CSCLEARNING?

PARTICIPATION, LEARNING ACTIVITIES AND KNOWLEDGE CONSTRUCTION IN COMPUTER-SUPPORTED COLLABORATIVE LEARNING IN HIGHER EDUCATION

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Preface

To finish my study of Educational Studies in Utrecht, I wrote my master's PHdissertation about collaborative writing and computer-supported tools. I found myself attracted to this topic and was pleasantly surprised when I read the vacancy for the PhD-project on Computer-Supported Collaborative Learning in a newspaper in the summer of 1997. So, it all began in September 1997 at Wageningen Agricultural University. However, Wageningen Agricultural University became Wageningen University and in the reorganisation plans, the chair group was doomed to be abolished. The years I worked on my PHdissertation were rather hectic and it was not always easy to keep my head above water. All the more so because the greater part of my colleagues left Wageningen. However, you are now reading my preface and that means that I have finished the project.

I want to thank the people who have offered me support over the years and have given me the opportunity to work on this project. Wout van den Bor and Frank de Jong, thanks for initiating the PhD-project. Besides, Frank, thanks for stimulating my independence and for executing projects together in Nijmegen. I would like to thank Martin Mulder for saving the chair group and breathing new life into EDU. Your positive attitude was pleasant. Thanks for becoming interested in CSCL and for moderating me critically. Robert-Jan Simons, I am proud you wanted to be my second supervisor, although the project had already started. Thanks for giving me advice, giving me the freedom I needed and trusting in my capability. Harm Biemans, thank you for preserving the correctness of the text by reading my concepts very carefully and showing interest in my work. Guus de Vries, thanks for always having an ear and taking care of me. My current colleagues, for their patience when I was printing lots of notes again. Sorry for retiring from daily life on the seventh floor and focusing on this PHdissertation the last six months.

Thanks to the Ontario Institute on Studies in Education for signing the research contract and doing much research on CSCL. I want to mention especially Marlene Scardamalia and Carl Bereiter, the founding fathers of CSCL. Mary Lamon and Nancy Smith-Lea, thanks for selecting databases. Hendrik Klompmaker, thanks for guaranteeing the safety of my data.

I want to thank Gaby Lutgens and An Verburgh for being sociable roommates, debating issues concerning analysing data and being second rater to validate the coding schemes. To the CSCL-analysis group, it was motivating and useful to have a critical sounding board. I hope the group will continue to exist (and that my PHdissertation will stand your criticism!). Maarten de Laat, thanks for bringing collaborative learning into practice. I enjoyed our discussions, and looking back it is a pity we did not write collaboratively earlier. Arja Veerman supported me from the very beginning as a colleague and friend. Drinking beers as well as writing collective articles were very pleasant. By drinking beer I also think back to Jerry Andriessen; you encouraged me to do research when writing my master's PHdissertation. Cita van Til, thanks for preparing courses together; it was a pity you changed your job. Harry Booltink, you were a great teacher and it was a pleasure to collaborate with you during all the years. Harry Gruppen, thanks for daring to work with CSCL. Besides, I would also like to thank all the students who have participated in the studies and were asked to fill out long questionnaires. Jan van den Berg corrected my English and I was allowed to use Peter de Wit's cartoon

in the introduction: thanks to both of you. My former teacher of Dutch, André van Dijk, was willing to correct the Dutch summary. He even triggered class 6VWO to criticise the summary; thanks.

I would like to thank my relatives and friends for showing interest and supporting me. I especially want to thank my parents. Papa, thanks for setting the example of studying as part of life. I know you would have been proud. Mama, I would like to thank you from the bottom of my heart for taking care of Rianne so many Wednesdays and for advising and motivating me to finish this project. My parents-in-law tried to slow me down in vain when I looked a little pale and to stand by me; thanks for your support. Rianne, you always are a ray of sunshine and you reminded me to keep things in perspective. And finally Gerard, you know my ups and downs best. Thanks for staying critical (although I did not always like it…), for giving valuable advice, for giving me confidence, and most of all, for loving me.

Veenendaal, January 2002

Else Veldhuis-Diermanse

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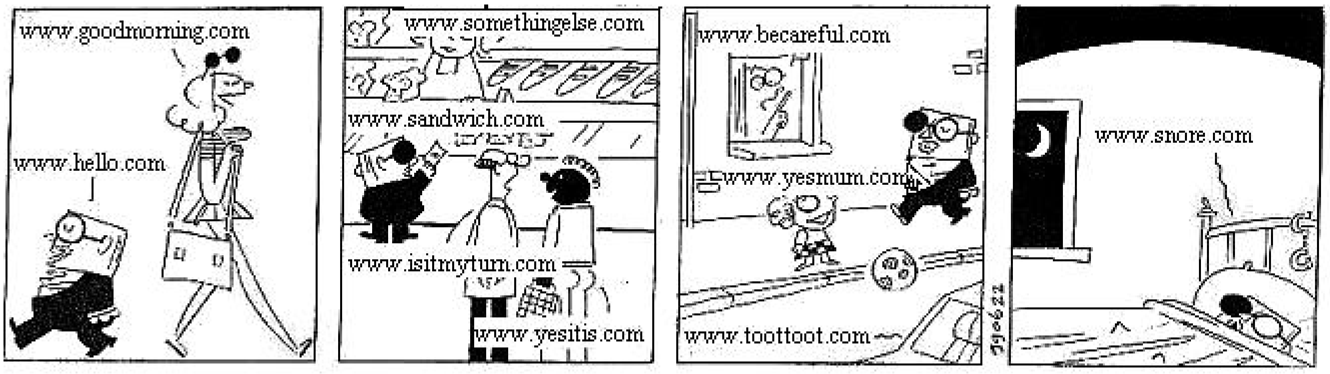

Figure 1.1. SIGMUND. Source: Peter de Wit, Volkskrant, 22-06-99.

The famous Dutch cartoonist Peter de Wit created the strip cartoon depicted above. The cartoon illustrates the increasing influence of Information and Communication Technology (ICT) on our daily life. ICT cannot be done away with in current society. In the area of education, developments of ICT assert their influence, too. This PHdissertation studies one specific ICT-application, namely Computer-Supported Collaborative Learning (CSCL). In CSCL, students learn collaboratively by using a CSCL-system. A CSCL-system can be considered to be a discussion forum in which students can contribute messages and can read each other's messages. Figure 1.2 shows students working on a task in a context of CSCL.

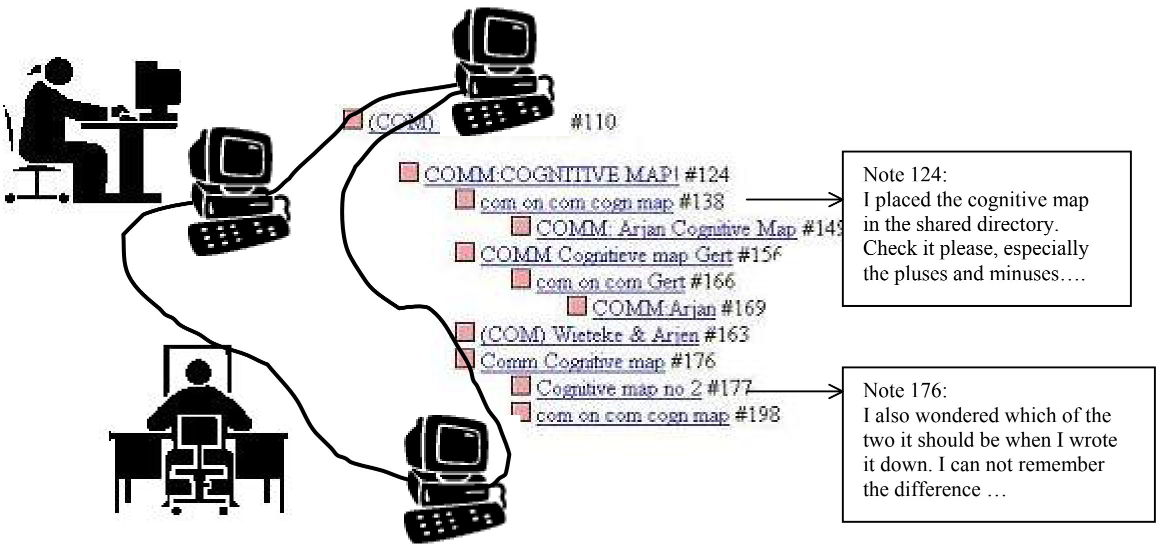

Figure 1.2. Visualisation of a CSCL-context: students work collaboratively at a task communicating by a computer program.

1.1 Problem definition

In educational studies, many researchers believe that CSCL seems to be a promising way of using Information and Communication Technology to put forward desired changes in educational practice in conformity with the constructivist view. Research shows that collaborative learning can be useful to reach intellectual goals such as critical thinking or debating. People learn by interaction (Erkens, 1997; Gokhale, 1995; Kanselaar & Van der Linden, 1984; Lethinen *et al.*, 2001; Newman, Johnson, Webb & Cochrane, 1999). Characteristic to collaboration is the interaction between people and people learn through interaction with each other (Biggs & Collis, 1982). Discussion is important because we will only 'give words to our thoughts' when we use these words to communicate with others, and this in turn may be related to our ability to clarify and remember ideas (Johnston, 1997). Besides group learning, CSCL seems to be a powerful constructivist learning tool for yet another reason. Using a CSCL-system implies that students have to write down their ideas, solutions, remarks and so on. When deep learning is the ultimate learning goal, writing seems to be an effective tool for learning (Rijlaarsdam & Couzijn, 2000; Tynjälä, 1999). Writing can be seen as the most important tool of thinking, and it has a crucial significance in explication and articulation of one's conceptions (Bereiter & Scardamalia, 1987). Finally, the use of a computer has another advantage, namely the existence of a 'conversation history'. Students can not only re-read contributions or notes, but it is also clear by whom a particular note was written, when a note was written and whether the note was a reaction to someone else's note or not.

Literature shows that there is a reasonable amount of published experiments indicating positive learning effects when CSCL-systems have been used in education (De Laat & De Jong, 2001; Koschmann, Feltovich, Myers & Barrows, 1997; Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001; Lipponen, 1999; Salovaara, 1999; Tynjäla, 1999). Most of the studies, however, are rather limited in terms of the duration of the experiment or the number of participants. In spite of these limitations, there are some important qualities in the results that make them noteworthy. Reported positive results indicate that improvement in student learning is found particularly in higher-order cognitive processes (Lethinen *et al.*, 2001); CSCL would be most promising to use in higher education. In higher education, students have to deal with abstract, ill-defined and not easily accessible knowledge as well as with open-ended problems, and deep learning is best achieved when learning takes place in ill-structured domains (Kirschner, 2000). It should be clear that the goals of higher education cannot be reached with (only) traditional ways of teaching. Research shows that skills that are required to achieve deep learning are more likely to be developed by students in constructivist settings than in traditional settings (Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001; Paolucci, Suthers & Weiner 1995; Reeves, 1998; Tynjäla, 1999).

Although research indicates some positive effects of using CSCL on students' learning, from practical experiences we know it is not easy to use CSCL in an educational setting in order to reach formulated learning goals. Despite developments in research and educational practice, much is still unclear about how to apply CSCL usefully in education. Below two fragments of instructions of two pilot projects are given to illustrate how implementing CSCL in a course will not succeed.

"Attached you will find a manual concerning details on how to access the discussion forum. You may decide in your group to use it, but it is not necessary. It may be handy to come to the following agreement: the first database is available for group 1, the second one for group 2, and if group 3 wants to use a forum, please let us know, we can make a third database. Much pleasure with reading the next articles, and if you log into the forum, let us know your experiences."

"The main goal of this assignment is that each group writes a joint report. In preparation, our students create data files from the experiments they did during the practical course in May 1998: respirograms of nitrite, ammonium and sewage. They send these files including all relevant practical information to their counterparts. Then each party of a group works out the tasks assigned to them. For all information exchange, the communication platform will be used. Finally, a number of joint tasks has to be done. Examples of subtasks are: (1) Calculate by means of a spreadsheet the area under the nitrite respirogram hypothesising the most probable baseline for endogenous respiration rate. (2) Decompose the ammonium respirogram in an ammonium oxidation part and a nitrite oxidation part by presuming a certain course for the nitrite respiration rate. (3) Calculate the total area under the ammonium respirogram. This is the total amount of oxygen utilised to oxidise the ammonium to nitrate. The ASM No.1 assumes that the nitrification occurs in one step."

Both pilot projects were unsuccessful; some students logged in the forum once or twice, some students did not at all. No notes were written and therefore, there were no notes to be read. It became clear that using CSCL in education is not that easy. We have learned much from these unsuccessful pilots. In the first pilot, students were not obliged to use the discussion forum. Students did not see the benefit of using the forum and therefore they did not use it. In later projects, students were always informed about the added value of CSCL and about what was expected of them during the course. Furthermore, participation and involvement in the course were assessed. In the second pilot project, students had to use the discussion forum to exchange all information. The main function of the forum was not discussing and interacting, but exchanging information. Teachers did not attach much value to students' own ideas and maybe the domain was not suitable for that, either. There was no reason to negotiate about knowledge, because one solution was the best. These students did not use the forum either.

In the present PHdissertation, the focus is on the problem how students in higher education learn in a CSCL-system and how CSCL-systems could be used effectively. This problem resulted in the following main research questions:

1. *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?*
2. *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?*
3. *Do students construct knowledge and what is the quality of that knowledge constructed by students in an asynchronous CSCL-system?*
4. *What are the effects of moderating a CSCL-discussion on students' learning?*

1.2 Organisation of the PHdissertation

This PHdissertation contains seven chapters. This first chapter presented the problem definition and addressed the research questions.

Chapter 2 will outline the theoretical framework and present the research questions in context. Our research is based on a constructivist view of learning and therefore constructivist principles are given compared to more traditional education. Next, the concept of knowledge construction will be discussed with a focus on higher education and more specifically, the meaning of knowledge construction in CSCL. Furthermore, the idea of CSCL will be explained and possible consequences of using CSCL for students and teachers will be discussed.

Chapter 3 will describe a selection of reviewed studies concerning CSCL to get an overview of different methods used to analyse CSCL-data in relation to effects found. Arguments will be given to focus on analysing the learning process instead of the learning product. Proposed indicators of the learning process are participation, interaction and content of the written notes.

Chapter 4 will deal with the method of analysing students' learning in CSCL used in this PHdissertation. The method used consists of three steps: (1) participation and interaction, (2) cognitive, affective and metacognitive learning activities, and (3) amount and quality of constructed knowledge.

Chapter 5 will report on four empirical studies focused on analysing students' learning processes. Log files saved in the CSCL-system used, (Web) Knowledge Forum, are analysed by means of the three steps of the method described in chapter 4, in order to answer the main research questions 1, 2 and 3 (section 1.1). First, the data will be analysed and discussed per study and next, findings of the different studies will be compared. In the studies 1, 2 and 3, three specific questions are added concerning group size, multidisciplinary teams and learning style, consecutively.

Chapter 6 will present two empirical studies. Again, students' actions and contributions were analysed on participation and interaction, learning activities, and amount and quality of constructed knowledge. However, in these studies, the focus is on the fourth main research question (section 1.1). Therefore, the courses in these two studies differ from the courses described in chapter 5, because there is an active teacher moderating half the discourses. The chapter will start with a short review of moderating techniques resulting in guidelines used to instruct teachers. Students in these studies are either moderated on social processes and on critical thinking or they are self-regulated.

Finally, chapter 7 will summarise the main research findings of the six empirical studies. After presenting the results, these findings will be considered from a theoretical and methodological point of view. The chapter will conclude with implications for educational practice and suggestions for future research.

Chapter 2 - Theoretical framework: A constructivist view of CSCL in higher education

".... What is the matter with all those general lectures? Despite the fact that all subject matter already can be found in books and readers, lectures are given as well in which all subject matter is told again. Two hours a week the teacher explains minutely what you already could have read in your literature. Welcome to the university!" (F. Provoost, 1998, p. 5)

The quotation cited above was from a student who started studying at university. The view on lectures is a little exaggerated to illustrate the gap between educational theories and educational practice. In recent theory, researchers have attached much importance to constructive and active learning. However, in spite of new theories of learning, the situation sketched above is relevant to many courses at the university, also in the zeros. Students regularly listen to teachers and absorb information, without reflecting critically on that new information in order to construct own ideas. The idea of Computer-Supported Collaborative Learning (CSCL) fits a constructivist view of learning. This chapter will outline the theoretical framework of the study described in this PHdissertation.

2.1 Introduction

Courses in which Computer-Supported Collaborative Learning (CSCL) is used are exceptional in Dutch education at the time in which this PHdissertation was written. At present, traditional ideas about learning shift towards a new concept of learning. Section 2.2 will explain what is meant by this view of new learning. The idea of new learning is strongly influenced by the constructivist learning theory described in section 2.3. First, constructivist education is opposed to traditional education and next, constructivist principles are given. Our research was conducted in higher education. Section 2.4 will discuss characteristics of learning in higher education and pay attention to the concept of knowledge construction. Section 2.5 will explain why collaborative learning is viewed as a promising way of learning to stimulate knowledge construction. Section 2.6 will describe what we mean by CSCL and explain why CSCL is assumed to be a powerful educational tool. Finally, it is discussed what kind of skills and attitudes CSCL requires from both the student (section 2.7) and the teacher (section 2.8).

The research of this PHdissertation is based on the theoretical framework presented in this chapter. In this theoretical framework, we work towards a clarification of the research questions. Five main research questions are formulated in total in section 2.4 until 2.8. These research questions are summarised in section 2.9.

2.2 Changing societies: New learning

In the past ten years, there has been a shift from an industrial society towards an information and knowledge society (Keating, 1998; Kessels, 1996). It is no longer the production of goods which is most important, but more and more importance is attached to the ability of dealing with information and acquisition of knowledge. Work situations change rapidly. Therefore, employees are expected to adapt to new circumstances all the time. They do not get a contract for the rest of their lives, but nowadays contracts of employment are flexible. Wijffels opened the academic year of 2000 at

Wageningen University with the claim that life-long learning is no longer a luxury, but a necessity (Wijffels, 2000). Other scientists have also stressed the need for life-long learning (e.g. Longworth & Davies, 1996; Onstenk, 1997; Simons, Van der Linden & Duffy, 2000; Thijssen, 1997). The labour market can be characterised as a dynamic environment in which people can only keep upright by permanent learning: learning to survive (Thijssen, 1997). Not only the period of learning is new, the view of learning, learning instructions and learning outcomes has changed fundamentally as well. Simons *et al.* (2000) gave three reasons for talking about 'new' learning: (1) There is much more attention for the role of active and self-directed learning than before; (2) there currently is a much greater emphasis on the combination of active learning, so-called learning to learn and collaborative learning than before, and (3) the present wave of attention to new forms of learning has much more of a basis in the psychology of learning and instruction than the waves of learning propagated by traditional school innovators.

2.3 Constructivism

The culture of new learning is strongly influenced by constructivist ideas about education, learning, instruction and knowledge. The present PHdissertation is based on a constructivist view of learning, too. Section 2.3.1 will discuss the constructivist view of learning compared to traditional education. Section 2.3.2 will shade the constructivist theory by distinguishing cognitive and social constructivism ending in a list of principles that summarises constructivism.

2.3.1 Constructivist view of learning

Before going into the principles of the constructivist learning theory, traditional education (roughly situated between the Fifties and the Eighties) will briefly be discussed. Bruner (1996) described three core beliefs of traditional education: (1) Knowledge of the world is approached as the 'objective reality' that can be transferred from one person to another, (2) a medium, such as a teacher or a book, is required to transfer the knowledge from the one who knows to the one who does not, and (3) learning has to be institutionalised in school. In more traditional education, the assumption was that knowledge is transmitted to the learners by an external source: The picture of a student who absorbs information like a sponge. Relan and Gillani (1997) characterised traditional education as follows: (1) Teacher talk exceeds student talk, (2) instruction occurs frequently with the whole class; small group or individual instruction occurs less often, (3) use of class time is largely determined by the teacher, (4) teachers look upon the textbook to guide curricular and instructional decision making, and (5) classroom furniture is arranged into rows of desks or chairs facing a chalkboard. Additionally, performances are judged by the teacher (Bielaczyc & Collins, 1999). Andriessen and Sandberg (1999) called this kind of education a 'transmission scenario'. In this educational approach, good education especially means a good teacher (Andriessen & Veerman, 1999; Hewitt, 1996) and a good student is a student who is good in drumming objective facts into his brains.

The image of traditional education was intentionally described in black-and-white to make clear the difference to constructivist education. A constructivist approach is almost diametrically opposed to the traditional approach. Education is not teacher-centred, but student-centred. Students can influence their education and are not only consumers as in traditional education. Students work in collaboration (see also section 2.5) to solve tasks and importance is attached to their own ideas;

reproducing facts is becoming less important. A central issue in this new way of learning is cognitive flexibility, which refers to the ability to restructure one's prior knowledge, to acquire information independently and using this information in new, known and unknown, situations (Bots & Veldhuis, 1998). It is not always clear how to use acquired knowledge in a new context. In contrast to more traditional education, it is assumed nowadays that knowledge domains often are ill-structured; knowledge is complex, many relations are possible between different concepts and knowledge can be used in different ways. Because of complexity of knowledge, it is less clear when to use certain knowledge (Spiro, Feltovich, Jacobson & Coulson, 1992; Spiro & Jehng, 1990). "An ill-structured knowledge domain is one in which the following two properties hold: (1) Each case or example of knowledge application typically involves the simultaneous interactive involvement of multiple, wide-application conceptual structures (multiple schemas, perspectives, organisational principles, and so on), each of which is individually complex (i.e., the domain involves concept and case complexity), and (2) the pattern of conceptual incidence and interaction varies substantially across cases nominally of the same type (i.e., the domain involves across-case irregularity)" (Spiro *et al.*, 1992, p. 2). Learners need to develop understanding and insights into these complex theories and concepts, which depend not only on facts and figures but also on prior knowledge and experiences, beliefs and values, and expectations on what has to be learned (Veerman, 2000).

In a constructivist view of learning, all knowledge is constructed. Every reflection is a human action by some particular person in some particular context. Consequently, no one else sees the world exactly as we do (Knuth & Cunningham, 1993; Roschelle, 1992); in other words, knowledge is subjective. Moreover, personal mental representations change continually affected by new experiences (Boekaerts & Simons, 1995; Simons, 1999). Not surprisingly, a fundamental question of constructivism is not only to know what we know, but also to know how we know: awareness of the constructedness of much of our knowledge and active control over that construction process (Knuth & Cunningham, 1993). The learning process is seen as an interesting object of study. Learning is viewed as an active, constructive, cumulative, goal-directed and self-directed process in which the learner builds up internal knowledge representations that form personal interpretations of his of her learning experiences (Biemans, 1997; Boekaerts & Simons, 1995; Duffy & Jonassen, 1992; Reeves & Reeves, 1997).

