and argumentative diagram construction. Whereas the chat discussion tool was used for all sorts of interactions, students used the diagram window solely for organising thematic information and argument construction. Thus, despite the many focus shifts, students did not tend to lose track of their thematic discussion and arguments.

To conclude, our research indicates that the Belvédère environment offers specific features that can support epistemic interaction, argumentation and collaborative learning. However, real advantage appears to depend heavily on student groups’ task approaches and preparation activities. We should realise that we do not only deal with software and interface design but also with academic goals and students’ orientation towards academic knowledge and technology (Andriessen & Sandberg, 1999). Although studies about interaction are complex by nature, particularly in open-ended knowledge areas, we found our level of analysis to be reliable and promising, meaning that some results were found and could be interpreted. A more global level of analyses may have resulted in the disappearance of distinguishing individual group differences (e.g. Järvelä & Häkkinen, 1999), whereas a more fine-grained level may have triggered more detailed but increasingly complex and difficult to interpret results (e.g. Katz, O’Donnel and Kay, 1999). In the future, we hope to continue this line of research to gain more insight into and better understanding of group characteristics, educational and technological issues in order to favour the types of activities, tasks and tools that may develop students’ collaborative learning.