Van Hout-Wolters, Simons and Volet (2000) gave two definitions of active learning. In the first definition, active learning is seen as a form of learning in which the learner uses opportunities to decide about aspects of the learning process. The second definition of active learning refers to the extent to which the learner is challenged to use his or her mental abilities while learning: active use of thinking. In this PHdissertation, most importance is attached to the second form of active learning. The idea of Biemans (1997) goes well with this definition. He argued that active learning refers to performing certain learning activities while processing information from a learning task to learn in a meaningful way (Biemans, 1997). Learning is an active process in which learners construct new ideas or concepts based upon their current and past knowledge. The learner selects and transforms information, constructs hypotheses and makes decisions, relying on a cognitive structure to do so. This cognitive structure provides meaning and organisation to experiences and allows the individual to go beyond the information given (Bruner, 1996). Learning is called constructive because students should elaborate new information and relate this knowledge to other information to retain simple information and to understand complex material (Biemans, 1997). According to a constructivist view, the intention of learning is that learners link new knowledge to their prior knowledge, i.e. learning as a cumulative process (Biemans, 1997; Boekaerts & Simons, 1995; Bruner, 1996). Goal-directed learning refers to intentional learning in which learning goals are formulated beforehand (Boekaerts & Simons, 1995). Self-directed learning refers to the number and kinds of decisions taken by learners themselves (Van Hout-Wolters *et al.*, 2000).

Another distinguishing characteristic of the constructivist view of learning is the idea of situated and distributed learning. Situated means that knowledge and skills are indexed by experiences in specific contexts and therefore situated cognition refers to the idea that knowledge is related to a specific application (Bednar, Cunningham, Duffy & Perry, 1992; Boekaerts & Simons, 1995; Brown, Collins & Duguid, 1989). A learner creates a meaning to newly acquired knowledge, but that meaning will change affected by a changing context. Distributed knowledge refers to the idea that knowledge is divided among people. Everybody creates his own specific knowledge and it is considered meaningful to share that knowledge and the attendant growth of individual knowledge (Scardamalia & Bereiter, 1994). Knowledge is negotiated through interactions with others where multiple perspectives on reality exist; reflectivity is essential and must be nurtured (Kirschner, 2000). Just in ill-structured domains, negotiating about knowledge is very important, because there are no clear answers and problems can be solved in different ways. Examples of approaches conforming to this idea are the 'Mathematics Classroom' of Lampert (1990), the 'Fostering a Community of Learners model' of Brown and Campione (1996) and the 'Knowledge Building Classroom' of Bereiter and Scardamalia (1996). Nowadays the concepts 'Learning community' or 'Knowledge Building Community' are used more often (Bielaczyc & Collins, 1999; Hewitt, 1996; Scardamalia & Bereiter, 1998). Such a community can be described as a group of persons exchanging ideas, information and experiences to reach a more advanced level of knowledge (Bielaczyc & Collins, 1999). It is not necessary for each member to assimilate everything the community knows, but each one should know who within the community has relevant expertise to address any problem. This is a radical departure from the traditional view of learning, which emphasises individual knowledge and performance and the expectation that students will acquire the same body of knowledge at the same time. Creating these kinds of communities will help to develop skills and knowledge adequate for dealing with the challenges of a world, which is becoming increasingly complex (De Jong, Veldhuis-Diermanse & Lutgens, in press). Therefore, it is necessary that a learning task is open-ended; it must be useful to debate about different ideas and solutions. Learning must be situated in problem-solving, real-life contexts in which the environment is rich in information and in which there are no correct answers (Kirschner, 2000), even if one answer would be more adequate than another one.

2.3.2 Cognitive and social constructivism

Though general characteristics of constructivism have been described above, in fact it is more correct to distinguish between several trends distinguished within the constructivist learning theory. In literature, many forms of constructivism were distinguished (see for example Bruner, 1996; De Jong & Biemans, 1998; Jonassen, 1992; Merrill, 1992; Simons & Bolhuis, under review). However, it seemed very difficult to make a clear distinction between different forms of constructivism. Two perspectives we often found in literature are: (1) Cognitive constructivism, and (2) social constructivism

(Anderson, Reder & Simon, 1996; De Jong & Biemans, 1998; Salomon, 1998; Simons & Bolhuis, under review). To the research described in this PHdissertation, both perspectives are relevant. Cognitive constructivism focuses on the active role of the learner and on real-life learning. Social constructivist learning theories, comprising the socio-historical and socio-cultural theories as well as the situated learning and community of practice approach, emphasise that learning is a process within, and a product of, the social process (Simons & Bolhuis, under review). Anderson *et al*. (1996, 1997) and Greeno (1997) have discussed the differences between situative perspectives (social approach) and cognitive perspectives (individual approach) on learning in several issues of the *Educational Researcher*. We do not have the intention of joining the discussion (and in the context of this PHdissertation, this is not necessary, either). However, a constructivist view of learning underlies our study and therefore we will broadly outline these two perspectives, realising that we are treading dangerous ground.

Cognitive constructivism is principally based on the work of the developmental psychologist Piaget (1977). Piaget's theory of cognitive development proposes that people cannot immediately understand and use information they are given. Instead, people must construct their own knowledge. Direct experience, making errors, and looking for solutions are essential for the acquisition of information and construction of knowledge. In a cognitive constructivist view, meaning is constructed as children interact in meaningful ways with the world around them. Therefore, cognitive constructivism attaches importance to whole activities as opposed to isolated skill exercises, authentic activities which are inherently interesting and meaningful to the student, and real activities that result in something other than a grade on a test (Anderson, 1980; Chen, 2001). Social constructivism is principally based on the work of another cognitive psychologist, Vygotsky. Vygotsky shared many of Piaget's assumptions about how people learn, but he put more emphasis on the social context of learning. By his 'zone of proximal development' he means that students can, with the help from other students or the teacher who are more advanced, can master concepts and ideas that they cannot understand on their own (Van der Veer, 1995). However, there is a great deal of overlap between cognitive constructivism and the social constructivist theory. "The cognitive approach in no way denies the importance of the social. From birth, we are social creatures; much of what we learn is social and many of the circumstances of our learning are social. Presumably, the situated view would correspondingly not deny that there are individuals interacting in all situations, that these individuals have minds, that much of their individuality comes from the (socially and individually) acquired knowledge contained in those minds, and that they are not just cogs in a social wheel" (Anderson *et al.*, 1997, pp. 20). Anderson *et al.* (1997) conclude that the situative and cognitive perspectives do not differ so much in the underlying principles, as in the questions that are asked. To illustrate, a question asked from the cognitive perspective was formulated as follows: "Will complex skills be acquired more successfully if instruction in various independent sub-skills is presented separately or in situations where all of the sub-skills are needed? In particular, will skills of complex social activities be learned more successfully if their independent sub-skills are learned in situations involving individual practice?" A question asked from the situative perspectives was formulated as follows: "Which combinations and sequences of learning will prepare students best for the kinds of participation in social practices that we value most and contribute most productively to the development of students' identities as learners?" (Anderson *et al.*, 1997, pp. 19).

Because of the overlap between cognitive constructivism and the social constructivist theory, we end this section with a list of principles that summarises constructivism and that forms the foundation of our research on CSCL. Based on Ryneveld (2001) we summarise as follows.
Constructivism:

- views knowledge as subjective and personal;
- emphasises learning and not teaching;
- accepts and encourages learner autonomy and initiative;
- encourages learner inquiry and nurtures learners' natural curiosity;
- thinks of learning as a process and considers how the student learns;
- emphasises performance and understanding when assessing learning;
- acknowledges the critical role of experience in learning;
- emphasises the context in which learning takes place;
- provides learners with the opportunity to construct new knowledge and understanding from authentic experiences;
- encourages learners to engage in dialogue with other students and the teacher;
- supports collaborative learning;
- emphasis working with open-ended problems and presenting information from different perspectives.

2.4 Higher education

Our research was executed in higher education, and more specifically, at three universities. This section will go into the characteristics of higher education and give meaning to the concepts of learning (section 2.4.1) and knowledge construction (section 2.4.2) in the context of CSCL.

2.4.1 Learning at university

In general, universities aim at a deep level of learning (Biggs, 1999; Gokhale, 1995). Deep learning is characterised by having the intention of fully understanding the learning material, interacting critically with the learning content, relating ideas to prior knowledge and experience, using organising principles to integrate ideas, and examining the logic of the arguments used (MacFarlane Report, 1992). Deep learning is opposed to surface learning which is characterised by having the intention of simply reproducing parts of the content, accepting ideas and information passively, concentrating on assessment requirements, not reflecting on purpose or strategies of learning, memorising facts and procedures routinely, and failing to recognise guiding principles or procedures (MacFarlane Report, 1992).

In university education, students have to deal with abstract, ill-defined and not easily accessible knowledge as well as with open-ended problems, and deep learning is best achieved when learning takes place in ill-structured domains (Kirschner, 2000). It should be clear that the goals of higher education cannot be reached with (only) traditional ways of teaching. Research shows that skills that are required to achieve deep learning are more likely to be developed by students in constructivist settings than in traditional settings (Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001; Paolucci, Suthers & Weiner 1995; Reeves, 1998; Tynjäla, 1999). Learning at university is the process of discovering and generating acceptable arguments and lines of reasoning underlying scientific assumptions and bodies of knowledge (Veerman, 2000). In this context, important skills are critical thinking, creative thinking, logical thinking, creating ideas, debating and arguing subjects, using knowledge in new situations, solving problems, formulating questions, linking different insights, summarising information concisely, sharing knowledge, and elaborating on each others' ideas and results (De Klerk, 1992; Gokhale, 1995; Jonassen, 1992; Van Ginkel, 1991).

In recent literature, skills such as the ones described above are called competencies. In educational contexts, there is a growing call for competency-based education (Kirschner, Van Vilsteren, Hummel & Wigman, 1997; Kirschner, 2000; Mulder, 2000, 2001). Van Merriënboer (1999) characterised competencies as a mix of complex cognitive and higher-order skills, highly integrated knowledge structures, interpersonal and social skills, and attitudes and values. Acquired competencies enable learners to apply these skills and attitudes in a variety of situations (transfer) and over an unlimited time span (lifelong learning) (Van Merriënboer, 1999). Van der Sanden, Terwel and Vosniadou (2000) also preferred to take a broad perspective of competence and point to the organised whole of knowledge, skill, attitudes and learning abilities. A quotation found in the study guide of Wageningen University emphasises the high value this university puts on competencies as well: "Many graduates will come into contact with complex problems asking for approaches from different perspectives. The approach to solving that kind of problem requires an analysis of the situation in its social context which leads to a scientific question" (1998; p. 19). We assume that deep learning will lead to knowledge construction. In the next section, we will discuss the concept of knowledge construction resulting in an operational concept.

2.4.2 Knowledge construction

From a constructivist point of view, learning is a dynamic process of knowledge construction. This knowledge construction process is not merely looked upon as an individual affair but rather as a process of interaction and negotiation with other participants in the learning environment, such as fellow students, the teacher and information sources (Kanselaar, De Jong, Andriessen & Goodyear, 2000). In this view, it is emphasised that knowledge is no longer absolute and belonging to a single learner, but relative and collective (Van der Linden, Erkens, Schmidt & Renshaw, 2000; see also section 2.3). From this view, knowledge construction has individual as well as social aspects. To understand learning and to analyse data, two different perspectives on the unit of analysis consist: (1) Cognitive acquisition-oriented perspective, and (2) situative participation-oriented perspective (Sfard, 1998). The cognitive acquisition-oriented perspective on knowledge construction sees knowledge construction as an individual activity, fed by a social context. Central to the situative participation-oriented perspective on knowledge construction is the socially based participatory construction of knowledge in which the individual and social participants form a unified learning system (Van der Linden *et al.*, 2000). In this study, the unit of analysis will be students' individual performance; here, the cognitive acquisition perspective is most relevant. However, individual performances are assessed in the social context. Notice that in literature the concepts of both knowledge construction and knowledge building are used. In section 2.3.1, the idea of a knowledge building community was described as a group of persons exchanging ideas, information and experiences to reach a more advanced level of knowledge (Bielaczyc & Collins, 1999). In knowledge building, the focus is on acquiring collective knowledge; the term knowledge construction is generally used in the meaning of individual learning (Bereiter, 2002). In this PHdissertation, we speak about knowledge construction to indicate that the accent is on students' individual learning processes.

The term knowledge has already been used 93 times in the first pages of this PHdissertation. It is not easy to define a complex term as knowledge and therefore many descriptions can be found in literature. For example: Declarative knowledge, procedural knowledge (Anderson, 1980; Pintrich, Wolters & Baxter, 1996), schematic knowledge, strategic knowledge and factual knowledge (Gagné, 1974; Mayer, 1987), statable knowledge, implicit knowledge, episodic knowledge, impressionistic knowledge and regulative knowledge (Bereiter, 2002), and scientific, vocational and applied knowledge (Watson & Taylor, 1998). It is not our intention to put the concept of knowledge up for discussion here and to present an overview of all different descriptions found in literature. However, it is important to give it a moment's thought. With a new perspective on learning, it is necessary to change our understanding of knowledge (Van der Linden *et al.*, 2000).

Knowledge can be viewed as a final or an intermediate product. Bereiter and Scardamalia (1996) prefer to see knowledge as an intermediate product at the service of learning. However, the relation between knowledge and learning is complex. Sometimes, people need to know facts. For example, you want to know at what time the train will leave. The times of departure are facts; no discussion is possible. However, there regularly is trouble in the current supply or the overhead wires are broken down. In that case, the traveller has to look for a good alternative. Does he wait until the train leaves or is it faster to go by bus? In this situation, it is necessary to link different facts. We think that, depending on the situation, knowledge can be seen as either an intermediate or a final product. Knowledge can be used directly, but it is also possible to use that knowledge in process of time or do not use it at all (Bots & Veldhuis, 1998). Kirschner (2000) also emphasised that knowledge is situated and related to the using context. "It should not be assumed that knowledge is transferable as an automatic consequence of assigning meaning to an experience. Knowledge is relatively specific to the purpose for which it was acquired" (Kirschner, 2000, p. 5). Making this assumption, it is neither possible nor useful to choose one specific description of knowledge. Therefore, we confine ourselves to listing some characteristics of university knowledge that are relevant in the context of this PHdissertation.

- University knowledge cannot be understood as something fixed that can be transmitted from experts to students. University knowledge is not reductive; it is unitary, indivisible (Veerman, 2000).
- University knowledge is complex; many relations are possible between different concepts and knowledge can be used in different ways (Spiro *et al.*, 1992; Spiro & Jehng, 1990).
- University knowledge is the result of a personal transformation of something that was read, seen or heard (Biemans, 1997; Boekaerts & Simons, 1995; Duffy & Jonassen, 1992; Knuth & Cunningham, 1993; Reeves & Reeves, 1997; Roschelle, 1992; Simons, 1999). This knowledge is generative, which means that students generate new appropriate statements about a subject and do not just reproduce the statements that were received (Gundry & Metes, 1996).
- University knowledge is elaborate; the amount of knowledge will increase by experience and negotiation about information (Baker, 1994; Gundry & Metes, 1996; Veerman, 2000).

It is difficult to gain insight into knowledge construction processes. Construction of knowledge usually takes place deeply hidden in the learner's head and therefore it will not be possible to analyse precisely what knowledge a learner constructed. Research on collaborative learning, and more specific CSCL, can be divided into two kinds: effect-oriented and process-oriented research. Effect-oriented research deals with effects of collaborative learning in comparison with other teaching methods or learning situations (Van der Linden *et al.*, 2000). In process-oriented research, analyses of the collaborative process as such are at the centre. In this PHdissertation, the effect-oriented trend was not relevant because CSCL was not compared to other learning situations. However, it should be noticed that besides analysing students' learning processes, students' contributions were also assessed on the level of understanding and with that, we neared the analysis of learning products. The process-oriented trend was most important, though. In CSCL, ideas and concepts are written down and discussed. This explicit or statable knowledge was analysed and used to say something about the process of knowledge construction (Baker, 1999; Hewitt & Scardamalia, 1998; Veerman & Veldhuis-Diermanse, 2001a). In this respect we operationalised knowledge construction as adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas. Concerning knowledge construction, we will focus on the following main research questions: *Do students construct knowledge in CSCL?* and *What is the quality of the knowledge constructed in CSCL?*

2.5 Collaborative learning

Collaborative learning has already been mentioned a few times above. Section 2.3 considered collaborative learning to be important within the constructivist learning theory. Section 2.5.1 will first describe what is exactly meant by collaborative learning, and next will explain why collaborative learning is viewed as a promising way of learning.

2.5.1 The importance of collaborative learning

Collaborative learning is one of the pedagogical methods that can stimulate students to discuss information and problems from different perspectives, and to elaborate and refine them in order to re-construct and co-construct (new) knowledge (Veerman, 2000). Many different definitions of collaborative learning are used (Dillenbourg, 1999) and therefore, while speaking about collaborative learning it is not automatically clear what we are talking about. In this PHdissertation, collaborative learning is described as a learning situation in which participating learners exchange ideas, experiences and information to negotiate about knowledge in order to construct personal knowledge that serves as a basis for common understanding and a collective solution to a problem. Research shows that collaborative learning can be useful to reach intellectual goals such as critical thinking or debating. People learn by interaction (Erkens, 1997; Gokhale, 1995; Kanselaar & Van der Linden, 1984; Lethinen *et al.*, 2001; Newman, Johnson, Webb & Cochrane, 1999). Characteristic to collaboration is the interaction between people and people learn through interaction with each other (Biggs & Collis, 1982). Discussion is important because we will only 'give words to our thoughts' when we use these words to communicate with others, and this in turn may be related to our ability to clarify and remember ideas (Johnston, 1997); understanding is achieved through interaction (Veerman, 2000). In addition, Lethinen *et al.* (2001) argued that deep conceptual understanding is fostered through explaining a problem to other students. Therefore, in collaborative learning it is necessary to formulate learning objectives, to make learning plans, to share information, to negotiate about knowledge and to take decisions. In a setting of collaborative learning, students can criticise their own and other students' contributions, can ask for explanations, can give counter arguments and, in this way, students will stimulate themselves and their fellow students. Additionally, they can motivate and help each other to finish the task. There is a growing consensus among researchers about the positive effects of collaborative learning on student achievement (Slavin, 1997). To sum up: collaborative learning seems to be a powerful educational method to reach academic aims.

Why is it thought that people learn by interaction? Which explanations can be found in literature? In interaction, people react to each other, intended or not. This feedback can be approval or disapproval, but also new information which can lead to new insights. People can get in conflict while solving or interpreting a problem in another way. It is believed that learning is achieved when we are presented with conflicts which we try to manage in order to produce a solution (Gokhale, 1995; Kanselaar & Van der Linden, 1984; Veerman, 2000). Another explanation is that much knowledge only functions because of agreements made between people and their collective interpretations. Without social interaction, much knowledge would not consist at all. For example, you know you have to wait when the traffic light is red, but that is just an agreement. Furthermore, meaning is culture-situated. For example, in the Netherlands it is not decent to smash a glass after drinking, but in some countries it is very decent to do just that. Therefore, people learn from each other within a social context and make use of cultural codes such as agreements, rules, symbols or language (Diermanse, 1997). Because of the importance of interaction in learning processes, we address the following main research question: *How can students' learning processes in a CSCL-system be characterised in terms of participation and interaction?*

2.6 Computer-Supported Collaborative Learning

In the introduction, we have already explained in short what is meant by CSCL. Section 2.5.1 will go into more detail and will explain the central idea of CSCL and argue why CSCL was expected to be a powerful constructivist learning tool. Next, section 2.6.2 will pay attention to CSCL-systems, focusing on the differences between synchronous and asynchronous communication.

2.6.1 The power of CSCL

Nowadays, CSCL is a popular term in the world of education. For example, a search on the World Wide Web for the term CSCL resulted in more than 25,000 Web pages showing how schools and universities use CSCL to organise their education; this number of pages still increases every day. In educational journals and on congresses CSCL is a frequently used concept as well. Newman, Johnson, Webb and Cochrane (1999, p. 487) gave the following description: "By Computer-Supported Collaborative Learning we mean the use of appropriately chosen or designed computer software and network computer hardware, in an instructional context that supports group learning processes". The central idea is that CSCL supports shared knowledge building by the learners (Scardamalia & Bereiter, 1994). The principles of shared knowledge building and CSCL (see Scardamalia & Bereiter, 1994, and this PHdissertation, section 3.3.1) are consistent with a constructivist view of learning. Scardamalia and Bereiter developed the idea of Knowledge Building Communities: groups of persons exchanging ideas, information and experiences to reach a more advanced level of knowledge (Bielaczyc & Collins, 1999; Newman, Johnson, Webb & Cochrane, 1999; Scardamalia & Bereiter, 1998).

Besides group learning, CSCL seems to be a powerful constructivist learning tool for yet another reason. Using a CSCL-system implies that students have to write down their ideas, solutions, remarks and so on. When deep learning is the ultimate learning goal, writing seems to be an effective tool for learning (Rijlaarsdam & Couzijn, 2000; Tynjälä, 1999). Writing can be seen as the most important tool of thinking, and it has a crucial significance in explication and articulation of one's conceptions (Bereiter & Scardamalia, 1987). The knowledge-transforming model developed by Bereiter and Scardamalia (1987) helps us to understand this claim. An essential aspect of this model is interaction between text processing and knowledge processing. Writers do not only tell what they know. Moreover, their content knowledge and their discourse knowledge affect each other during the writing process, thus transforming their thoughts (Diermanse, 1997; Tynjälä, 1999). Furthermore, formulating clearly is even more important in a CSCL-system than during face-to-face group learning. While having face-to-face contact, people use mimicry and gesticulate, something they cannot do in a CSCL-system. Finally, the use of a computer has another advantage, namely the existence of a 'conversation history'. Students can not only re-read contributions or notes, but it is also clear by whom a particular note was written, when a note was written and whether the note was a reaction to someone else's note or not. Text-based communication is less cursory as verbal communication (Sharples, Goodlet, Beck, Wood, Easterbrook & Plowman, 1993).

2.6.2 Two aspects that differ in CSCL-systems

Nowadays, many different CSCL-systems are available and, undoubtedly, new systems will be developed in the years to come. Of course, these systems differ in many aspects. There are, for example, differences between synchronous and asynchronous communication, in the way of structuring the interaction, the availability of cognitive tools, the interface of a system, the organisation and structure, the use of a local area network or a wide area network, the availability of help functions, the use of graphics, the use of hypertext and so on. Several studies have been carried out to describe and compare different software systems that are on the market (see for example CINOP, 1999; Lethinen *et al.*, 2001; Suthers, 1998; Veerman & Treasure-Jones, 1999). It is obvious that the nature of each communication medium has a direct impact on the extent and quality of interaction among the users of a certain medium (Moore, 1993). It goes beyond the central theme of this PHdissertation to describe and compare all CSCL-systems. Because research has shown that two characteristics influence the learning process, we have selected these characteristics of CSCL-systems to discuss, namely (1) synchronous versus asynchronous communicating, and (2) way of structuring discussions.

In synchronous systems, students can work from different places in real time. In asynchronous systems, work is independent of time and place. Veerman and Veldhuis-Diermanse (2001a, 2001b) described four studies taking place as part of a university course, in which students had to work collaboratively on complex tasks by the use of a CSCL-system. Two of the systems used were synchronous, the other two were asynchronous. These studies were compared on a total number of task-related and non-task-related messages, on the mean number of words per message and on the content of the messages. In the synchronous systems, a high frequency of short messages was sent to the discussions. In the asynchronous systems, frequencies were less high but messages were much longer. These differences characterise the different types of collaboration and communication across synchronous and asynchronous CSCL-systems. Synchronous collaboration has to be fast; the psychological pressure to react as fast as possible is high (Moore, 1993). Synchronous discussions can be perceived as ongoing dialogues in which the messages are short and communication is fast. Asynchronous discussions can be regarded more as printed text, in which the flow of communication is slower but in which the messages are longer (Mason, 1991; Veerman, 2000). Consequently, in synchronous communication students have less time to search for information, contributions are critically but not always very thoroughly evaluated, elaborated questions are rarely asked and less information is given to support ideas with explanations. Findings of Veerman and Veldhuis-Diermanse (2001b) confirm this idea. In the synchronous studies, fewer ideas were elaborated compared to the ideas presented in the asynchronous studies (respectively 15% and 47%). To conclude: with academic learning in view, asynchronous systems are to be preferred to use in education. We want students to make facts and insights explicit, to elaborate their ideas, to evaluate facts and insights of themselves and others critically, to link different ideas and to change and/or sharpen their original insights. Asynchronous systems offer better possibilities to reach this kind of learning.

Concerning the second aspect of CSCL-systems, the way of structuring discussions, we noticed the following. In the two asynchronous systems, students worked in separated discussion themes, which made it easier for them to follow the progress of the discussion compared to the discussions in the two synchronous systems. Content-related messages were separated from organisational and technical issues (Veerman & Veldhuis-Diermanse, 2001b). A reason to structure interaction in network-based environments is to encourage students to focus on specific parts of the communication or problem-solving process. Baker and Lund (1997) compared interactions of two groups of students using two interfaces that differed in the extent in which the interaction was structured. The interactions produced with the structured interface were more task-focussed and reflective than those produced with the unstructured interface. Baker and Lund (1997) concluded that structuring interaction can lead to an increase of task-oriented behaviour and a decrease of off-task behaviour.

Threaded structures have become a frequently used structure of CSCL-systems. Threaded discussion refers to an asynchronous method of communicating in which comments to an original post are listed below and indented under the original post. Comments to comments are indented again: a hierarchical organisation of comments. A thread refers to the full list of comments, including the original post and all the comments participants made to it (Collison, Elbaum, Haavind & Tinker, 2000). Although frequently used, some problems with threaded discourse can be noticed (Hewitt, 1998). First, threaded discourse discourages convergent discourse operations. Mostly, before a note is saved in a threaded discussion, the learner must first identify which other note in the conference his current note is responding to. This reduces the likelihood that an individual will consider the option of simultaneously responding to more than one note. A problem related to this is called 'the tunnel vision effect' and refers to situations in which a contributor's focus is narrowed to the extent that earlier conversation is neglected.

Secondly, the content of threaded on-line discourse gradually becomes more diffuse. Inherent to an hierarchical organisation is the convention that each note responds to (at most) one earlier note. Threads become very long and as a result, the discussion can become disordered so that students will lose the focus of the discussion. Another problem could be that threads introduce a tendency toward a sub-optimal intellectual effort. It is intellectually easier to respond to a single note than to many. From an educational perspective, multiple associations between new ideas and existing knowledge encourage more deep learning. Threaded on-line environments discourage students from investing this additional intellectual effort by supporting simplistic add-on contributions, discouraging higher levels of note connectivity (Hewitt, 1998). It is important to be aware of these problems while using a CSCL-system structured by threads. Possible solutions called by Hewitt (1998) are: (1) Avoid sustained growth; start a new conference area whenever the old conference grows too large and becomes disorderly. An additional solution could be to label contributions to make clear what kind of note was written (for example: question, comment, answer, announcement). (2) Create the option not only to select notes on thread, but also on date or author, so that students become more aware of what their group members are working on. (3) Counteract the equalising focus of asynchronous discourse by appointing a moderator or organising face-to-face meetings.

2.7 CSCL and the student

We have described above what we mean by CSCL and why we wanted to use CSCL in education. However, we have to realise that CSCL is new for many students (Veldhuis-Diermanse, 1998). This section will go into this problem, focusing on different learning activities and different learning styles. Section 2.7.1 will emphasise the search for a good balance between effort and learning results. Sections 2.7.2 through 2.7.4 will describe cognitive, affective and metacognitive learning activities, consecutively. Then, in section 2.7.5 the relation between the use of learning activities, ideas about and attitudes to learning and teaching, and learning outcomes will be described within the concept of learning styles.

2.7.1 Effort versus result

In CSCL, active learner participation is required. Active learning is not an easy thing for learners to do: students can only be active learners if they believe in the benefits of active learning, know how to learn in an active way, get rewarded for active learning, have the necessary thinking and learning skills and are learning in a stimulating learning environment (Simons, 1993). Johnston (1997) pointed out that very little research has been done into how students view educational change, 'because no one ever asks them'. She referred to one study that did elicit student perspectives on an educational innovation, and the remark of one of the students illustrates possible feelings of 'discomfort' very clearly: "You suddenly get dumped in the deep end. Suddenly they say they are going to teach us as adults after teaching us as babies for years" (Johnston, 1997). CSCL requires a skill to monitor one's own learning, to work with and listen to others from diverse backgrounds and views, and to develop ways of dealing with complex issues and problems that require different kinds of expertise, knowledge and depth of understanding (De Jong *et al.*, in press). We have to realise that CSCL will be new for many students and will ask a lot of them. In the beginning, students will need some time to accustom themselves to this new educational method. They will be hesitant to publish unfinished work because they are not used to it. They will be a little uncertain, because the teacher does not say whether something is correct or not. However, we expect students to become enthusiastic about CSCL because it is innovative and because they can influence their own learning process. Nevertheless, we have to take into account the required cognitive load. It is a great effort for students to construct knowledge actively and besides to monitor their learning processes; in other words, CSCL will ask for a high cognitive load. However, more effort leads to deeper mental processes and that leads to deeper learning (Salomon, 1995). Of course, in this context effort is defined as effort useful to carry out the task. In other words, the quality of learning depends on students' effort. It is essential to search for a good balance between required effort on the one hand and expected learning results on the other. In educational literature, different types of learning activities are distinguished. Students must spread their effort over these different learning activities. A generally accepted classification of students' learning activities is the classification of (1) cognitive learning activities, (2) affective learning activities, and (3) metacognitive learning activities (Pintrich, 1988; Steinbusch, 1998; Vermunt, 1998). The construction of our methods used to analyse students' learning processes was heavily based on the classification of Vermunt (1992) as depicted in Figure 2.1.

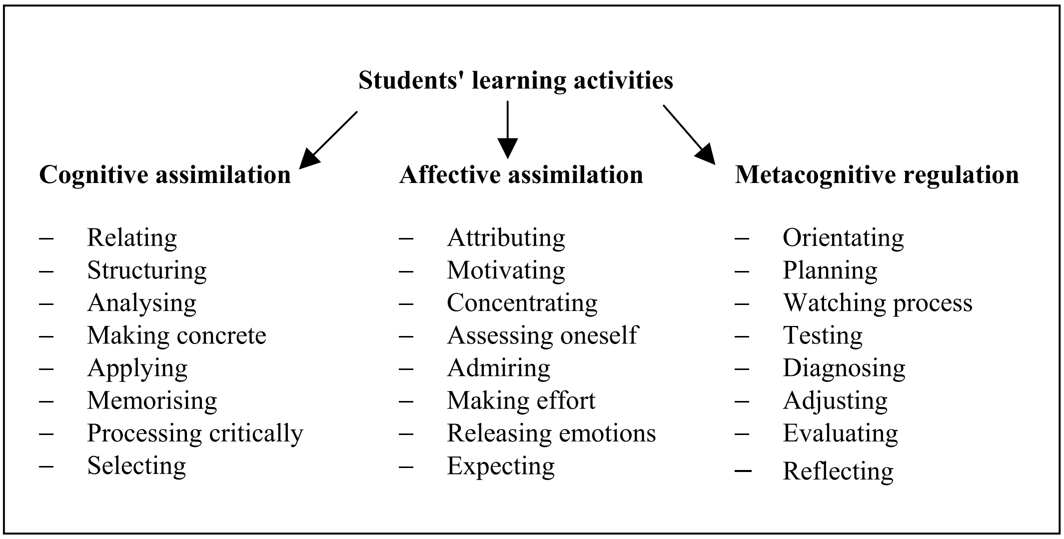

Figure 2.1. A classification of learning activities by Vermunt (1992).

In the next three subsections, these three types of learning activities will be discussed in sequences of the given order, related to the context of CSCL.

2.7.2 Learning activities (1): Cognitive assimilation

Cognitive assimilation activities can be described as the thinking activities students use to process the learning content and to attain their learning goals (Steinbusch, 1998; Vermunt, 1998). These cognitive learning activities lead directly to mental learning results such as knowledge, understanding, insight and skill (Vermunt, 2001). These activities influence the way in which acquired information can be transformed into knowledge and the way in which knowledge can be transferred to other contexts (Laurillard, 1993; Vermunt, 1992). The acquired information concerns facts, concepts, formulas, lines of reasoning, arguments, definitions, theories, ideas and conclusions. Vermunt (1992) defines the activity relating as the search for connections between the different parts of the subject matter, between these different parts and the whole, the main line of the subject matter, and between new information and prior knowledge. Structuring refers to joining separate parts of information into an organised whole, trying to organise subject matter and to integrate newly acquired knowledge into prior knowledge. Analysing means dividing a large amount of information into smaller pieces, stepwise searching out which different aspects could be distinguished within a problem, line of thoughts or theory. Making concrete, according to Vermunt (1992), means that a student tries to make a representation of abstract information, based on known phenomena. Applying refers to practising subject matter for example in daily activities, in solving problems or in interpreting events in topics of the day. Memorising means drumming information into one's head, for example learning definitions, list of characteristics or formulas. Processing critically concerns checking what authors, teachers or fellow students claim, not blindly accepting everything that is said or written. The last activity distinguished by Vermunt (1992) was called selecting. Selecting refers to distinguishing main points from matters of secondary importance. For other classifications of learning activities, see also Anderson (1980), Ausubel (1968), Joyce and Weil (1980), Mayer (1987), Pintrich (1988), and Prins, Busato, Elshout and Hamaker (1998).

Students in constructivist education need other cognitive learning activities compared to students in traditional education, because of differences in pedagogical methods, formulated learning goals and used tests. For example, when students are tested on drumming objective facts into their heads they will use memorising and rehearsing techniques. When students are assessed on critical thinking and formulating an opinion supported by arguments, they will use the activities structuring, selecting and processing critically. Although the cognitive learning activities listed above certainly were useful to direct our thinking, it was not possible to use all of these categories in this way to analyse students' learning processes in a CSCL-system. It was necessary to create a new category of cognitive learning activities relevant to university students, learning computer-supported and collaboratively. Besides the fact that this new category must be relevant, it was also important to formulate measurable items. Chapter 4 elaborates on the choice of cognitive learning activities. This chapter will also describe the cognitive learning activities we used to analyse all students' messages contributed to the CSCL-system.

In this context, we address the following research question: *How can students' learning processes in a CSCL-system be characterised in terms of cognitive learning activities?* In other words, we are interested in the question which types of cognitive learning activities students use in a CSCL-system and, moreover, how often students used the different cognitive learning activities.

2.7.3 Learning activities (2): Affective assimilation

Someone's feelings or state of mind can influence the learning process positively, negatively or neutrally (Steinbusch, 1998; Vermunt, 1992, 1998). Figure 2.1 listed eight affective activities, which we will explain now. Attributing refers to ascribing results recorded in a learning process to causable factors: stable versus variable, controllable versus uncontrollable, global versus specific, and internal versus external. Motivating means developing and maintaining one's willingness to learn. Concentrating concerns focusing on task-relevant aspects and dealing with diverting actions and non-task-related thoughts and emotions. By assessing oneself, Vermunt (1992) means evaluating and assessing oneself as a learner. This assessment concerns one's general capability or one's ability with respect to some specific domains. Admiring means assigning subjective values resulting in the willingness or unwillingness to invest energy. Examples are estimating task relevance or time and effort needed to decide to execute the task or not. The last activity, making effort, refers to the use of thinking activities requiring mental energy. Certain thinking activities can be executed routinely and automatically (for example memorising). Other thinking activities require a higher cognitive load and more metacognitive regulation (for example structuring).

These affective learning activities are of importance to the extent in which and how students develop learning activities (De Jong, 1992; Steinbusch, 1998). Following this reasoning, students' feelings will affect students' learning processes in CSCL, too. From educational experience, we know it is not always easy for students to collaborate in a CSCL-environment. For example, students can get irritated because they do not know what is expected of them, or because they feel their fellow students do not spend enough time in the learning environment, or because the server is down, and so on. Feelings that are more positive were also found in CSCL-databases. For example, students compliment fellow students because of their contributions, or students ask for feedback when the discussion volume is down. In this PHdissertation, the assumption is that affective learning activities will affect students' learning processes and for that reason, a category concerning affective learning activities was incorporated into the methods for analysing students' learning processes. By including a category affective learning activities in the method of analysis we will provide information about students' feelings in order to interpret better the nature of the social interactions between students. Chapter 4 will describe the affective learning activities we used to analyse all students' messages contributed to the CSCL-system and elaborate on the choice made to use these activities.

Comparable to the research question as formulated in section 2.7.2 we address the following research question: *How can students' learning processes in a CSCL-system be characterised in terms of affective learning activities?* In other words, we want to know if students express their feelings in their contributions and how the use of affective learning activities affects students' learning processes.

2.7.4 Learning activities (3): Metacognitive regulation

In general terms, metacognition refers to a learner's awareness of objectives, ability to plan and evaluate learning strategies and capacity to monitor progress and adjust learning behaviours to accommodate needs (Flavell, 1979). Metacognition concerns metacognitive knowledge as well as metacognitive skills. Metacognitive knowledge can be defined as knowledge concerning one's own cognitive processes and products or anything related to them (De Jong, 1992). Metacognitive skills concern the extent to which students can regulate their cognitive and affective learning activities and, therefore, their own learning process (Elen, 1998; Vermunt, 1998) by using metacognitive learning activities. This explains the term metacognitive regulation also used by Vermunt (1992). In this PHdissertation, we are especially interested in students' metacognitive learning activities contrary to metacognitive knowledge. Experiences showed that students did not express their metacognitive knowledge in their messages. On the contrary, metacognitive learning activities are reasonably easy to find in CSCL-data. Besides, we are more interested in regulation of group processes aimed at stimulating collaborative learning than in individual use of metacognitive knowledge.

The use of metacognitive learning activities is essential to successful learning because it enables individuals to manage their cognitive skills, and to determine problems that can be solved by applying other cognitive activities (Schraw, 1998). De Jong (1992) showed in research that successful students more often use metacognitive regulation activities in comparison to less successful students. Furthermore, these metacognitive regulation activities are more adapted to task demands and text characteristics than the metacognitive regulation activities of less successful students. Research indicates that regulation of someone's learning process depends on the person's age; learners regulate their own learning process to a higher extent when they are older (De Jong, 1992). In general, it can be expected that university students will regularly use memory strategies, will studying according to a plan, can evaluate their achievements, can judge task characteristics and have self- and strategic knowledge (De Jong, 1992). In agreement with this are findings of Scardamalia, Bereiter, McLean, Swallow and Woodruff (1989). They found successful students to be better skilled in making their own objects, revising and reorganising their knowledge, relating old knowledge to new knowledge and drawing conclusions referring to certain information. Less skilful students are characterised by organising mental activities by subjects instead of goals, being directed to shallow aspects, working forward instead of looking backward sometimes, reading information and accepting it as true instead of actively acquiring information. The research of Scardamalia *et al.* (1989) was carried out in the context of CSCL.

Figure 2.1 shows the eight activities distinguished within the category metacognitive regulation (Vermunt, 1992). Orientating refers to preparing the learning process by inspecting task characteristics, context and testing. Thinking about prior knowledge and available time are aspects of orientating as well. Planning concerns designing a learning process related to learning goals, subject matter, tools, and time. The learner outlines a plan about how to execute a task. By watching the process, Vermunt (1992) means keeping one's eye on the planning. For example, students realise that they do not understand something; students experience nervousness or notice that they have read an article twice without knowing what they read. Testing refers to checking whether learning goals have been reached. In other words, does the learner understand the subject matter and is the learner able to remember and to apply the acquired knowledge? Diagnosing differs from testing in searching for possible factors that cause trouble or successes. Evaluating also concerns checking whether learning goals have been reached, but compared to testing, more importance is attached to the learning process. Did the learning process confirm the expectations? The final activity was called reflecting. Reflecting is thinking about the learning process in general terms. Relevant questions are: What happened during executing the task? Which approach was followed? Which learning activities could be used next time? Was the collaboration with fellow students useful? (Vermunt, 1992). In our opinion, the distinction between testing, evaluating and reflecting is not very clear; these three activities do not differ very much.

Chapter 4 will describe the metacognitive learning activities we decided to use to analyse students' messages contributed to the CSCL-system. Comparable to the research question as formulated in sections 2.7.2 and 2.7.3 we address the following research question: *How can students' learning processes in a CSCL-system be characterised in terms of metacognitive learning activities?* In other words, we are interested in the question which types of metacognitive learning activities students use and how often they use those types of metacognitive learning activities to regulate their learning processes in a CSCL-system.

To summarise, one of our main research questions could be formulated as: *How can students' learning processes in a CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?*

2.7.5 Learning style

Research has shown that students prefer to use certain learning activities and, therefore, each student learns in a specific way. Students make themselves familiar with a certain study method; in other words, they develop their own learning style. The most general definition of learning style is a "student's consistent way of responding to, and using stimuli, in the context of learning" (Pham, 2001). Learning style refers to the characteristic way in which we attend to, take in, organise, store, retrieve and utilise what we learn. Following the terms described above, it means that students use different cognitive, affective and metacognitive learning activities. Each person has a preferred learning style as well as several back-up strategies for learning particular material. Learning styles are the result of interaction between personal and contextual factors (Schmeck, Geisler-Brenstein & Cercy, 1991). Examples of personal factors are intelligence, age, educational experience and prior knowledge. Examples of contextual factors are the structure of the task, the complexity of the knowledge domain, the learning goals of a course, the test and the teaching method. Personal factors cause consistency in the way students learn, contextual factors cause variability (Vermunt, 1992). During the past thirty years, many researchers have been interested in the subject of learning styles. However, each researcher has defined the concept of learning style with respect to his or her theory. Some examples of researchers who defined and classified learning styles are Dunn, Dunn and Price (1975), Gardner (1983), Grasha (1984), Gregorc (1976), and Kolb (1976). Studies in this context concerned issues such as differences between cultures or gender, developing education based on learning styles or measuring learning styles. In this PHdissertation, we will use the classification of learning style as described by Vermunt (1992), because the use of concrete learning activities and because his classification fit the constructive view of learning.

Vermunt (1992) showed that the cognitive learning activities students use for learning are connected with a certain regulation strategy, their view of learning and with a specific learning orientation. Vermunt (1992) called the relation between these four factors 'learning style' and he showed that the stability of someone's style of learning is rather high in general (Vermunt, 1998). Figure 2.2 shows a model of the learning style as formulated by Vermunt (1992).

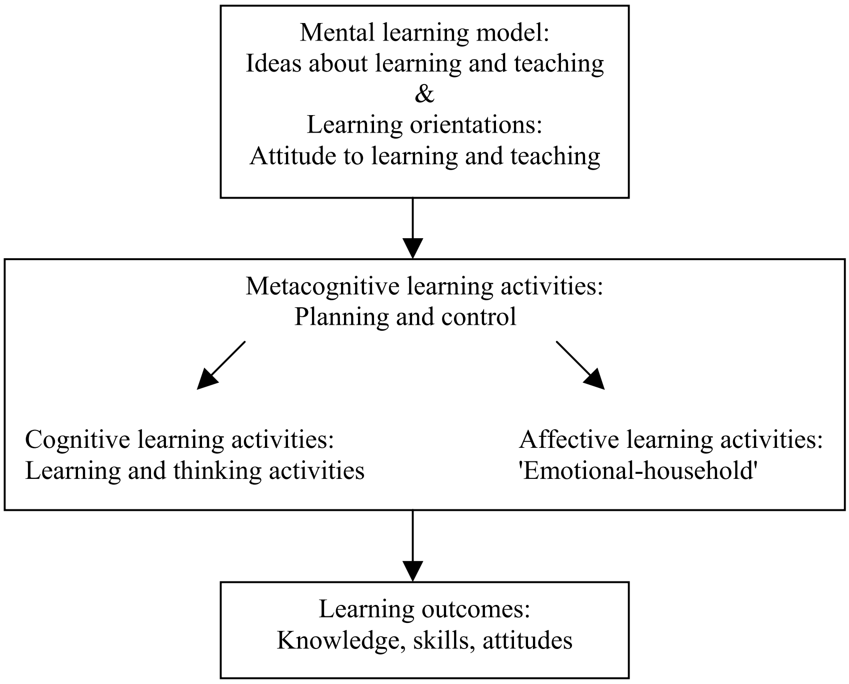

Figure 2.2 Learning style: relation between students' view of learning, the learning activities used and their learning outcomes (Steinbusch, 1998; Vermunt, 1992, 1998).

Vermunt (1992, 1998) discerned four different learning styles: (1) reproduction-directed learning style, (2) meaning-directed learning style, (3) application-directed learning style, and (4) undirected learning style. Below, we will describe these learning styles in short. For a more detailed description, see Vermunt (1992). Notice that the learning styles distinguished by Vermunt are ideal types. In daily practice, students will often have characteristics of several learning styles and, therefore, it would be difficult to ascribe one of the four described types.

Students with a reproduction-directed learning style are directed at remembering subject matter to reproduce it at the test. They spend a lot of time selecting main points in a text and underline the information that could be asked for in the test. They work through the subject matter stepwise and thoroughly, but are less critical while studying the information. Students with a reproduction-directed learning style are strongly directed at external regulation; in this context, this means instructions by the teacher or the educational tools. They evaluate their learning result especially by answering questions and exercises presented by the teacher or the method used. Their learning goal is passing the exam and not surprisingly, their learning is oriented at certification and self-testing.

Students with a meaning-directed learning style are directed at acquiring insight into the subject matter. They try to follow the lines of thought of authors and teachers as well as possible. They are not very interested in details, but search for main points, hypotheses and the essence of the subject matter. However, contrary to the reproduction-directed learning style, students with a meaning-directed learning style try to select information in texts and lectures that they themselves attach importance to. An important learning activity of these students is relating parts of the subject matter to each other or to their prior knowledge and creating an overview of all information. Learning is seen as constructing knowledge and using this knowledge in other contexts. In other words: understanding and thinking out a line of reasoning. Sometimes students with a meaning-directed learning style are directed at external regulation; sometimes they regulate the learning process by themselves. Motives to learn often are personal interest and personal development and, finally, studying is seen as an enjoyable activity.

Students with an application-directed learning style are strongly directed at using and applying the subject matter. They do not select information because of the final test or because of personal interest, but because of the practical relevance of the information. They use actual events as examples while studying subject matter. Furthermore, these students drum less objective facts into their head. They only do this when they find something not interesting; otherwise, they could not remember these facts. Compared to students with a meaning-directed learning style, students with an application-directed learning style are, depending on the specific context, directed at both internal and external regulation as well. Their studying goal is acquiring knowledge and using this knowledge in practice. These students often are vocation-oriented.

Finally, the undirected learning style. Students with this learning style do not use certain learning strategies, do not aim at learning goals and cannot regulate their learning process. Therefore, they are strongly directed at external regulation, but that is not enough to go by. Furthermore, they have difficulty with selecting main points, relating facts, applying knowledge and assimilating subject matter critically. Students with an undirected learning style attach much importance to collaboration with fellow students. They hope to motivate each other and to share their problems. A stimulating context is important to help these students in their study that they find difficult. Students in this group have a mix of learning orientations (Vermunt, 1992).

Related to the theory described above, we address the following research question: *What is the relationship between students' learning style on the one hand and students' participation, learning processes and knowledge construction in a CSCL-system on the other hand?* In this section, we discussed which attitude, skills and kinds of learning activities students need in CSCL. The next section will discuss consequences of using CSCL for the role of the teacher.

2.8 CSCL and the teacher

To teachers, working with CSCL generally means a big change to their educational approach. They often teach in the way they received education and are afraid to lose control of their teaching. The safe environment of transmission education and the familiar teacher's role are put under pressure (Van Heule, 1998). The past shows that education changes slowly. Education does change, but not according to logical paths and by way of accurately planned steps. That experience was acquired after many failures of large-scaled as well as modest attempts to innovate the education (Lagerweij & Haak, 1994). Jongmans, Biemans and Beijaard (1998) cited two factors playing a part in educational innovation: teachers' professional orientation and teachers' involvement. Professional orientation was described as the total of conceptions about their work and the knowledge and skills they have. They distinguish self-involvement, task involvement and other involvement. Professional orientation as well as involvement in colleagues and the school as organisation play a crucial part in succeeding innovations (see also Bakkenes, 1996). Oddly enough, with the rise of CSCL in education, at the beginning very little research was carried out with regard to the teacher's role in constructivist education (see for example Keursten, 1994; Veen, 1994). More often the students' role or design of the electronic environment were subject of research. That is striking because teachers remain very important. They filter and select an overflow of information and offer that information to students in a way that goes well with them (Baten & Bogaards, 1998).

More and more teachers are interested in new educational approaches and they must be helped not to lose their grip on the educational learning situation. It is not easy to describe the role of the teacher in constructivist education and especially in CSCL. However, it is clear that the teacher cannot be the one who has a monopoly of wisdom any longer, transmitting his knowledge to students. The traditional role of the teacher as information deliverer is changed to the role of facilitator. This means facilitating collaboration between students, encouraging them to monitor their understanding (without directly giving them information), communicating with them and carefully examining knowledge produced by students (Lipponen, 1999). Resta, Christal, Ferneding, Kennedy and Puthoff (1999) noticed two fundamental changes in teacher's role: (1) Teachers use less lecture and demonstration and act more as a learning guide or coach for students who pursue their own knowledge goals, and (2) teachers become less consumers of a curriculum and become more involved in designing a curriculum that is more sensitive to students' interests. Instruction must be given in such a manner that students learn to learn. This supposes offering and coaching meaningful learning activities and stimulating students' thinking by offering authentic problem situations (Gokhale, 1995; Spiro, Feltovich & Coulson, 1997). The teacher is the one who has to stimulate students to actively construct knowledge and create the opportunity to come to negotiation about knowledge (Veldhuis-Diermanse, 1999c). He is forced to make decisions concerning questions such as: What do students pick up of their own accord? How much self-activity can I expect? Where do I have to intervene? Do students have enough time to read each other's contributions? (Baten & Bogaards, 1998). Knuth and Cunningham (1993) characterised teacher's instruction as constantly feeding the ongoing learning process whereby learners come to understand the world in a natural way. Ideally, a teacher teaching by CSCL is expected to:

- trust students' independence and share responsibility;
- take care of a safe learning climate in the group and create conditions in which students dare and can collaborate;
- help students to negotiate about knowledge by giving useful indications when they get stuck;
- offer meaningful learning activities such as problem cases;
- keep students motivated by being interested and giving feedback to their actions;
- evaluate, judge, value and validate not only the product but also the learning process;
- take care of the basic conditions to make education possible as far as he is able to do that.

(Based on Korthagen, Klaassen & Russell, 2000).

Though it is obvious that the role of the teacher must change fundamentally, much is unclear about possible effects of moderating discussions in CSCL-systems on students' learning processes. Therefore, the following main research question was formulated: *What are the effects of moderating a CSCL-discussion on students' learning?* A problem underlying this question is how to operationalise teacher interventions. In chapter 6, we will elaborate on this problem.

2.9 Research questions

To summarise: in this PHdissertation the following main research questions will be addressed:

1. How can students' learning processes in a CSCL-system be characterised in terms of participation and interaction?
2. How can students' learning processes in a CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?
3. Do students construct knowledge and what is the quality of that knowledge constructed by students in an asynchronous CSCL-system?
4. What are the effects of moderating a CSCL-discussion on students' learning?

To end this chapter: Figure 2.3 presents a conceptual model of the theoretical framework of our research.

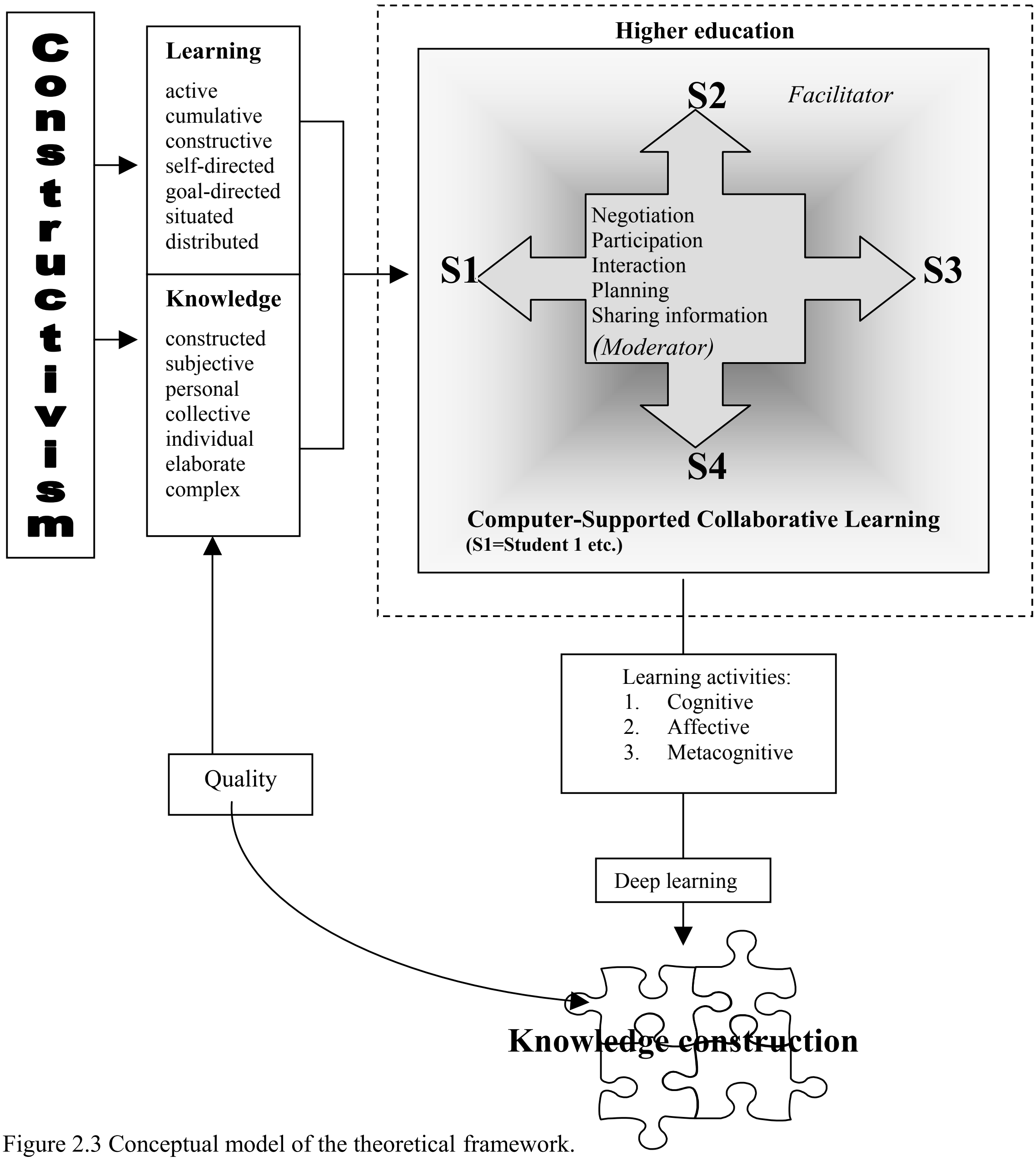

Figure 2.3 Conceptual model of the theoretical framework.

Chapter 3 – CSCL: How to analyse data in a CSCL-system?

"In a communication process, reactions are not based on the intended messages but on the perceived one…"
(Lowyck, Elen, Proost & Buena, 1995, p. 21)
"Through interpretations by others, you may come to mean more than you thought you did…"
(Pea, 1993, p. 270)

In our opinion, the quotations above illustrate both the usefulness and the complexity of collaborative learning as well as the problem of analysing this kind of learning. To find an answer to our research questions, first we carried out a literature study to get to know how other researchers have tackled the problem of analysing CSCL-data.

3.1 Introduction

This chapter will discuss a selection of methods other researchers used to analyse their CSCL-data. The aim is to get an overview of different methods to get to know whether available methods are usable to answer the research questions as formulated in this PHdissertation. Section 3.2 will explain the essential choice to analyse learning processes instead of learning products. Section 3.3 will discuss some parallel studies in which CSCL-data were analysed, each time ending in a conclusion concerning the use of that specific method. Section 3.3.1 will focus on analysing students' participation and interaction; section 3.3.2 will focus on analysing the content of students' written contributions. Finally, section 3.4 will summarise the findings and the conclusions drawn with regard to the usability of existing methods in this PHdissertation.

3.2 Analysing the process

In CSCL, many factors play a part in setting up a CSCL-context. Some factors are the selection of a CSCL-system, the composition of a group, the group size, the role of the teacher and the design of the task. A large body of empirical research on collaborative learning has been inspired by questions such as: What is the optimal group size? Should I select group members with respect to some criteria or leave them to make the group by themselves? Is it better to have group members who have the same viewpoint or not, the same general level of development or not, the same amount of knowledge with respect to the task at hand or not? Which tasks are suited for collaborative processes and which are not? (Dillenbourg, 1999). Although these questions are interesting for this PHdissertation, the focus is not on them. Beyond a few main results it appeared in research that these conditions interact with each other in a complex way. Because of these multiple interactions, it is very difficult to set up initial conditions that guarantee the effectiveness of collaborative leaning (Dillenbourg, 1999; Webb & Sullivan Palinscar 1996). Because general effects related to the complexity of the different conditions could not be found, the necessity of analysing the collaborative process as such is increasingly emphasised. Researchers should no longer treat collaboration as a 'black box', but zoom in on the collaboration to aim at better understanding what is happening (Dillenbourg, 1999). One should not talk about the effects of collaborative learning in general, but more specifically about the effects of particular categories or interactions. In chapter 2 we have already explained that the process-oriented perspective is most relevant compared to the effect-oriented perspective in this PHdissertation (see section 2.4.2). In effect-oriented research, CSCL is compared to other didactic teaching methods or learning situations. Questions as described at the beginning of this section also concern the effect-oriented trend and are not the essence of our research. To set up courses, of course we have to do with such questions; courses have to be prepared very well. However, we want to study CSCL in ecological settings and do not set up experimental conditions varying in factors as described above. In all courses, the idea of using CSCL came from the teachers themselves.

It was obvious to us to analyse the log files that are automatically saved in the databases of the CSCL-system used, because these log files contain all information concerning students' activities. Examples of logged/saved activities are the text of students' written notes and therefore also the number of written notes per student, the notes students read and therefore the number of read notes per student, the date of contributing a note to the forum, the times students edited their notes and so on. Additionally, the choice of analysing students' learning processes instead of their products implies that we did not analyse final tests. Theoretically, it would have been possible to video students behind their computers working at the task to collect additional data. For several reasons, we did not do that. First, it was not practically, because in most courses students worked not in one room but in different rooms at the university or even at home. Therefore, it was not possible to record all moments that students used the CSCL-system. Besides, we expected students to behave in another way, influenced by our presence and the video camera, compared to a situation in which students worked alone, and that seemed not desirable to us. The last reason was a pragmatic one: videotaping all moments would take too much time, time that then could not be used to do other work. To get an impression of the progress of the course, the way students worked and the sphere among students, regularly we visited students. Additionally, in most courses we asked students to fill out an evaluative questionnaire (see also section 3.3.1).

3.3 How previous studies analysed data in a CSCL-system

This section will give an overview of methods found in parallel studies on CSCL, focused on basic as well as on more advanced analyses. Section 3.3.1 will describe several studies in which CSCL-data were analysed on participation and/or interaction. In section 3.3.2 the focus will be on studies in which CSCL-messages were analysed in terms of content.

3.3.1 Basic analyses: Students' participation and interaction

In general, participation means taking part in something. In CSCL, students are expected to participate in the CSCL-system and take part in the discourse; an active learning attitude is expected (see also section 2.7.1). In this context, active learner participation may be a misleading term. Instead, a distinction between active and passive participation has to be made (Veldhuis-Diermanse, 1999b). In our opinion, active participation refers to writing notes and passive participation refers to reading notes. Notice that in this context the term participation has a poorer meaning than in the participation metaphor of Sfard (1998) in which learning is considered to be like becoming a member of a certain community (see also section 3.2). Here, participation only refers to the number of written and read notes. Based on the theoretical framework described in chapter 2, we assume that more active and more passive participation will lead to deeper learning and better learning results. For that reason, it is important to analyse students' participation. Participation data, although not theoretically supported, obviously can be very useful in giving an overall impression of activity in a CSCL-system. It may immediately give an indication of the range of participation levels during the whole course and the differences in participation rates between students in the course (Lally, 2001). Thus, analysing students' participation means a very basic analysis in which the number of written notes and the number of notes read will be counted. Many researchers in the field of CSCL have analysed students' participation by counting number of written and read notes (see for example Brett, Woodruff & Nason, 1999; Lipponen, 1999; Lipponen & Hakkarainen, 1997; Muukkonen, Hakkarainen and Lakkala, 1999).

Another indicator of participation could be the amount of time spent on working in the CSCL-system. However, most of the CSCL-systems do not record this time very well. Moreover, it would be a problem to interpret the indicator time: does it concern time on-task or time off-task (Mayer, 1987)? Were students logged in but drinking coffee or were they really writing or reading notes? Furthermore, some students work faster than others and therefore time is not a valuable indicator of participation. In this PHdissertation, time is not used as an indicator of participation because of the doubtfulness of its validity. Hewitt and Teplovs (1999) did analyse the aspect of time, but from a totally different point of view. They were interested in the development of threads to gain insight into students' participation evolving over time. A total of 1,521 threads in seven education courses were examined by Hewitt and Teplovs (1999) on their day-by-day evolution and it was found that notes acquired most of their responses in the first few days after they were initially added to the discussion. The odds of a response dropped dramatically over time. The longer a thread had been inactive, the greater the chance that the thread would remain inactive until the end of the course (Hewitt & Teplovs, 1999). Apparently, in our courses attention must also be paid to activate students continually and to keep threads alive.

In many studies it was found that students read many notes but created relatively few notes: students' passive participation is larger then their active participation (see for example Brett, Woodruff & Nason, 1999; Kleine Staarman, Trimpe, Veldhuis-Diermanse, Verhoeven & De Jong, 1999; Nurmela, Lethinen & Palonen, 1999). This is not surprising because reading notes will usually take less time than writing notes and all group members will write notes to be read. From the point of view of collaborative learning, this is a positive finding, because reading each other's notes refers to interaction. Moore (1993) identified three types of (social) interaction: (1) learner-content, (2) learner-learner, and (3) learner-instructor interaction. Learner-content interaction concerns the learners' involvement with the content as they construct their knowledge by building on the information given. Learner-learner interaction is either one to one exchange of information within a small or large group. Learner-instructor interaction refers to the communication between the learner and the instructor for the purpose of explaining, elaborating, scaffolding and providing feedback (Moore, 1993). In this line of reasoning, Garland, Teles and Wang (1999) distinguished five categories of messages to identify patterns of interaction among the participants of an on-line course: (1) Students' responses to course topics, (2) student to student messages, (3) student to instructor messages, (4) instructor's responses to students, and (5) instructor's assignments/comments.

Dix, Finlay, Abowd and Beale (1993) contrast human-human interaction to human-computer interaction. Notice that in this PHdissertation no attention is paid to interaction between the student and his or her computer. Issues concerning user performance or design of the interface are not an object of research. In this PHdissertation, interaction refers to social interaction between participants in a CSCL-system, communicating with each other while working at the task given. Interaction is defined as the process through which negotiation of meaning and construction of knowledge occurs (Gunawardena, Lowe & Anderson, 1997). In this process, the CSCL-system used only serves as a medium to support the communication. This communication mostly concerns learner-learner interaction, but it sometimes refers to interaction between learner and instructor. In chapter 5 of this PHdissertation we will focus on student-student interaction, in chapter 6 on teacher-student interaction.

In CSCL-research, a central question is whether students really collaborated or mainly worked individually in the CSCL-system used. In other words, while studying CSCL, we want to identify the social structure. Questions that arise in this respect are: 'Did students read notes?', and more specific, 'Who read whose notes?', but also, 'Who did react to whom?' and 'Was there a key student with a central role?'.

The idea of quantifying interactions between group members is not new. For instance, Cohen, Lotan and Morphew (1998) suggested that counting the number of interactions between participants in a learning environment may help designers to assess the success of groupwork interventions (see also Hakkarainen, 1998; Hewitt, 1996; Johnston, 1997). In addition, Wortham (1999) described a framework to analyse interaction patterns in small groups. He calculated with expected values starting from the idea of an idealised situation of interaction: a fully connected network which means that each student equally participates. This framework fits the idea of calculating density; an indicator of interaction often used in Social Network Analysis (SNA). Social Network Analysis (SNA) emerged as a set of methods for the analysis of social structures, methods which especially allow an investigation of the relational aspects within and between these structures (Nurmela *et al.,* 1999; Scott, 2000). SNA is focused on uncovering the patterns of people's interaction; it is especially designed to facilitate the analysis of relational data and provides an approach that can not easily be achieved by others tools (Lethinen, Palonen & Nurmela, 1999). The methods appropriate to relational data are those of network analysis, whereby the relations are treated as expressing linkages that run between agents. While it is, of course, possible to undertake quantitative and statistical counts of relations, network analysis consists of a body of qualitative measures of network structure (Scott, 2000). Examples of studies in the field of CSCL in which SNA was used are Lakkala, Muukkonen, Ilomäki, Lallimo, Niemivirta and Hakkarainen (2001), Lipponen, Rahikainen, Lallimo and Hakkarainen (2001), Nurmela *et al.* (1999), and Palonen and Hakkarainen (2000).

An additional way to gain insight into patterns of social interaction is analysing replies or build-on notes. These kinds of analyses are often used before executing SNA. Hewitt and Teplovs (1999) found evidence for their hypothesis that students only reply to, or build on, the three or four most recent notes in a thread. By the time a thread contains six or more notes the first few notes in the thread usually are several days old. The probability that such notes will inspire a response is extremely low. Therefore, the contribution made by old notes to the probability that the thread will grow is negligible. To illustrate: 80% of the 1,521 threads analysed by Hewitt and Teplovs (1999) contained four notes or fewer. "42% of the 4083 notes received a response. 63% of the replies occurred on the first day, 16% on the second day, 8% on the third day and 4% on the fourth. The cumulative sum of the probabilities for the remaining days is approximately 9%. Therefore, if a note fails to attract attention in the first few days, it is unlikely to receive any responses at all" (p. 234). Results of Guzdial (1997) and Brett *et al.* (1999) confirm these findings.

Breuleux, Owston, Laferrière, Estes, Resta, Hunter and Awalt (1999) approached the analyses of interaction in a total different way. They drew sociometric pictures of the weekly growing interaction between students. Advantage of this approach is that numbers of actions are not counted cumulatively and, therefore, possible shifts of students' roles within groups can be found. When only cumulative numbers would be used, these shifts could be lost because of the effect of neutralisation. Kynigos (1999) combined a sociometric, ethnographic and discourse analytic model to describe group dynamics. He was interested in how members of a group perceive their role during collaborative learning and how they perceive their social interaction and collaboration in the context of the computer-based environment. Group norms regarding collaboration and criteria for positive and negative social behaviour were also investigated. In the light of the research question of this PHdissertation, collaborative learning will not be considered from a group dynamics view. However, in some cases we asked students some questions in order to better interpret the results. This concerned questions such as whether they were satisfied with the collaboration within their group, whether there was in their opinion a student with a central role or whether they had stimulated group members to be critical or to be more active in the forum.

Hakkarainen (1998) used another approach. He analysed the content of notes on several aspects. One of the categories was called 'communicative idea'. These communicative ideas were divided into three groups: (1) Type of comments, (2) object of comments, and (3) explication of referent. A comment could be classified as supportive, neutral or critical. Furthermore, the object of comments could be linguistic form, research question or method, information, explanation or other and unspecific. Finally, a distinction was made between non-explicated, partially explicated and explicated ideas. With these analyses, Hakkarainen did not only count the number of students' actions, but added an aspect in order to say something about the nature of the interaction. The added value of using this method is that one gets to know what the communication is about. A disadvantage of Hakkarainen's method is the lack of general use; it is difficult to use his system in other data sets, because it is strongly based on the Progressive Inquiry Model (PI-Model; see also section 3.3.2). One of his conclusions was that there was a very close relationship between the epistemological nature of knowledge produced by students and the learning tasks they carried out. If students did not have to carry out a task according to the PI-Model, the method failed to ascribe a code to the activities. The PI-Model was developed by Hakkarainen (1998), based on Bereiter and Scardamalia (1993), and among others used by Muukkonen *et al*. (1999), Salovaara (1999), and De Laat and De Jong (2001). Progressive inquiry entails that new knowledge is not simply assimilated but constructed through solving problems of explanation and understanding.

Hewitt (1996) also studied the content of students' notes in his analyses of interaction. The subject of his study was a grade 5-6 classroom participating in the course Human Biology, taught by an experienced teacher with a strong scientific background. This six-week course was repeated each year; students used the CSCL-system 40 minutes a day. Over the four-year experimental period, no child participated for more than two years. Hewitt (1996) developed a scale for rating the quality of students' interaction. The scale consisted of seven categories: (1) Off-task/social chat, (2) non-specific feedback, (3) statements about surface features such as spelling or grammar, (4) specific feedback relating to note content, (5) suggesting a different procedure or recommending a different line of investigation, (6) connecting the reader with other notes or information sources, and (7) advancing direct knowledge (Hewitt, 1996, p. 50). An increase in the proportion of category 7 indicated a steady increase in interactions aimed at advancing knowledge. The first six categories are expected to be evident, category 7 may be less clear. We quote some examples to explain what Hewitt (1996) meant. "I found out that spiders have eight legs not six, so they cannot be insects", "You said that the chromosomes in the nucleus split apart. How does that happen?" and "I think that brain cells are larger than normal cells because they have to hold a lot of information" (Hewitt, 1996, p. 50). By the fourth year, almost 90% of the interactive events were assigned to category 7 (Hewitt, 1996).

In our opinion, Hewitt only paid attention to the regulation of students, in category 5 and 6 ('suggesting a different procedure or recommending a different line of investigation' and 'connecting the reader with other notes or information sources' respectively). With regulation, we here mean the way in which students approach the task and monitor their planning. Some examples of events classified as category 5 or 6 are: "You should explain…", "Maybe you should make a chart about that", "Ask Many for that information" (Hewitt, 1996, p. 50). In the other studies reviewed here, regulation was not concerned in the analysis. That is striking, because interaction is assumed to be essential in CSCL. The idea behind surveying social interaction is that higher-order social interaction will have a positive effect on better learning in terms of deep understanding (Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001). Social interaction between participants forces them to consider their conceptions from the viewpoint of others, and this facilitates a growing awareness of one's own knowledge and beliefs. Biggs (1999) associated deep learning approaches with 'affective involvement', which is supported by interaction. Critical thinking has been seen as a key skill that is required in deep learning. Group learning, such as CSCL, provides a good educational context for critical thinking processes and deep learning styles, as well as promoting critical thinking through interaction. The lack of interaction in lectures and other unidirectional information transfers severely limits the scope for the testing of ideas, justification and criticism that occurs in more challenging group learning situations (Newman, Johnson, Webb & Cochrane, 1999).

To summarise: in this PHdissertation, the extent of both students' passive and active participation as well as the extent, the direction and the quality of interaction are concerned in the analysis of the log files of CSCL.

3.3.2 Analysing the content of students' contributions

With respect to CSCL, analysis of the content of students' written contributions is no common practice. This kind of analysis is difficult and very time intensive. However, it seems important not only to know how often students participate and to whom they communicate, but also to analyse students' contributions in depth. Only in this way, it seems possible to gain insight into students' learning and communication processes in CSCL. It is important to know what students write. Explicit or statable knowledge in the form of written contributions could be analysed and used to say something about the learning process (see also Baker, 1999; Hewitt & Scardamalia, 1998; Veerman & Veldhuis-Diermanse, 2001, and chapter 2 of this PHdissertation). Examples of questions that arise are: Do students explore problems, concepts or solutions? Do students relate ideas and information? Do they discuss new information? Do they link various subjects? But also: Do students understand each other's notes and do they help each other on request? Do they motivate each other? And: How do they approach the task? In the previous chapter, knowledge construction was operationalised as adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas. In CSCL-studies we searched for methods that analysed students' written contributions to the process of knowledge construction.

An interesting study concerning qualitative CSCL-analyses can be found in Veerman (2000). In her research, executed at university, she looked at what happened with knowledge during a discussion. "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" (Veerman, 2000, p. 102). The following constructive activities were distinguished: (1) Additions, (2) explanations, (3) evaluations, (4) summaries, and (5) transformations (Baker, 1999; Veerman, 2000). Additions contained new information that could not be linked to earlier contributions in the discussion. Explanations contained an elaboration of an idea contributed earlier in the discussion. Evaluations were justified considerations of the strength or relevance of information already added or explained. Transformations were based on evaluations and led to new insights or directions for further discussion. In summaries information already stated was (re)organised in such a way that selected points of the discussions were put in relation to each other and reflected the main content of the discussion. Veerman regarded the production of constructive activities as signals of potential support for collaborative learning-in-process as they appeared to be connected with knowledge-building discourse to co-construct meaning. She compared synchronous discussions to asynchronous discussions and found that synchronous discussions contained mainly additions and evaluations whereas asynchronous discussions mostly included explanations. In both types of discussion, hardly any summaries or transformations were produced by the students (Veerman, 2000). Veerman set an example, which helped us to translate theories about learning into measurable concepts. Although Veerman influenced our thinking about the concept of knowledge construction, we decided not to use her system to analyse our data. In our opinion, her categories were rather large and we aimed at a more detailed analysis of knowledge construction. Another reason was the lack of metacognitive categories. Veerman did not analyse how students approached a task and how they regulated their learning processes. Her focus was on collaborative argumentation, whereas we are interested in the use of both cognitive, metacognitive learning and affective learning activities.

Newman *et al.* (1999) also developed a method to evaluate the quality of students' learning in CSCL. Their method is based on a theory of critical thinking (Garrison, 1992) and is especially meant for the analysis of learning processes of students in higher education. Garrison's theory considered critical thinking to be a problem-solving model with five stages: (1) Problem identification, (2) problem definition, (3) problem exploration, (4) problem application, and (5) problem integration. Newman *et al.* (1999) were looking for signs of critical thinking in a social context as evidence for deep learning. In their research, the learning process was subject of analysis; they were not assessing the final outcome as an assessment of student performance. They developed a set of paired indicators by looking for indicators in all of Garrison's stages and from their experience in using similar techniques for assessing student work in collaborative learning. Examples of pairs are critical assessment of own or others' contributions versus uncritical acceptance or unreasoned rejection, generating new data from information collected versus repeating information without making inferences or offering an interpretation, relevant statements versus irrelevant statements, and clear and unambiguous statements versus confused statements. They converted the counts of the analyses for each pair of indicators to a depth of critical thinking ratio, to scale learners as surface or deep learners (Newman *et al.*, 1999). A controlled experiment was set up with 49 students participating in an Information Society course. The students did half their seminars face to face, and half using a CSCL-system. The teacher used the same coaching style in both. The results suggested that the face-to-face seminars were better for creative problem exploration and idea generation, and that CSCL better supported the later stages of linking ideas, interpretation and problem integration. It seemed that the face-to-face seminars produced more spontaneous interaction, stimulated more new ideas and more participation than CSCL. However, CSCL encouraged a more valuable, more considered, style of interaction, led to more important statements, and made it easier to link ideas. The analysing method said something about the nature and the quality of learning taking place. However, using this method would be problematic for people without having any knowledge of the domain students are working on. For example, it would be very difficult, if not impossible, for a non-expert to judge a statement as relevant or irrelevant or to judge issues as important or unimportant. Another problem concerns the large number of indicators (a total of 45 codes was distinguished). It would be difficult to interpret the data and not to get lost in all codes. Furthermore, the inter-rater reliability was not measured and therefore the method is not ready to be used. It has only been piloted in a small-scale test and needs more work in other learning contexts to validate and improve it (Newman *et al.* 1999). All in all, the ideas underlying this method seem promising to us, but we had practical difficulty to use the method in our data.

The basic idea of the theory of critical thinking shows agreement with the PI-Model. In both theories, it is essential that learners formulate and create their own ideas, ask their own questions and make decisions about how to solve problems. The PI-Model was the starting point of Hakkarainen's analyses of interaction between students (see section 2.3.1), but also formed the basis of his analysis concerning knowledge construction (Hakkarainen, 1998). Progressive inquiry entails that new knowledge is not simply assimilated but constructed through solving problems of explanation and understanding. Seven elements are distinguished: 1) Creating the context, 2) setting up research questions, 3) constructing working theories, 4) critical evaluation, 5) searching deepening knowledge, 6) generating subordinate questions, and 7) constructing new working theories (see De Laat, De Jong & Simons, 2002; Muukkonen *et al*., 1999). The purposes of the seven elements are as follows. 1) The purpose of creating the context is to help students understand why the issues in question are worthwhile to investigate, and cognitively commit them to solve these problems. 2) Conceptual problems that arise from students' own attempts to understand and explain the problems being investigated have a special cognitive value; setting up research questions will guide the process. 3) Constructing their own working theories guides students to systematically use their prior knowledge and to elaborate on their prior knowledge. 4) Critical evaluation of assessing different explanations on strengths and weaknesses, on completeness and on contradiction, will help to direct and regulate shared cognitive efforts towards searching for new information that will help to advance shared understanding. 5) By searching for new information students will become aware of their prior knowledge and their assumptions. New information will also be helpful to reconstruct the conceptual understanding of the formulated problem. 6) During the process, students will refine and specify their research questions to deepen their inquiry. 7) By passing through the different phases, students will construct new theories step by step.

Based on the PI-Model, Hakkarainen distinguished three principal features of scientific thinking: (1) Engagement in deepening levels of explanation, (2) progressive generation of subordinate questions, and (3) collaborative effort to advance explanation (Hakkarainen, 1998). Next, Hakkarainen analysed students' written contributions with respect to two categories: knowledge production and communicative ideas. Knowledge production concerned cognitive ideas and elaboration of the ideas; communicative ideas were classified as contributions concerning the interaction (see section 3.3.1). He distinguished knowledge production between research questions and content ideas. Content ideas were encoded as intuitive knowledge or scientific information and formed the main body of students' messages. Scientific information meant that a student reviewed or introduced pieces of new scientific facts or theories; students were not familiar with this information. Intuitive knowledge referred to contributions in which a student generated his or her own view. Subsequently, the content ideas were analysed on level of explanation: (1) isolated facts, (2) partially organised facts, (3) well-organised facts, (4) partial explanation, and (5) explanation. It should be noted that the students in Hakkarainen's research were children of primary schools. Two classrooms were followed in a three-year period. In the course of the study more research questions were asked and the mean level of explanation increased. "Even though the students did not always succeed in answering their research questions and achieving a constructive synthesis, their process of inquiry led to successive deepening of their explanations" (Hakkarainen, 1998, p. 306). Another interesting finding was: "Engagement with complex cognition is very difficult and presupposes an intentional effort from both the teacher and the students as well as group support for advancement of inquiry" (Hakkarainen, 1998, p. 290). A general conclusion concerning the method used was that although the material gave detailed information about the students' process of inquiry, it did not provide direct information about the actual psychological processes involved (Hakkarainen, 1998). This conclusion refers to the general problem that subjects do not verbalise all steps in their thinking. A problem that may even be more serious when it concerns analysing written productions. In this method, we did not find what we were looking for, either. First, we could not grasp the method; we had difficulty understanding how the CSCL-data were analysed exactly. And when we understood what Hakkarainen meant, we did not always know how to apply his method to our data. For example, the category scientific information referred to information a student reviewed or introduced into the discourse and that was new to the students. Our problem was how to assess whether the information was new or that the student was already familiar with the information. Another example illustrating the difficulty in applying the method concerns the category partial explanation. We could not always assess whether something was explained partially or totally. Next, as we have argued above, the method was strongly based on the PI-model and that makes it difficult to analyse data collected in courses that were not organised according to the PI-model. We studied the method with great interest but we did not know how to manage it very well and therefore we searched for other methods.

Another study describing a qualitative approach to analyse CSCL-data was presented by Salovaara (1999). Her approach fits the study of Hakkarainen described above. In Salovaara's system, categories of analyses were also based on principles and phases of progressive inquiry (Salovaara, 1999). She distinguished between inquiry notes and comment notes. Inquiry notes included expressions that were related to students' individual inquiries. Comment notes consisted of students' suggestions, reflections or commentaries related to fellow students' contributions. Expressions in inquiry notes were grouped to seven subcategories representing different phases of students' knowledge construction processes. It concerned the following subcategories: (1) Research questions: questions students produced in the beginning of the project, (2) working theories: these included spontaneous theories and explanations students presented in order to activate their prior knowledge related to the research problem, (3) knowledge processing: students revised and focused research questions and notes that included reflection on the working theories presented earlier, (4) source-based knowledge: expressions that were obviously based on some scientific reference such as encyclopaedia and course material, (5) experience-based knowledge: this comprised students' own or their peers' opinions, assumptions, examples or experiences, (6) explanations: expressions that tried to elaborate, explain or reflect new knowledge that was presented earlier, and (7) meta-expressions: in these notes students reflected, reported or planned their own activity or the quality of the work or information they had brought to the database. Comment notes were divided into the following three subcategories: (1) Knowledge-building expressions: these included notes in which students provided new information, follow-up questions or direct suggestions related to the investigation process to their peers, (2) meta-expressions: these evaluated the investigation process or assessed the quality of information presented on the note the comment was based on, and (3) social expressions: these included expressions with only a social function. Notice that meta-expressions within the category inquiry notes concerned reflections of students' own work in contrast to meta-expressions within the category comment notes, which concerned reflections of external information.

One of Salovaara's conclusions was that in most discussions the strategies consisted of surface-level activity, in which students only went through the phases of the inquiry process, without reflecting on the questions thoroughly and trying to increase their understanding related to the topic. Only 10% of the expressions were encoded as knowledge processing and 5% as explanations. Furthermore, all knowledge-processing expressions were written by half of the participating students. Salovaara was more satisfied with the quality of students' expressions scored within the comment notes: 90% of the comments were scored as knowledge building.

Although Salovaara used an interesting method, the distinction between several categories was not always very clear (e.g. knowledge-processing and knowledge-building expressions). Furthermore, we did not understand very well the relation between analysing used strategies and assessing the quality of students' expressions. Following the line of reasoning described above, it seemed that the main category comment notes was used to assess the quality of the inquiry notes and in our opinion that is not correct. We also missed the aspect of regulating the task execution. It is true that comment notes concern interactive aspects, but all the three subcategories are evaluative and reflective in nature and therefore we could not use the system to analyse how students approached a task.

There still are some other researchers who have analysed the content of the notes. Hewitt (1996) studied one teacher's attempt to move from a traditional student-centred model to a knowledge-centred model over a four-year period. He analysed the degree to which students' practices changed over the four-year period and discussed how that change was brought about. Therefore, all databases were analysed on connectivity, discourse depth, interaction, problem-centredness, explanation and communal effort (see Hewitt, 1996). The content of the notes were analysed to answer questions about two of these aspects: problem-centeredness and explanation. To measure problem-centeredness, Hewitt (1996) looked at the type of questions students asked. Were questions concerned with factual information or did they focus on causal or explanatory questions? To measure the extent of students' explanation Hewitt (1996) counted causal and epistemological terms in students' notes. Causal terms such as 'because', 'otherwise', 'then', 'procedure' and 'demonstrates' were counted to see whether students were becoming more explanatory over the years. Epistemological terms, such as 'agree', 'guess', 'realise', 'sort' and 'sure' were seen as an indicator of students' reflection, concerned with students' understanding. The idea behind analysing explanation was that the process of trying to explain something to someone might cause the explainer to put additional cognitive effort into the process of clarifying concepts and reorganising their thinking and therefore would facilitate understanding. The results suggested that students were increasingly sharing their explanations with classmates. However, "... it should also be recognised that the preceding quantitative measures only focus on surface features (e.g., word counts, thinking type tags), and did not directly address the content of student conjectures or explanations..." (Hewitt, 1996, p. 70). At this point, Hewitt is critically about the method he used. He only counted terms, which were isolated from the context. He did not check whether the terms really indicated explanations. And what about the quality of the explanations? Another problem in the analyses could be that students did explain ideas but did not use the words Hewitt (1996) was counting. His study is valuable to gain insight into implementation and innovation processes, but in our opinion, the method is not very useful to analyse students' learning processes.

Henri (1992) proposed a method of analysing content of messages created in computer-mediated communication (CMC), too. This method involves breaking messages down into units of meaning and classifying these units according to their content. Henri's analytical framework consists of five dimensions: (1) Participative, (2) social, (3) interactive, (4) cognitive, and (5) metacognitive. Each of Henri's dimensions is based on a detailed theoretical model that is related to teaching and learning contexts. The only exception to this is the dimension participative, in which the number of messages contributed by participants is counted (see also section 3.3.1). The dimension social refers to contributions that are not related to formal content of subject matter. By the interactive dimension, Henri means a chain of connected messages. The dimension cognitive concerns statements exhibiting knowledge and skills related to the learning process. The last dimension, metacognitive, refers to statements related to general knowledge and skills and showing awareness, self-control, and self-regulation of learning. The dimensions interactive, cognitive and metacognitive are divided into specific categories. The interactive dimension is subdivided into explicit and implicit interaction/response/commentary. The cognitive dimension is analysed by means of two models: Cognitive skills and processing information. The model of cognitive skills concerns five reasoning skills, namely: (a) Elementary clarification, (b) in-depth clarification, (c) inference, (d) judgement, and (e) strategies. These five categories are defined and indicators are given to decode the units of meaning. The second model was developed to evaluate the skills identified by the first model and to contrast surface processing to in-depth processing. In the metacognitive dimension, metacognitive knowledge as well as metacognitive skills involved are operationalised by the following seven categories: (a) Person, (b) task, (c) strategies (knowledge), (d) evaluation, (e) planning, (f) regulation, and (g) self-awareness (skills).

At first sight, Henri's model looks very useful to analyse CSCL-data. We like the approach to segment contributions into units of meaning, the classification of the five dimensions and the thorough, theoretical framework. However, some shortcomings were noticed by Gunawardena, Lowe & Anderson (1997) who tried to apply the model. First, when coding units of meaning according to the metacognitive dimension, it was difficult to distinguish between the cognitive and the metacognitive dimensions. A large number of units of meaning could be coded as both cognitive and metacognitive. Newman, Webb & Cochrane (1995) also used Henri's model and they had similar problems. The second shortcoming of Henri's model and its theoretical foundations was its treatment of the concept of interaction. Henri explains that interactive content consists of meaning units clearly linked to one or more preceding messages. She states that messages are either 'monologic' or 'interactive' and then suggests further analysis based on observing whose messages garner the most response. However, this kind of analysis merely describes the pattern of connection among messages and not the entire gestalt to which the messages contribute. Henri's interpretation of interaction is mechanistic and descriptive, but not central to the construction of knowledge. In agreement with Gunawardena *et al.* (1997), we will emphasise the crucial importance of interaction for the construction of knowledge (see also section 3.3.1). Although Henri's basic ideas interesting and inspired us to think critically about analysing CSCL-data, in our opinion, these shortcomings are relevant so much that we continued to search for other methods.

The last study we will discuss here concerns the study of Gunawardena *et al.* (1997) already mentioned above. In contrast to Henri (1992), messages are coded as a whole in this method because the emphasis is on the process of social knowledge construction. Characteristic to their analysing method is the classification of the process of social construction of knowledge into phases. A total of five phases was distinguished: (1) Sharing/comparing information, (2) the discovery and exploration of dissonance or inconsistency among ideas, concepts or statements, (3) negotiation of meaning/co-construction of knowledge, (4) testing and modification of proposed synthesis or co-construction, and (5) agreement statement(s)/applications of newly constructed meaning. Gunawardena *et al.* (1997) found that metacognitive statements by participants illustrated that their knowledge or way of thinking had changed as a result of the interaction in the discourse. However, metacognitive statements were closely related to cognitive activity and were difficult to distinguish in many instances. Therefore, they were described as strategies in the co-creation of knowledge and negotiation of meaning and included in phase five.

In chapter 2 (section 2.4.2), two different perspectives on the unit of analysis were discussed: the cognitive acquisition-oriented perspective and the situative participation-oriented perspective. In this PHdissertation, analyses are viewed from the cognitive acquisition-oriented perspective: the unit of analysis will be students' individual performance, assessed in the social context. However, the method of Gunawardena *et al.* (1997) fits best the situative participation-oriented perspective. Therefore, their method is of less importance to us. In our opinion, another disadvantage is the inclusion in phase 5 of the metacognitive statements. We prefer to distinguish cognitive and metacognitive activities into two categories. Finally, Gunawardena *et al.* (1997) presented a study in which they had used their analysing method. The total numbers of messages in each of the five phases of the model were as follows: 191 messages (phase 1), 5 messages (phase 2), 4 messages (phase 3), 2 messages (phase 4), and 4 messages (phase 5). De Laat (2002) also applied the model of Gunawardena *et al.* (1997). He did not code any messages according to phase 4 or 5. Comparable to the results just given, most messages were coded as phase 1 (128). Additionally, 35 messages were coded as phase 2 and 14 messages as phase 3. In this PHdissertation, we want to analyse students' learning processes in detail. Besides our interest in the process of knowledge construction, we want to know what kind of learning activities students use and what happens in a CSCL-system. The model of Gunawardena *et al.* (1997) would produce too little information; to answer our research questions, the chosen perspective is too narrow or the categories are defined with too little distinction.

To summarise: studying a number of methods did not result in finding a ready-made method to answer our research questions. However, the reviewed methods supplied many ideas that we could use to develop a new method and besides, the study helped us to clarify our view on analysing CSCL-data.

3.4 Summary and conclusions

This chapter reported on a literature study carried out to get to know how other researchers had tackled the problem of analysing CSCL-data. A number of studies were discussed and some conclusions were drawn with a view to analysing our data. This section will summarise our ideas about analysing CSCL-data, relevant findings and the decisions made in this chapter.

First, we want to analyse the learning process instead of the learning product. To the CSCL-data, this means that the log files, which are automatically saved in a CSCL-system, will be studied. Students' participation in CSCL-systems as well as the interaction between students will be analysed. Besides these basic analyses, students' contributions in the CSCL-system used will be analysed in terms of content. Explicit or statable knowledge in the form of written contributions will be analysed and used to say something about the learning process (see also chapter 2).

Concerning participation, the extent of both students' passive (read notes) and active participation (written notes) will be involved in the analysis. While analysing written notes, the direction will also be taken into account to indicate to whom a note was sent. In our opinion, the direction of written notes relates to the concept of interaction. In this PHdissertation, interaction refers to interaction between participants in a CSCL-system, communicating with each other while working at the task at hand. Interaction is seen as the process through which negotiation of meaning and construction of knowledge occurs. In the participation analyses, the indicator time will not be used because of the doubtfulness of its validity. For analysing participation and interaction, adequate tools are available: software developed to CSCL-systems and SNA-software.

Analysing the content of written contributions seemed to be more complex. Studying a number of methods did not result in finding a workable, ready-made method to answer our research questions (see section 2.9). Using CSCL in higher education, we aim at deep learning and, finally, at construction of knowledge in collaboration with fellow students (see section 2.4). Therefore, a method is needed to gain insight into students' (collaborative) learning processes, students' knowledge construction processes including the regulation of the task execution. However, the reviewed methods supplied many ideas that we could use to develop a new method and besides, the study helped us to clarify our view on analysing CSCL-data. In our method to develop we aim at a method that:

- can be used to decode the complete text of students' written notes;
- is based on a classification of learning activities;

- emphasises cognitive processing as well as regulation strategies;
- pays attention to affective issues;
- can be used to analyse the process of knowledge construction in detail;
- can be used to assess the quality of the constructed knowledge;
- can be used to gain insight into the process of interaction between students;
- can be used to analyse students' individual performance, related to the whole context;
- is clear in the distinction between the scales and codes used;
- can be used without the help of a domain expert;
- can be used in a simple way;
- is not strongly based on a specific task students work at in a CSCL-system.

The next chapter will present the method we developed on the basis of the methods discussed in this chapter, the theoretical framework outlined in chapter 2 and experiences with CSCL in pilot studies.

Chapter 4 - Method used to analyse students' learning in CSCL

This chapter is written in co-authorship with Maarten de Laat[1], Nijmegen University, Department of Educational Science

"There has been a change from learning and from experiments and projects with CSCL in real life settings to more detailed research on the characteristics of discourse and argumentation, on the patterns of participation and networking. And the most promising {turn of events} is the attention that is presently being paid to evaluation and frameworks for analyses. It is this last development that will help us to benefit from experiences gained elsewhere, and in this way, will promote a better transfer from research to the innovation process within existing educational practice" (Dillenbourg, Eurelings & Hakkarainen, 2001, p. ii).

4.1 Introduction

In this PHdissertation, we focus on students' learning processes in an asynchronous CSCL-system used in higher education. In this chapter, the method used to analyse students' learning in CSCL will be presented and explained within the theoretical framework described in the second chapter of this PHdissertation. In chapter one, the research questions directed to students' learning processes were formulated as:

1. *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?*
2. *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?*
3. *Do students construct knowledge and what is the quality of that knowledge constructed by students in an asynchronous CSCL-system?*
4. *What are the effects of moderating a CSCL-discussion on students' learning?*

Following these research questions, the method consists of three steps: (1) analysing students' participation and interaction, (2) analysing students' contributions on cognitive, affective and metacognitive learning activities, and (3) assessing the amount and quality of students' constructed knowledge. Section 4.2 will describe how students' participation was measured and how Social Network Analysis was used in our studies to gain insight into the interaction processes between students in the CSCL-system. In section 4.3, the focus will be on the second step of the analysis: analysing learning activities. This section will describe the development of the coding scheme used to code cognitive, affective and metacognitive learning activities, consecutively, illustrated by real examples. Section 4.4 will present the third step of the analysis: assessing the amount and quality of knowledge constructed by students. Therefore, a second coding scheme based on the SOLO-taxonomy is described.

[1] Both authors take responsibility for the complete chapter. Else Veldhuis-Diermanse developed the coding schemes and deepened the SOLO taxonomy (section 4.3 and 4.4). Maarten de Laat focused on the first step of the analysis (section 4.2) and besides, he elaborated the framework of the second step of the analysis (section 4.3).

4.2 STEP 1: Analysing students' participation and interaction

Chapter 2 and 3 stressed the importance of analysing students' active and passive participation. In CSCL, an active learning attitude is expected: students should regulate their own learning processes and be less dependent on the teacher. Measuring participation helps to indicate the extent of students' activity. We wanted to know how many notes students contributed and how many notes they read. To measure students' active as well as passive participation, the Analytic Toolkit (ATK) for Knowledge Forum was used (OISE, 2001). The ATK provides summary statistics on activity in a Knowledge Forum database.[2] Figure 4.1 is a screendump of the ATK showing the different types of reports.

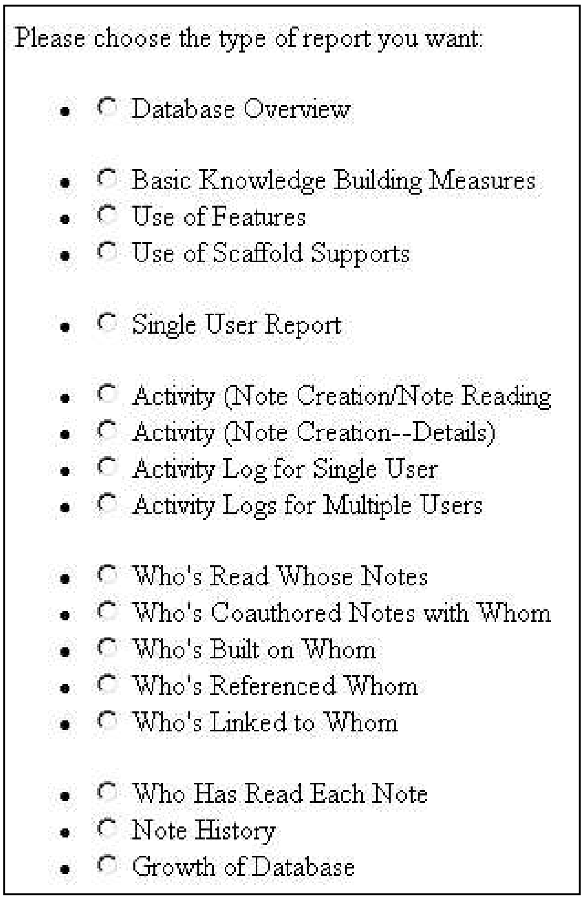

Figure 4.1. Screen-dump of the Analytic Toolkit: Types of reports.

Table 4.1 summarises the analyses we used to answer the question concerning the extent in which university students participate in an asynchronous CSCL-system.

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[2] The Analytic Toolkit is Web-based, and accessed with a browser through an URL. The URL for the Toolkit can be obtained from Learning in Motion or OISE/UT (http://www.oise.utoronto.ca/).

Table: 4.1. Overview of the reports produced by the ATK to measure students' participation

Database Overview: Presenting summary statistics and group averages on contributions to the database. It shows how many notes students have contributed, which views they have contributed to in the past month and past week, how much of the database students have read, and how many of their notes are linked to other notes. It is intended to provide evidence for the extent of knowledge-building activity in the database, and also for where the recent activity has been. This report was used to get a first impression of the activities in the database.
Activity (Note Creation/ Note Reading): Showing reading and writing activity in the database for a specified time period. This report was used to measure active as well as passive participation in the different views or discourses.
Activity (Note Creation--Details): Measuring the types of notes each user has contributed to the database during a given time period. The report shows details of what each user has been doing, how many build-on[3] notes vs new notes the user has contributed and the number of group notes vs individual notes. This report was used because students worked in co-authorship in some discourses.

In chapter 1, we cited Biggs and Collis (1982): "Characteristic to collaboration is the interaction between people and people learn through interaction with each other". In chapter 2, we went more specifically into the meaning of interaction for CSCL and we reflected on the importance of analysing interaction between students in a CSCL-system. Students can share information, regulate how to execute the task, negotiate about knowledge and elaborate on each other's ideas. Furthermore, we described and discussed some studies concerning student-student interaction. Besides, Social Network Analysis (SNA) was described as a set of methods for the analysis of social structures, methods that especially allow an investigation of the relational aspects within and between these structures (Nurmela, Lethinen & Palonen, 1999; Scott, 2000). SNA focuses on uncovering the patterns of people's interaction. This section presents the way Social Network Analysis was used in our studies added to the ATK-analysis on interaction.

To use SNA in our research, the relational data had to be organised in a data matrix, or more specific, a case-by-case matrix. By a case-by-case matrix, we mean a matrix showing the actual relations between participants and the strength of the relations. The relations in the matrix are directed from one actor in the pair to the other actor in the pair, to indicate if a student reacted to the note of the other student or read a note of the other student. In this research, the case-by-case matrices were produced by using the ATK. Table 4.2 summarises the analyses we used to create these matrices.

[3] Notice that, although it is possible to run the ATK to measure the number of build-on notes per student, these analyses were done by hand. In some projects a note was created by the teacher aimed at structuring students' notes. So students were expected to write their answers on a question in specific part of the view. If such was the case, students used build-on notes such as new notes to present their ideas. The ATK would measure all these notes as build-on notes, whereas these notes did not indicate social interaction.

Table: 4.2. Overview of the reports produced by the ATK to measure student-student interaction

Who has read whose notes?	The report shows who has read whose notes in a selected view and during a selected time period.
Who has built on whom?	The report shows who has built on whom in a selected view and during a selected time period.
Who has referenced whom?	The report shows who referenced whom in the written notes in the selected view and time period.

Next, SNA was used to answer the following question: How dense is the participation within the network? To get an indication of the overall linkage of students in the discourse we conducted density calculations. Density indicates the level of engagement in the network. In other words: density describes the general level of linkage among the students in a discourse graph (Scott, 2000). A complete graph is a graph in which all points are directly connected to every other point (Wortham, 1999). The density of a graph is defined as the number of lines in a graph, expressed as a proportion of the maximum possible number of lines (Lipponen, Rahikainen, Lallimo & Hakkarainen, 2001; Palonen & Hakkarainen, 2000; Scott, 2000). The social network analyses in this PHdissertation were executed by using the UCINET program. UCINET is a very general program designed to facilitate the analysis of actor by actor social network data (Borgatti, Everett & Freeman, 1999).

4.3 STEP 2: Analysing students' contributions on cognitive, affective and metacognitive learning activities

The second step of the analyses focuses on identifying cognitive, affective and metacognitive learning activities. Section 4.3.1 will give some background information about content analysis and the process of developing a coding scheme. Section 4.3.2 will describe the developed coding scheme in sequences of the three parts of the scheme. Section 4.3.2.1 will present the cognitive learning activities, 4.3.2.2 the affective learning activities and 4.3.2.3 the metacognitive learning activities. Finally, in 4.3.2.4 the rest category will be given. In chapter 2 of this PHdissertation, we argued why cognitive, affective and metacognitive learning activities are of importance in CSCL. Section 4.3 will summarise the arguments used, and next, the three learning activities will be operationalised to implement in the coding scheme. All codes are given and illustrated by real examples.

4.3.1 Content analysis and the process of developing a coding scheme

Studies of the educational uses of computer-mediated communication (CMC) have shown that the dynamics of group communication within the learning process and the content of interaction itself must be taken into account. However, these studies have not produced tools for in-depth analysis of message content, which now seems so crucial to understand the learning process (Henri, 1992). Content analysis, when conducted with an aim to understanding the learning process, provides information on the participants as learners, and on their ways of dealing with a given topic (Henri, 1992). CSCL-generated messages differ from texts as we know from daily life and therefore, analysing these messages needs a specific approach. The chronological sequence of the messages does not follow the logic of spoken or written discourse: CSCL-messages follow upon each other without immediate continuity of meaning, issuing from several students who do not usually exchange ideas and opinions before contributing. Each message, each students' contribution, has its own meaning. Therefore it is not possible to analyse CSCL-messages as a 'constructed' text; a student' s contribution must be considered both single and in relation to those of the others. Furthermore, Henri (1992) stresses the importance of interpreting the results of content analysis in relation to the tasks assigned to the learners. "If knowledge acquisition is the aim, we can expect to find high levels of clarification and inference activities; if problem resolution is the aim, we can expect the whole range of skills to surface. If only a superficial processing of information is occurring, it might be due to the task at hand - or to lack of relevant information - or even to the inability of learners to carry out in-depth processing of information" (Henri, 1992, p. 131). In a constructivist view of learning, the focus is on the process of learning rather than on its product. So, in analysing students' contributions, it is important to identify what and how students understand, rather than on what should have been understood. The construction of the coding scheme was influenced by the idea of content analysis described above.

There is also a similarity between analysing CSCL-data and protocol analysis. In both analyses, the focus is not so much to capture the representation a solver has, but capturing the processes of solving a problem or making decisions (Chi, 1997). Chi (1997) describes a practical guide to quantify qualitative data. She advises to reduce protocols, to go into the problem of segmenting protocols and to describe features used for segmenting. She stresses the importance of a correspondence between the grain size of analysis and the research question one is asking; this assists the development of a coding scheme and the operationalising evidence for the actual coding. This practical guide of Chi's was helpful in the process of developing the coding scheme in this PHdissertation. However, according to Chi (1997) the most difficult step in analysing protocols is to develop the codes based on theoretical orientations, hypotheses or questions being asked, the task and the content domain that guide this research.

The theoretical orientations described in chapter 2 formed the first basis to develop the codes needed to gain insight into the learning processes taking place in an asynchronous CSCL-discourse. We were guided most directly by our view on learning. Learning, in our view, can be formulated as a directed and creative process in which students explicitly formulate facts and insights, elaborate their ideas, evaluate facts, insights and ideas of themselves and others critically, link different ideas and change and/or sharpen original insights. Next, chapter 3 of this PHdissertation discussed a selection of methods used by other researchers to analyse their CSCL-data. This review study resulted in a list of characteristics that directed the process of developing a method to analyse CSCL-data. Because of the aim to code the learning process, we decided to use the classification of learning activities of Vermunt (1992) as a framework to develop the coding scheme. The choice to use learning activities agrees with the Henri's approach (1992) (see section 4.3.2). The theoretical design principles provided by Scardamalia and Bereiter (1992) were also used as a starting point to construct the coding scheme. In their article "An architecture for collaborative knowledge building" they describe design principles used to develop their CSCL-programme. These principles inspired us to create categories for the coding scheme. The principles can be summarised as follows: (1) *Objectification*: treat knowledge as an object that can be criticised, modified, compared and related, and regarded from different viewpoints, in different contexts; (2) *Progress*: knowledge building should lead somewhere and progress should be perceptible to the students; (3) *Synthesis*: encourage the construction of higher order representations and integration of knowledge rather than the proliferation of loosely connected items; (4) *Consequence*: something nice should happen and consequences that make a difference in the scientific world include seeing one's work cited or commented on, one's ideas being used or confirmed; (5) *Contribution*: students should see their entries in the communal database, not solely in terms of their independent merits, but also in terms of their contribution to the advancement of the group's knowledge; (6) *Cross-fertilisation*: maximise chances to come into contact with related ideas, kindred spirits, and useful information; (7) *Sociality*: there should be no discontinuities between work in CSILE[4] and other curricular activities. Instead, CSILE should help to integrate the social life of the classroom.

Inspired by these principles, but also by the theory described in chapters 2 and 3, a framework was created to decode the data. However, our coding scheme was built through direct interaction with the data. So, on the one hand theoretical principles directed the construction process of the coding scheme, CSCL-messages collected in educational projects were used to get clear which activities should be inserted in the coding scheme on the other hand. In other words: the process of constructing the scheme was embedded in practice, but directly linked to theoretical ideas. We wanted to chart students' learning processes concretised in activities.

The development of our coding scheme was an iterative process. After studying literature and messages in the CSCL-system, a first version of the scheme was developed. This first scheme was applied to a number of databases to check inter-rater reliability. The analysing process consisted of two steps: (1) dividing the notes into meaningful units (Creswell, 1998; Henri, 1992; Lipponen *et al.*, 2001) and (2) assigning a code to each unit. We decided to segment notes into units of meaning by using semantic features such as ideas, argument chains, topics of discussion (Chi, 1997; Ericsson & Simon, 1984; Wouters & Jong, 1982) or by regulative activities such as making a plan or explaining unclear information. Thus, the content of the notes has to be read for meaning to determine segment boundaries. Although it may be considerably easier to use syntactic boundaries to segment notes such as sentences with connecting words such as 'because' or 'therefore' or the use of equations, it often is more meaningful to use semantic boundaries (Chi, 1997).

Many notes were independently analysed by the two raters and the results of both analyses were compared. If a category was not clear, it was reformulated. If a category was missing, a new category was added. Sometimes two categories were combined. This process of revising the subcategories was repeated until the analysing results of both raters were comparable. Then, Cohen's Kappa was calculated using another set of notes to determine the inter-rater reliability of the scheme (Hays, 1988). In contrast to De Jong (1992), Cohen's Kappa in our developing process concerns step one (determining unit of meaning) as well as step two (assigning a code) of the analysing process. In

[4] CSILE refers to Computer-Supported Intentional Learning Environment. This CSCL-system functions as a collaborative learning environment and a communal database, with both text and graphics capabilities. CSILE was developed at OISE (http://csile.oise.utoronto.ca/).

our opinion, the process of determining the size of a unit relates strongly to the process of assigning a code to a unit. The process of dividing a note into units of meaning is influenced by the content of the note and therefore we preferred to involve both steps in calculating Cohen's Kappa. For this purpose, twenty notes were selected at random from another database. Cohen's Kappa was satisfactory, namely 0.82. In qualitative analysis, a Cohen's kappa between .61 and .81 can be considered to be 'substantial'; a kappa between .81 and 1.00 is 'almost perfect' (Heuvelmans & Sanders, 1993; p. 450). When the assigned codes were not similar, this was mainly due to the determination of the length of a unit and not to the choice of a specific code. To illustrate: rater one distinguished three units within a note and assigned the actions (1) presenting an idea followed by an illustration or argumentation, (2) contributing new information found in other sources than the discourse and (3) linking facts, ideas or remarks presented in the discourse. Rater two distinguished only two units within the note and assigned the actions (1) presenting an idea followed by an illustration or argumentation and (2) linking facts, ideas or remarks presented in the discourse. Rater two did not assign the 'action contributing new information found in other sources than the discourse' because it was seen as part of the given argumentation in action one and was therefore not segmented in two different learning activities.

4.3.2 Description of the coding scheme

The classification of students' learning activities described in the first chapter of this PHdissertation was used to classify the units of meaning in students' contributions. The three main categories are: (1) cognitive learning activities, (2) affective learning activities and (3) metacognitive learning activities. In a constructivist view of learning not only cognitive learning activities are considered to be important; metacognitive learning activities are relevant as well. Cognitive activities are invoked to make cognitive progress, metacognitive strategies to monitor it. The process of metacognition deals with the knowledge and skills the learners bring to bear on the overall cognitive activity: managing and controlling their cognitive learning activities. Affective learning activities could be useful to interpret the nature of the interactions between students in addition to the results of SNA (Henri, 1992). The codes within these three categories will be described in the order given.

4.3.2.1 Cognitive learning activities

Cognitive activities can be described as the thinking activities students use to process the learning content and to attain their learning goals (Vermunt, 1998). These activities influence the way in which acquired information can be transformed into knowledge and the way in which knowledge can be transferred to other contexts (Laurillard, 1993; Vermunt, 1992). Types of information presented in learning contents are, for example, facts, concepts, formulas, reasoning, arguments, definitions, theories, visions and conclusions.

In the first chapter of this PHdissertation, we focused on several descriptions of cognitive learning activities. We also discussed which cognitive learning activities students need in constructivistic education. Depending on theoretical orientations, the task, the test and the learning content, different cognitive learning activities are desirable. For example, memorising is important when students have to drill facts, relating and selecting are important when students have to summarise a text, applying is important when students have to run a model and so on. In CSCL relevant cognitive learning activities are looking for relations between the parts of the subject matter, summarising or evaluating information, thinking along with the author, teachers and fellow-students, negotiation of meaning, asking questions and giving answers, sharing and comparing information, and applying information in the discourse (Baker & Lund 1997; Bielaczyc & Collins, 1999; Gunawardena, Lowe & Anderson, 1997; Henri, 1992; Newman, Johnson, Webb & Cochrane, 1999; Tynjäla,1999; Veerman, 2000).

In the coding scheme, we only selected learning activities which were considered to be relevant and which we found in the CSCL-databases. For example, students did not use the learning activity 'memorising' in a CSCL-system. Analysing defined as studying subject matter stepwise and detailed (Steinbusch, 1998; Vermunt, 1992) also was a learning activity we did not found in the databases. In other words, the selection of learning activities in the first coding scheme was determined by the aim to characterise students' learning processes reflected in a CSCL-system. We formulated learning as a directed and creative process in which students explicitly formulate facts and insights, elaborate their ideas, evaluate facts, insights and ideas of themselves and others critically, link different ideas and change and/or sharpen original insights. This definition influenced us to fill in the cognitive component of the coding scheme.

The main category 'cognitive learning activities' consists of three subcategories: (1) debating, (2) using external information and experiences, and (3) linking or repeating internal information. *Debating* refers to the process of negotiation, critical thinking, asking questions and discussing subjects with other participants in the database. *Using external information and experiences* is inserted into the scheme because in an asynchronous CSCL-system students have time to search for information to support their ideas with explanations and to elaborate their questions. Information can be used to evaluate contributions thoroughly. Types of information contributed to the CSCL-system are, for example, articles found on the Internet, notes made in a lecture, a summary of a book chapter, results of running a specific tool or a summary of another discussion. The third subcategory is *Linking or repeating internal information*. With internal information, we mean information found in the discussion view students are working in. Referring to and linking notes are considered to be important because of increasing coherence in the database. It is assumed that more coherence between notes means more interactions between students. Next, we will describe these three subcategories in more detail and illustrated by real examples.

Table 4.3 gives an overview of the codes in the subcategory Debating. In CDPF as well as in CDPNF a student presents a problem, solution or idea. However, CDPF differs from CDPNF in explaining the presented problem, solution or idea by giving an illustration, elaboration or argumentation. The code CDPF refers to 'Cognitive Debating Presenting a problem, solution or idea Followed by an illustration, elaboration or argumentation' and CDPNF means 'Cognitive Debating Presenting a problem, solution or idea Not Followed by an illustration, elaboration or argumentation'. In other words, in CDPNF a student only contributes an idea into the discourse, but does not explain his thoughts. The same distinction was made between CDAF and CDANF ('Cognitive Debating Agree or disagree Followed by arguments' and 'Cognitive Debating Agree or disagree Not Followed by arguments', consecutively). The difference between CDPF/CDPNF and CDAF/CDANF is that CDPF/CDPNF refers to a new (= not mentioned in the discourse before) problem, solution or idea, whereas CDAF/CDANF always concerns a reaction to another participant and therefore CDAF/CDANF refers to interaction. With respect to the processes of learning and knowledge construction, the actions CDPF and CDAF are of course found to be more valuable than the actions CDPNF and CDANF. The last code within the subcategory Debating was defined as CDAQ, what means 'Cognitive, Debating Asking a Question'. CDAQ was inserted into the scheme because asking content-directed questions points to critical thinking, curiosity or a need to understand information (Hakkarainen, 1998). Table 4.3 shows an overview of all codes within the subcategory debating, illustrated by real examples.

Table 4.3. Codes in the subcategory Debating (main category: cognitive learning activities)

CDPF	–	A problem, solution or idea is presented. This contribution is followed by an illustration, elaboration or argumentation. *"These crops are very suitable for the field. One restriction is that these crops (certainly potatoes) can be grown only once every 4 or more years, because of diseases. It is not good to grow potatoes and sugarbeets in a sequence, either. So they should be separated by another crop."* *" I think that they need more than this. Learned helplessness replaces other learning, which should have taken place. Specifically, it replaces the ability to take charge of one's own learning. It is easy to realise that what one is doing is not working, but much harder to see what should be done. Natural Environment FOR HIGH LEVEL PROCESSES A new set of skills need to be learned to replace the learned helplessness, before the student can experience the success of which you speak."*
CDPNF	–	A problem, solution or idea is presented. This contribution is *not* followed by an illustration, elaboration or argumentation. *"The best research procedure would be watershed level (i + 3) with the use of simple comprehensive methods."* *"In Nashville, Tennessee quite a few schools have Knowledge Forum. Last spring a school board member got the superintendent to adopt Hersch's core curriculum. So here are teachers who are trying to change their teacher styles and organisations and at the same time being told what to teach and having their students tested every few weeks to see if they have learned it. This is a ridiculous situation and any fool can see that, but not these educators."*
CDAF	–	A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is followed by a backing, refutation or restriction. *"I agree that Income Optimisation is not an easy term, though I think it's quite right here. A cognitive map only gives an overview of the problems to make things clearer. All influences concerning agriculture will affect the income of the farmers".* *"... and I think the model can be quite well because it shows that it is possible to distinguish different phases in students' learning. In every lesson steps of the model could return and in that way the model is useful."*

Table 4.3 continued

CDANF	–	A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is *not* followed by a backing, refutation or restriction. *"I agree with Eesge, Maartje and Ries that the arrow between pr. far and Land Char. should be rotated 180 degrees."* *"I like the idea!"*
CDAQ	–	Asking a content-directed question *"What balance should there be between direct basic information delivery and constructivist-style teaching (going for deeper knowledge)? (That is, assuming that there should be any basic information delivery at all)."* *"In that school the aim is diagnostic testing. What does that mean to the students? Is it not necessary for them to be coached? And what sort of coaching? Are these tests serious?"* *"Now, a question. If we accept that in a real world, some of the understanding of course material must go on outside of the classroom, what amount of such 'homework' is desirable? ... and what form should it take?"*

Table 4.4. shows the codes in the subcategory Using external information and experiences. New information is necessary to construct new theories, ideas, solutions and so on. By studying external information students get new insights that could inspire them, activate them to think critically and help them to refine their ideas. Thus, these activities provide evidence of processes aimed at actively acquiring information and are considered to be constructive for the learning process.

Four codes were distinguished in this part of the scheme: CREI, CCEI, CSEI and CREE. CREI means 'Cognitive Referencing External Information'. A unit encoded as CREI contains only a reference to an article or to a site on the Internet. In CCEI not only the reference is presented, but also the text found elsewhere, so CCEI refers to 'Cognitive Contributing External Information'. In CSEI the information is not only contributed, but also summarised ('Cognitive Summarising External Information'). Sometimes in a summary information is selected literally; sometimes a summary contains also a more personal reflection on the information. The code CREE refers to 'Cognitive Referencing Earlier Experiences' and was used to decode a unit in which a student contributed scholastic or daily experiences assumed to be relevant to the context of the discourse.

Table 4.4. Codes in the subcategory Using external information and experiences (main category: cognitive learning activities)

CREI	–	Referring to information found in other information sources (mentioned or not) than the discourse. *"See for example the study of 'De Vries et al.1992' in the paper of Bouma where K2 knowledge on European level is used to make measurements more efficient."* *"Especially young children cannot collaborate. They are lacking certain cognitive and social skills (Crook, 1997)."* *"I found an interesting site: http://www.sainsbury.co.uk/gm/."*

Table 4.4 continued

CCEI	–	Contributing new information found in other information sources (mentioned or not) than the discourse. *"Yields according to Wofost when using sowing dates as mentioned in the CIM: potatoes - very high (15,847 kg/acre), winter wheat - low (7,653 kg/acre), sugar beets - very high (14,293 kg/acre)."*
CSEI	–	Summarising or evaluating the information found in other information sources (mentioned or not) than the discourse. *"Summarising: A LUT is sustainable if it is ecologically possible, economically viable and socially acceptable. The three characteristics of a LUT distinguished in the article are… "* *"There has been a lot of press lately about companies that have been ignoring the year 2000 (Y2K) compatibility problems that are perhaps imminent. It is predicted that a lot of these companies will suffer as a result of Y2K problems, contracts will be lost, people laid off, companies will close, etc. This reflects a winner/loser model based on knowledge or lack of knowledge on how to solve Y2K problems."* *"Five points are listed in the article about the ICT platform FLOT. First, both teachers and students must have general skills: digital drivers' licence. Besides general skills they must also have more specific skills such as for example CD-rom, dvd and video. Furthermore they must be able to create their own web sites. I think one important condition is the availability of enough money and time and..."*
CREE	–	Referring to earlier experiences (scholastic or daily)/ Referring to outcomes of running a model. *"In Germany farmers told me that rape seed is grown on fallow fields. The legislation (15 % fallow) allows rape seed."* *"I just remembered a lecture of Simons. He had a good example concerning cow mooing. Researchers developed an instrument to recognise the moo of every cow. Great finding, but a farmer already recognises all the cow mooing."*

In Table 4.5 the two codes of Linking or repeating internal information are described and followed by some real examples to illustrate the codes. The code CIL means 'Cognitive Internal Linking'. In units encoded as CIL, two or more messages in the discourse are linked. When this code is assigned to a unit, a remark will always follow. It is not 'just linking', but students give a reason why they linked the notes. For example, students link notes because they think some concepts are related to each other, or because they want to draw attention to a certain contribution, or because they want to react to a certain note. The code CIR refers to 'Cognitive Internal Repeating' of information. A student copies and pastes text from another note in the discourse. This information could be written by himself or by other students. Characteristic for this code is that the information was not edited; nothing was changed. Not surprisingly, we consider purely repeating information as less constructive than linking or referring to specific parts of information.

Table 4.5. Codes in the subcategory Linking or repeating internal information (main category: cognitive learning activities)

CIL	–	Linking facts, ideas or remarks presented in the discourse/ Referring explicitly to a contribution in the discourse *"I found results similar to those of Eesge and Ries."* *"The simulations run by Ries and Marthijn with early sowing (oc-nov) gives poor results while later sowing (Ries, Eesge) gives much better results."* *"It would appear, from Lena's comments and my own experience, that there is far too much transmission-style teaching..."*
CIR	–	Repeating information without drawing a conclusion or interpreting that information *"In approach 1 land units are derived from extensive soil sampling and Remote Sensing. Four functional layers are distinguished and combined to soil profiles. Two land units are distinguished: one with a mainly sandy texture, one more clayey. " (= note 34)* *"In approach 1 land units are derived from extensive soil sampling and Remote Sensing. Four functional layers are distinguished and combined to soil profiles. Two land units are distinguished: one with a mainly sandy texture, one more clayey. " (= note 56)*

4.3.2.2 Affective learning activities

In this coding scheme, affective learning activities are not related to content of subject matter; they are non-task related (Henri, 1992). However, affective learning activities are considered to be important in the learning process. Affective learning activities are used to cope with feelings occurring during learning and can lead to a state of mind influencing the learning process positively or negatively (Vermunt, 1992). By affective learning activities we mean students' feelings expressed in their notes while working in the learning environment. Sometimes, these feelings are negative. From educational experience, we know it is not always easy for students to collaborate in a CSCL-environment. Students can for example get irritated because they do not know what is expected of them, because they feel their fellow-students do not spend enough time in the learning environment, because the server has crashed and so on. Besides negative feelings, more positive feelings can also be found in students' contributions. We think for examples of expressions such as giving compliments because of clear or innovative contributions, or expressing feelings about the pleasant atmosphere or notes in which students are thanked for doing something. The examples mentioned above should be encoded as AM ('Affective Motivation'). Other contributions encoded as affective learning activities are statements in which students ask for feedback, responses or opinions (AA='Affective Asking for...'). This concerns quite general questions; the question is not specified. The final code in the main category affective learning activities was called AC ('Affective Chatting') (see table 4.6). In databases, students can have social talks; talks about the weather, a coffee break, the newspaper and so on. These social talks provide information about the group atmosphere, too.

In relation to the research problem of this PHdissertation, the affective component is not very extensive. Including an affective category in the coding scheme will provide information about the kinds of feelings and could be useful to interpret the nature of the interactions between students. Be aware that interpretation of the frequency of affective units must take into account the overall results of the analysis (Henri, 1992). Many affective-oriented messages may sometimes be a disruptive element, distracting learners from the purpose of the communication; in other cases, these messages can be supportive of the learning process (Henri, 1992).

Table 4.6. Codes in the main category affective learning activities

AM	–	General: reacting emotionally to notes of fellow-students, without directly reacting to the content of that note. This reaction can be *positive*, *negative* or *neutral* *"I think Anton makes a good point here. "* *"It is a very interesting and mainly correct map…."* *"What Ries said in note 54 helped me a lot."* *"I read your note, I think we agree."*
AA	–	Asking for (general) feedback, responses or opinions by fellow-students *"What is your opinion about my minor case? "* *"Is it clear what we have planned to do?"* *"Well, it is very quiet in this view. I will drop a new idea and try to provoke you. I would like to debate and hope to read your contributions soon."* *"I am interested in your opinion about this statement."* *"Taking the risk of being called grumbler, there is not much speed in our discussion. I will do some efforts and hope it will bring about some response."*
AC	–	'Chatting' or 'social talks'; contributions that are not relevant to solve the case/task *"Anton, Happy birthday! "* *"Sorry, I put the WWW-site in the wrong directory. But now, you can find it in the shared directory."* *"What about a pizza this afternoon?"* *"I have had enough of it. Come on, let's have a break!"* *"Sorry for not logging in the forum, but I was ill last week. From now I hope to be active and to contribute."*

4.3.2.3 Metacognitive learning activities

The process of metacognition deals with the knowledge and skills the learners bring to bear on the overall cognitive activity: managing and controlling their cognitive learning activities (Elen, 1998; Flavell, 1979; Pintrich, Wolters & Baxter, 1996; Vermunt, 1998). In chapter 2, a classification of metacognitive learning activities was given. The approach used to select metacognitive learning activities was comparable to the approach we used to select cognitive learning activities (see section 4.3.2.1); we only selected metacognitive learning activities we considered to be relevant to CSCL and found in the CSCL-databases. For example, although we assumed that the metacognitive learning activity orientate on the learning process by studying characteristics of the learning task, learning situation and testing and thinking about learning goals and time needed to carry out the task

(Steinbusch, 1998; Vermunt, 1992) was of importance in CSCL, students did not write notes expressing orientation activities. Therefore, this learning activity was not inserted in the coding scheme. Another activity we did not select was testing and diagnosing (Steinbusch, 1998; Vermunt, 1992). These learning activities are especially directed to acquiring subject matter and in our courses acquiring subject matter did not have priority. Because of this students did not test or diagnose and as a consequence we did not insert these activities in the coding scheme. The intention of CSCL is to stimulate students' collaborative learning. In collaborative learning, clear communication and co-ordination are required. In analysing students' learning processes on metacognitive learning activities, the focus is on analysing external regulative learning activities, in contrast to metacognitive knowledge (see chapter 2, section 2.7.3). External regulation can help students to run group processes, to make plans aimed at successfully carrying out the task and to create a well-structured database.

The category 'metacognitive learning activities' consists of three subcategories: (1) planning, (2) keeping clarity and (3) monitoring. Planning contains three codes: MPA, MAA and MEA. In MPA ('Metacognitive Presenting Approach') an approach is presented to carry out the task; in MAA ('Metacognitive Asking for an Approach') an approach is asked for. In a unit encoded MEA ('Metacognitive Explaining Approach'), the approach used is explained or summarised. Approaches can relate to practical issues such as making appointments, subdividing parts of the task, appointing a group member chairperson, or to theoretical issues such as choosing a definition after discussing about a concept or deciding to run a specific tool. Characteristic of these content-related approaches is their effect on the process of the task performance. Table 4.7 shows an overview of these three codes illustrated by some real examples.

Table 4.7. Codes in the subcategory Planning (main category: metacognitive learning activities)

MPA	–	Presenting an approach or procedure to carry out the task *"Let us analyse all individual crop grown in the Alora region."* *"I would suggest first to formulate a problem and next to divide the work."* *"Maybe it is interesting to have a look at the course 'ICT in training and education'. In this view we specialised in ICT and maybe we can discuss how to use more ICT in that course."* *"I think we can take the report as point of departure to write our policy note."*
MAA	–	Asking for an approach or procedure to carry out the task *"...maybe someone has an idea to incorporate this in a nice way by changing the scheme?"* *"It is not very clear to me what we have to discuss exactly. Is the subject advantages and disadvantages of Kennisnet in education or is the subject how to realise Kennisnet in secondary school and the organisational problems that play a part in that process?"* *"I read a lot of articles, but I do not know if it was useful. Summarised: it is non-organic and better to the milieu. It is possible to acquire it synthetically, but it can also be found in nature. Is this wasting time or shall I search for more information?"*

Table 4.7 continued

MEA	–	Explaining or summarising the approach already adopted *"Next, some simulations for rape have been made."* *"I searched for information on Kennisnet about how they see it and how they use it in education. I picked out a piece about webmail."* *"I have written a note to Myrna (in this view) discussing a wonderful example of KB by students (taft database) exploring King Arthur."* *"After reading the article 'Dewey's Problem' I went back to my notes on the online document given above. There are several comments that Dewey makes there that bear on CSILE, and I thought that I would share them. I'll post my thoughts on the article separately."*

The subcategory *Keeping Clarity* refers to messages written in order to keep the structure and the content of the notes clear. For example, a note - or a part of a note - is encoded 'Metacognitive Structuring Database' (MSD) if the author of that note summarised the discussion, formulated the key point of the discussion or if a student moved contributions to another place in the database and made a note of that movement. MAC ('Metacognitive Asking for Clarification') and MGE ('Metacognitive Giving Explanation') belong to one another. In MAC a student asks for an explanation, clarification or illustration as a reaction to a certain note and in MGE a student gives that explanation, clarification or illustration. At first instance, these two codes seemed to be cognitive. The reason to classify them as metacognitive is that this interaction of question and answer aimed at regulating the learning process; indistinctness and problems have to be solved because they impede the learning process. Table 4.8 presents some real examples of these three codes.

Table 4.8. Codes in the subcategory Keeping clarity (main category: metacognitive learning activities)

MSD	–	Structuring the contributions in the database *"In the discussion I found that there are basically four ideas which appear the most. There is the concept of efficiency, accuracy and reliability; there is the concept of clarification of research; there is the concept of identifying the scale dependency of the questions raised and finally there is the concept of problem analysis where data requirements are identified."* *"I think note 45 is related strongly to note 67 and 89. So, I replaced the note."* *"In the debate over spoon-feeding, therefore, we are really asking the following questions:* *1. How much time should be allotted to particular areas of the course, and what basic information has to be covered to get there?* *2. Is there any such thing as "basic information"?* *3. What balance should there be between direct basic information delivery and constructivist-style teaching (going for deeper knowledge)? (That is, assuming that there should be any basic information delivery at all)."*

Table 4.8 continued

MAC	–	Asking for an explanation, clarification or illustration as a reaction to a certain note *"I don't understand how you are able to discriminate sandy and clayey soil from the CESAR image. Can you explain how to do that? "* *"Jos, I do not understand what you mean by 'full learning'. Can you explain that to me?"* *"What do you mean by a process-directed environment?"* *"First a remark: Water-limited production is higher than potential production. This unique fact can never be correct of course. What is going wrong here?"* *"Hmmm, almost any model can fit this problem? (to 5.) Can you explain this briefly?"*
MGE	–	Explaining unclear information in notes; answering a question asked by another participant *" I think the models we are going to use are point-driven models: you make a yield estimate for a certain point in a field. This would automatically mean that you're doing a precision farming approach, because you can run the program for different points in the field and thus acquire a set of different treatments."* *"Legislation and the farming policy have a positive influence on the problem of leaching. That is what is meant with the +. "* *"Indeed, that is what I meant by teaching a student rope. Familiar with the learning process. How to start a project and how to find out something by yourself..."*

The last subcategory of metacognitive learning activities is called *Monitoring*. While executing the task, students will keep watching the learning process. MKW ('Metacognitive Keep Watching') refers to all activities aimed at monitoring the original planning, aim or time schedule. Examples of these kinds of activities are urging fellow-students to be more active, reminding them of the delivery date, criticising the quality of the work and being worried about the teacher's assessment. In a unit encoded as MRP ('Metacognitive Reflective Process'), students reflect on their own or other students' actions. This reflection is not directly focused on the content, but related to the progress of the course or to someone else's personal progress. Sometimes the reflection is aimed at diagnosing and improving the process; sometimes the reflection is just an aimless observation. Table 4.9 shows some examples of MKW and MRP.

Table 4.9. Codes in the subcategory Monitoring (main category: metacognitive learning activities)

MKW	–	Monitoring the original planning, aim or time schedule. *"Okay, until so far. But I think we do not make much progress with our opinions. Maybe we have to make concrete plans about the content of the note and come to an allocation of tasks."* *"I think we need clarity about the concept and ideas. We only have two weeks to finish the course".* *"It is very unclear to me. What is the aim of this course? What do have we to do?"*

Table 4.9 continued

MRP	–	Reflecting on one' s own actions or on certain contributions to the database *"I notice some confusion about the meaning of + and – in the cognitive map."* *"Not sure if this is useful to you but aside from emotions, some chats like I chat have lists of emotions that you can append to messages. I am too conservative and unimaginative to see a way of effectively including emotions in our text and graphic interchanges. Real time video seems to be the answer and is only waiting for bandwidth."* *"I am certain that scaffolding can still occur when technology is used in the class room. I believe that with CSILE, for example, sophisticated instances of scaffolding must surely occur. However, I believe that much scaffolding relies on a teacher's detection of the non-verbal cues that a student expresses (e.g., facial expressions, body cues, affective cues, etc...). With educational applications of technology, such as CSILE, any scaffolding that occurs cannot take into account the many non-verbal cues that a teacher can pick up from a student in the process of their immediate moment to moment interaction (that is, in real time). I suppose I am simply wondering what implications technology within the classroom will have on the process and quality of scaffolding."*

4.3.2.4 Rest activities

With developing a method to analyse content of CSCL-data, we aimed at encoding the complete text. However, in every database there are some notes that cannot be encoded by using the distinguished categories. So, RNE refers to 'Rest Not Encoded' and was created to score the remainder of the units (see table 4.10). Units encoded as RNE often concern 'technical' issues such as questions about software or irritations because of crashed computers. Without implementing this category, presenting results in percentages of all activities would be incorrect.

Table 4.10. The category rest

RNE	–	Units that can not be decoded according to the categories above *"If it is mentioned somewhere, consider this as not written and please indicate where this information is to be found."* *"This note is still under construction!"* *"I tried to open the PowerPoint file, but that did not work."* *"Can someone explain me how to draw an arrow in a chart?"* *"*$#@%#&#@. My computer crashed again and I was just going to save my note! I will stop, tomorrow try again..."*

To summarise, table 4.11 shows an overview of all main categories, subcategories and codes: the entire coding scheme.

Table 4.11. Coding scheme to analyse students' learning activities in a CSCL-system

	Cognitive learning activities
	Debating
CDPF	• A problem, solution or idea is presented. This contribution is followed by an illustration or argumentation
CDPNF	• A problem, solution or idea is presented. This contribution is *not* followed by an illustration or argumentation
CDAF	• A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is followed by a backing, refutation or restriction
CDANF	• A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is *not* followed by a backing, refutation or restriction
CDAQ	• Asking a content-directed question
	Using external information and experiences
CCEI	• Contributing new information found in other information sources (mentioned or not) than the discourse
CREI	• Referring to information found in other information sources (mentioned or not) than the discourse
CSEI	• Summarising or evaluating the information found in other information sources (mentioned or not) than the discourse
CREE	• Referring to earlier experiences (scholastic or daily)/ Referring to outcomes of running a model
	Linking or repeating internal information
CIL	• Linking facts, ideas or remarks presented in the discourse/ Referring explicitly to a contribution in the discourse
CIR	• Repeating information without drawing a conclusion or interpreting that information
	Affective learning activities
AM	• General: reacting emotionally to notes of fellow-students, without directly reacting to the content of that note. This reaction can be *positive*, *negative* or *neutral*
AA	• Asking for (general) feedback, responses or opinions by fellow-students
AC	• 'Chatting' or 'social talks'; contributions that are not relevant to solve the case/task
	Metacognitive learning activities
	Planning
MPA	• Presenting an approach or procedure to carry out the task
MAA	• Asking for an approach or procedure to carry out the task
MEA	• Explaining or summarising the approach already adopted
	Keeping clarity
MSD	• Structuring the contributions in the database
MAC	• Asking for an explanation, clarification or illustration as a reaction to a certain note
MGE	• Explaining unclear information in notes; answering a question asked by another participant
	Monitoring
MKW	• Monitoring the original planning, aim etc.
MRP	• Reflecting on one' s own actions or on certain contributions to the database
	Rest activities
RNE	• Units that cannot be decoded by using the categories above

4.4 STEP 3: Assessing the quality of students' knowledge construction

Although the coding scheme presented above was found useful to gain insight into the kind of learning activities students used, it appeared to be difficult to assess the quality of students' learning. However, the second part of the third research question of this PHdissertation focussed on the quality of the knowledge constructed by students in an asynchronous CSCL-system. Section 4.4.1 explain the relation between the second and the third step of the analysis. Section 4.4.2 will describe the SOLO-taxonomy as a basis for assessing students' knowledge construction. Section 4.4.3 will summarise the method used to analyse students' learning in CSCL.

4.4.1 Relation between the second and the third step of the analysis

In this respect we operationalised knowledge construction as: adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas. Because this third research question could not be answered by using the first coding scheme, it was necessary to add a step to the process of analysis. For example, by using this first coding scheme we knew whether students made a summary (CSEI); but what about the quality of that summary? Did students only cut and paste some text or did they read the information very well to select the main points? And if they selected main points, were these points listed or were they discussed in relation to each other?

Another example: a student's contribution was encoded as CDPF (a problem, solution or idea is presented followed by an illustration or argumentation). But was the idea elaborated clearly or was only some, not very well organised, information given? Were arguments criticised on relevance and truth or were arguments given and not checked at all? Furthermore, were arguments related to each other or were they not connected? Another example concerns the code CIL (Linking facts, ideas or remarks presented in the discourse). Did a student explain why the different notes were related to each other or were the notes linked without additional comments? Due to the focus of this research, cognitive learning activities are most relevant to deeper analysis. CDPNF and CDANF were dropped because of a missing illustration or argumentation. CDAQ was not selected because we knew from experience that these kinds of questions often were very short and not elaborated; therefore we did not find it interesting to analyse CDAQ deeper. Although MGE is a code from the category metacognitive learning activities, MGE was selected because of the explanation that could be assessed on the aspect of quality. Table 4.12 shows a selection of codes from the coding scheme that we found relevant to analyse on the aspect of quality, based on our definition of knowledge construction.

Table 4.12. Codes selected from the coding scheme that will be assessed on the aspect of quality

CDPF	• A problem, solution or idea is presented. This contribution is followed by an illustration or argumentation
CDAF	• A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is followed by a backing, refutation or restriction
CCEI	• Contributing new information found in other information sources (mentioned or not) than the discourse
CSEI	• Summarising or evaluating the information found in other information sources (mentioned or not) than the discourse
CIL	• Linking facts, ideas or remarks presented in the discourse/ Referring explicitly to a contribution in the discourse
MGE	• Explaining unclear information in notes; answering a question asked by another participant

4.4.2 The SOLO-taxonomy as a basis for assessing students' knowledge construction

In the first chapter of this PHdissertation, learning was seen as a dynamic process of knowledge construction and, in accordance with Baker (1999) and Veerman (2000), learning was proposed as non-normative. This means that the knowledge students construct in a CSCL-system is not always necessarily correct from a normative point of view. Notice that this view does not imply that we did not attach importance to the correctness of students' ideas, solutions or answers, but it is not the focus of our research. In other words, the aim in this research was not to question the correctness of students' ideas and their elaboration, but the focus in our analysis was on assessing the quality of understanding in terms of cognitive learning activities used. The use of specific cognitive learning activities assumed a certain level of understanding (Biggs, 1999). In the first coding scheme, we already used cognitive learning activities. However, this coding scheme appeared to be not detailed enough to assess the quality of students' learning and their constructed knowledge. The scheme helped to describe what kind of learning activities students used to carry out a task, but is was difficult if not impossible to assess how well students used these learning activities.

The view of learning as non-normative fits the standards model that was designed to assess changes in performance as a result of acquiring for the purpose of seeing what, and how well, something has been acquired. Such assessment must be criterion-referenced; this is contrary to the measurement model which starts from the point of view that assessment must be norm-referenced (Biggs, 2001). In a norm-referenced model, determining students' grade depends on how students compare to each other. In agreement with Biggs (2001), we see the standards model as the relevant one for summative assessment at a university. The point is not to identify students in terms of some characteristics but to identify performances that tell us what has been acquired and how well. Furthermore, the standards model is based on the idea that an outcome of learning should be assessed holistically, as a whole structure, not analytically as the accrual of discrete marks or percentages (Biggs, 2001).

The development of understanding is a complex process and its outcomes have been typically difficult to identify and classify (Jackson, 2000). The work of Biggs and Collis (1982) has provided a powerful taxonomy, the Structure of the Observed Learning Outcome (SOLO) taxonomy, which might provide a useful tool to define the ranges of understanding intended for students in higher education. As students learn, the outcomes of their learning display similar stages of increasing structural complexity. The SOLO-taxonomy systematically describes an hierarchy of complexity learners show in mastery of academic work. It is based on research by Marton and Säljö (1976). They asked students to answer questions about a given text in order to examine their understanding. They distinguished four different levels of outcome reflecting different modes of text understanding. Unlike the levels distinguished by Marton and Säljö (1976), the levels of the SOLO-taxonomy are not context-dependent and may be applied across a range of disciplines (Jackson, 2000; Whittle, Morgan & Maltby, 2000). Table 4.13 shows the basics of the SOLO-taxonomy: five stages of understanding are distinguished, that can be encountered in learners' responses to academics tasks.

Table 4.13. The SOLO-taxonomy: five stages of understanding

1)	E	Prestructural	The activities are irrelevant or inappropriate to the task *(no understanding at all)*.
2)	D	Unistructural	One relevant aspect of the task is picked up and used *(understanding as nominal)*.
3)	C	Multistructural	Several relevant aspects of the task are acquired but not connected. They are as bricks without a blueprint for building *(understanding as knowing about)*.
4)	B	Relational	The learned components are integrated into a coherent whole, with each part contributing to the overall meaning *(understanding as appreciating relationships)*.
5)	A	Extended Abstract	The acquired structure becomes transferable to far domains. The integrated whole is conceptualised at a higher level of abstraction, which enables generalisation to a new topic or area, or is turned reflexively on oneself *(understanding as far transfer and as involving metacognitive knowledge)*.

The SOLO-taxonomy can be symbolised as depicted in figure 4.2 (Biggs, 2001).

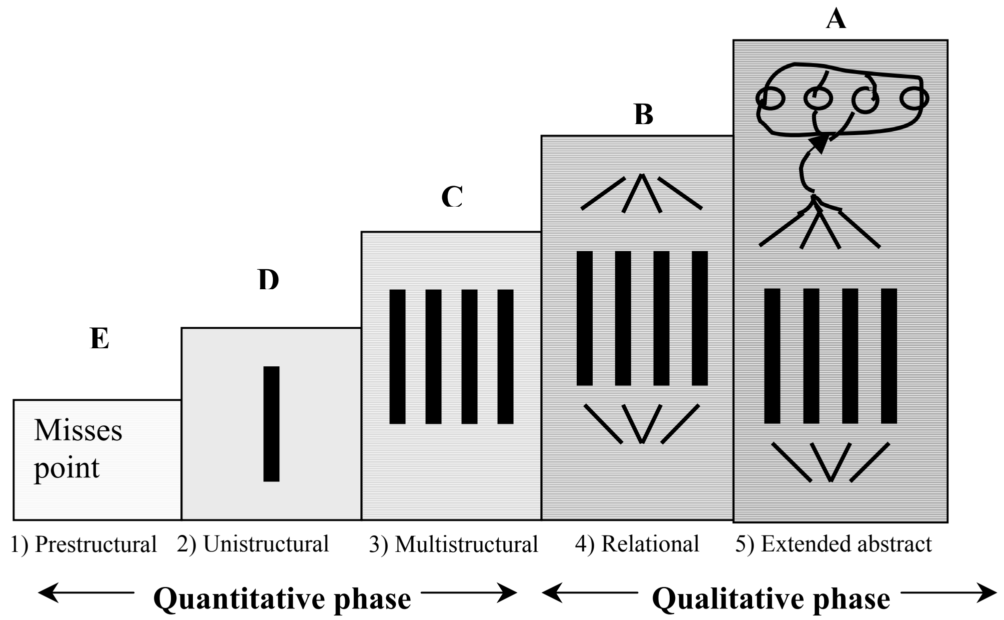


Figure 4.2. Structure of the Observed Learning Outcome or SOLO-taxonomy by Biggs and Collis

The five stages are subdivided into two main changes: quantitative, as the amount of detail in the student's response increases, and qualitative, as that detail becomes integrated into a structural pattern. The quantitative stages of learning occur first, after which learning changes qualitatively. In the pre-structural stage, students miss the point. All their activities are irrelevant or inappropriate to the task. In the second stage, students contribute only one idea. In the third stage, students contribute a number of ideas. However, these ideas are not connected, in contrast to stage four, in which students relate ideas to one another. In the fifth stage, students abstract ideas, reflect on these ideas and create their own theory (symbolised in the element that is added to stage five). In stages four and five, the learner integrates the new knowledge and skills into a coherent structure; the learner is making meaning.

Learning at these levels is characteristic of learning in higher education, and it is the desired aim of most established programmes.

The SOLO-taxonomy is not context-dependent. On the one hand, it could be seen as an advantage of being usable across subject areas. On the other hand, because of being context-independent, it is necessary to operationalise the taxonomy to a specific context. Several researchers used SOLO to evaluate students' learning. Before presenting our own coding scheme, some examples will be given to illustrate the wide use of SOLO. Whittle *et al.* (2001) studied a 15-week educational course in which students had to design an on-line study guide for an undergraduate course. Initially, students were required to work in small groups or pairs to develop one design topic and later they collaborated as a class to integrate all design topics into a single guide. In the data analysis, only the relational and extended abstract stages were selected because the three lower, quantitative stages seemed inappropriate for university expectations of higher order cognitive responses (Whittle *et al.*, 2001). Biggs (1999) argued that developing understanding means that it becomes more structured and articulated. "In learning a new topic, understanding moves through a quantitative phase, from uni- to multistructural, which involves finding out more and more facts. These are the 'bricks' of understanding, which form more or less elaborate and original working structures at the relational and extended abstract levels" (Biggs, 1999, p. 51). In our opinion, it is better to score these 'bricks' as well, in contrast to Whittle *et al.* (2001) who did not do so. However, an interesting finding of their research is the positive relation found between students' SOLO-levels, their engagement with content and their final grades.

Such a positive relation was also found by Tang (2001). She used the SOLO-taxonomy to score students' performance in an 'Integrated Professional Studies' course in which students had to learn basic pre-clinical science subjects as well as specialised professional therapeutic procedures. Besides the SOLO-scores, students were assessed by a more traditional assignment score. Results showed a positive relation between the use of deep strategies and the performance in the writing assignments. Deep strategies were expected to be required for the assignment. Results confirmed this expectation: students who adopted appropriate deep strategies achieved a better performance in the writing assignments.

Other researchers who used the SOLO-taxonomy to evaluate students' learning were Hawkins and Hedberg (1986). In this context, evaluating students' learning meant describing and classifying K12-student responses when using the computer language LOGO. The five SOLO-levels were briefly explained in terms of skill acquisition which were directly related to the actions carried out while using LOGO. They found that children did in fact work at various levels; even when two or more students successfully solved the same problem, they could do this at their own level of cognitive development. Furthermore, Hawkins and Hedberg (1986) concluded that the SOLO-taxonomy has proved to be an effective system for assessing students' learning. This research illustrates the general applicability of the SOLO-taxonomy, because of the totally different domains and subjects compared to a university setting.

To answer the research question mentioned in the beginning of this section, we also used the SOLO-taxonomy to assess the quality of the knowledge constructed by the students on levels of understanding as formulated by Biggs and Collis (1982). Biggs (1996) provided a starting point for the development of an evaluative protocol, focusing on the effect of understanding: if one understands something properly, one acts differently in contexts involving the same content. Biggs (1996) proposed an hierarchical list of verbs expressing the 'performances of understanding', from most desirable to barely satisfactory, using SOLO as a baseline. In Biggs' opinion, activities are expressed in verbs. Using verbs emphasises that learning and understanding come from student activity. Thus, practically speaking the verbs we want students to enact are specified in the context of academic learning (Biggs, 1999). The focus is not on *what* students know, but on *how well* they know it. Biggs described a framework meant to be filled in with verbs relevant to a specific context. He gave the following guidelines to fill in this framework: When defining verbs, it is necessary to define the quality of acquired knowledge in each level in the grading hierarchy. This may be achieved by applying the appropriate ranges in the SOLO-taxonomy that might be appropriate for the content being taught in the course in question. The best that can reasonably be expected becomes level A. Probably next, we would define that which is minimally acceptable, and that becomes level D. Level B and level C fall in between. Biggs suggested some generic verbs for each level which might help to define desired grading levels, but of course, each discipline area and topic would need its own verbs that refer to the specific content (Biggs, 1999; 2001). Stages two to five of the SOLO-taxonomy (see Table 4.13 and Figure 4.2) correspond to level D, C, B and A, consecutively. Stage one was left out of the classification of levels, because in stage one, students did not understand anything at all. They scored lower than what was minimally acceptable.

The development of the second coding scheme, in which the SOLO-taxonomy was operationalised, again was an iterative process. Based on both our experiences with CSCL and formulated academic learning goals, verbs were distinguished and described. We looked for examples to illustrate the different levels. Next, many notes were independently analysed by means of the distinguished verbs, and then the results were compared. If a level was not clear, verbs were redefined. If we found an activity in the database that we could not decode as one of the distinguished verbs, a new verb was added and described. The process was concentrated on the levels and not on the verbs itself because it was often possible to assign more verbs to one fragment. Furthermore, we decided to code complete notes and not only units within a note because the SOLO-taxonomy describes an hierarchy in which each construction of knowledge is the foundation of following construction (Biggs, 1999) and because of the assumption underlying the standards model to assess learning results holistically and not analytically as the accrual of discrete marks or percentages (Biggs, 2001). This process of revising, analysing and comparing was repeated until the analysing results of both raters were comparable. Then, Cohen's Kappa was calculated by using another set of twenty-five notes that were selected at random, to determine the inter-rater reliability of the scheme. Cohen's Kappa was satisfactory, namely 0.72, which means that 80% of the notes were scored similarly. When the assigned levels were not similar, they differed only one level. Table 4.14 presents the coding scheme, based on the SOLO-taxonomy used to assess the quality of students' constructed knowledge expressed in the CSCL-system used in our courses.

Table 4.14. Coding scheme to assess the quality of students' constructed knowledge expressed in a CSCL-system

Level	Verb	Description
Low *LEVEL D*	• Identify	Recognising or distinguishing something from others. One point or item is given that is not related to other points in the discourse. Furthermore, this new point is not elaborated.
	• Define	Describing clearly what something is. The description is taken over from a text or someone else; it is not a self-made definition.
LEVEL C	• List/enumerate/ number	Writing things one after another, usually in a particular order, but it can be a disorganised collection of items, too. Marking something with a number, usually starting at one.
	• Describe/organise	Giving a self-made definition of something (like for example a theory, idea, problem or solution) which explains distinguishing marks of that thing. Organising ideas or theory, but descriptive in nature. No deeper explanatory relations are given; it concerns a rough structure of information.
	• Classify	Dividing things into groups or types so that things with similar characteristics are in the same group.
LEVEL B	• Explain	Giving reasons for a choice made. Elaborate on an idea, theory or line of thought.
	• Relate/combine	Linking two or more things or facts, which are related to each other.
	• Apply	Using acquired knowledge in a(nother) situation.
	• Compare/contrast	Considering things and discovering differences or similarities between those things.
LEVEL A **High**	• Reflect/conclude	Criticising arguments on relevance and truth. Deciding something is true or not, after considering relevant facts. A judgement is given after considering an argumentation or theory. (The conclusion has to be a point, it must rise above the earlier statements, not just a summary)
	• Generalise/ theorise/ hypothesise	Surpassing the concrete ideas and formulate one's one view or theory. Predicting that something will be true because of various facts; this prediction has to be checked/examined.

4.5 Summary

To end this chapter, Figure 4.3 summarises the method used for analysing students' learning in CSCL in this PHdissertation.

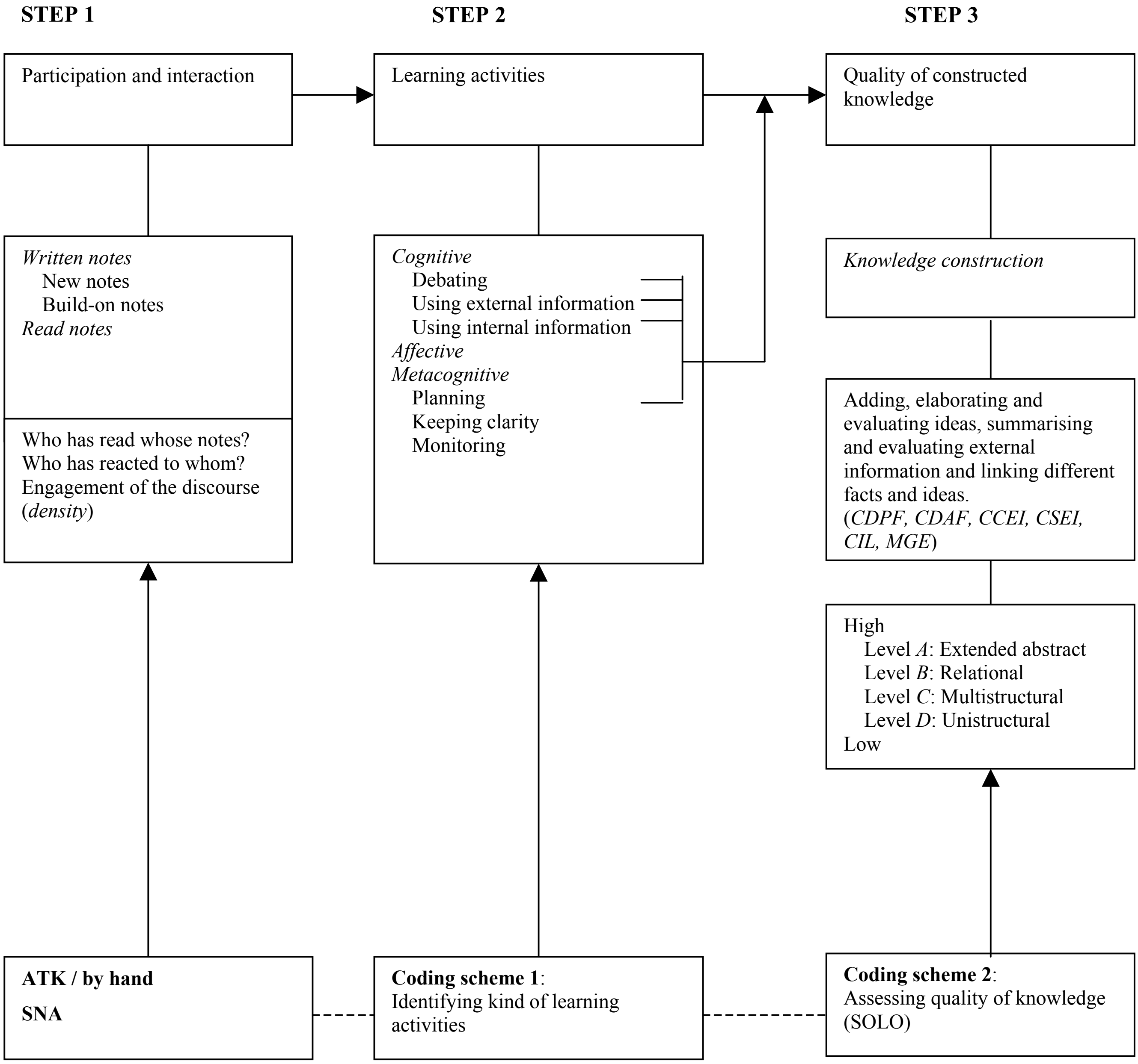


Figure 4.3. Summary of the method used to analyse students' learning in CSCL.

The next chapter describes four studies in which CSCL was used in university courses. The collected data were analysed by using this method.

Chapter 5 - CSCL in university education: Analysis of four courses

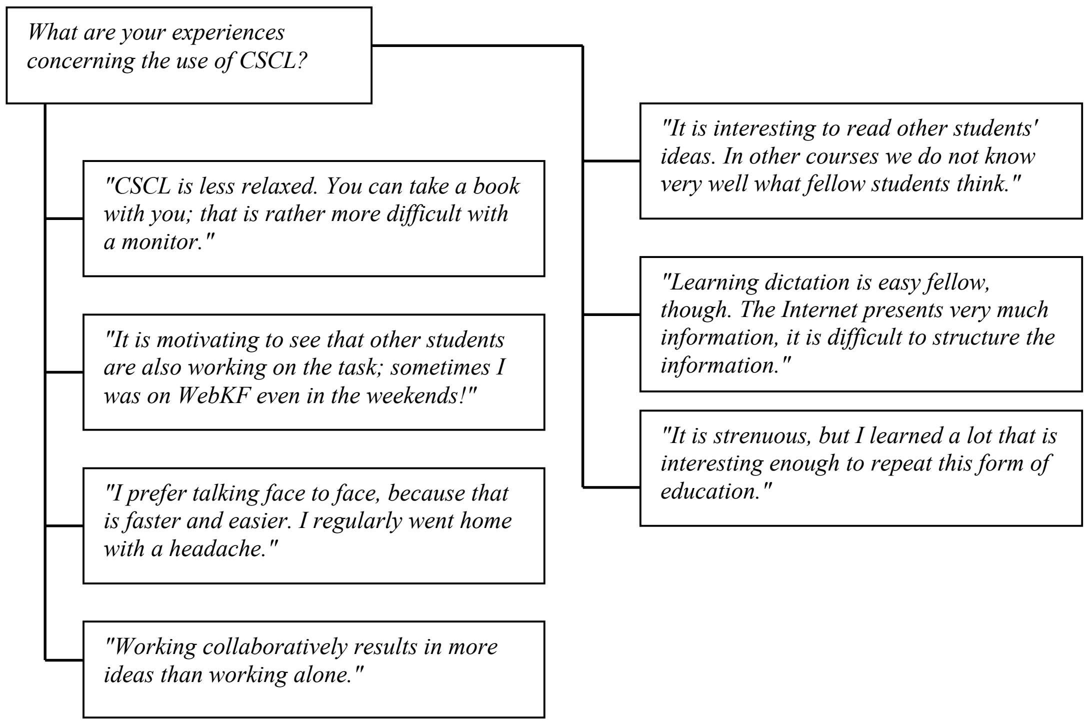


Figure 5.1. Statements of students about the use of CSCL.

The quotations above (Figure 5.1) are a selection of positive and negative statements of students found in the evaluative questionnaires of the four courses described in this chapter. In this chapter, we will present our experiences with CSCL and present and discuss the results related to the research questions. The methods described in the previous chapter will be used to analyse the data collected in the studies described in the present chapter.

5.1 Introduction

After formulating the research questions and expectations in section 5.2, section 5.3 will summarise the methods used to analyse the data. Next, section 5.4 will discuss some background issues concerning the executed studies and describe the CSCL-systems used. Sections 5.5 to 5.8 will present four studies: three Dutch and one Canadian study. Each section is organised according to the following topics: methods, formulation of specific questions (except study four), presentation of the results, formulation of some conclusions drawn and discussion of the findings. The organisation of the presentation of the results in sections 5.5 to 5.8 are comparable as well. First, the main research questions are answered in the sequence of the questions given below: participation/interaction, use of learning activities and amount and quality of constructed knowledge. Next, results are given concerning the more specific questions of each study. Finally, section 5.9 will compare and discuss the results of the four different studies leading to some overall conclusions.

5.2 Research questions

The purpose of this chapter is to understand the way students learn in a CSCL-system and to assess the amount and quality of the knowledge students constructed by means of CSCL. In line with the developed methodology described in the previous chapter, the following main research questions are formulated (see also chapter 1 and chapter 2):

1) *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?*
2) *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?*
3) *Do students construct knowledge and what is the quality of the knowledge constructed by students in an asynchronous CSCL-system?*

A total of four studies was executed in different settings in order to answer the research questions formulated above. These three main research questions are meant as explorative questions. We want to zoom in on the collaboration and learning processes to aim at a better understanding of what is happening (see also chapter 3, section 3.2). Besides these overall research questions, three more specific questions related to specific characteristics of the different educational tasks and settings were formulated.

– *What are the effects of different group sizes on students' participation, use of learning activities and knowledge construction in an asynchronous CSCL-system?* (section 5.5.1)
– *What are the effects of working in a multidisciplinary group on students' participation, use of learning activities and knowledge construction in an asynchronous CSCL-system?* (section 5.6.1)
– *What is the relationship between students' learning style on the one hand and students' participation, learning processes and knowledge construction in an asynchronous CSCL-system on the other hand?* (section 5.7.1)

5.3 Data analyses

In the four studies, all students' notes were automatically logged as text files on the computer. To analyse these notes we used the methods described in the previous chapter. Participation (*main research question 1*) was operationalised as the number of notes read and written. Additionally, the proportion between new and build-on notes was measured, partly by use of the ATK and partly by hand, using the prints of the threads (see chapter 4, section 4.2). The second part of the first main research question concerns the interaction between students in a group. In this PHdissertation, interaction refers to social interaction between participants in a CSCL-system, communicating with each other while working at the task given. To gain insight into the extent of interaction among students, the Analytic Toolkit (ATK) was used for the analysis of 'Who had read whose notes' and 'Who was linked to whom' (see also chapter 4, section 4.2). The results of these analyses were organised in case-by-case matrices. Next, these case-by-case matrices were analysed with social network analysis. We examined interaction among students with a density test. Density describes the general level of linkage among the students in the different discourses. Therefore, the case-by-case matrices were dichotomised in density analyses, i.e., the relations between students were marked with only two values: 1 (representing an existing relation) and 0 (representing no existing relation). Density was calculated twice; once based on read notes and once based on linked notes. A linked note could be a build-on note or a reference to another note.

To analyse cognitive, affective and metacognitive learning activities *(main research question 2*) the developed coding scheme described in chapter 4 was used. The main category 'cognitive learning activities' consisted of three subcategories: (1) debating, (2) using external information and experiences and (3) linking or repeating internal information (section 4.3.2.1). The main category 'affective learning activities' was not divided into subcategories (section 4.3.2.2). Finally, the category 'metacognitive learning activities' consisted of three subcategories: (1) planning, (2) keeping clarity, and (3) monitoring (section 4.3.2.3). In each study, Pearson correlation was calculated between the three types of learning activities to find out if the extent of using these learning activities was related to each other. Knowledge construction (*main research question 3*) was operationalised as adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas (see chapter 4, section 4.4.1). The coding scheme that was used to analyse students' learning activities could also be used to measure the amount of constructed knowledge by selecting a number of codes (see Table 4.12, section 4.4.1).

We had to use a standard in order to assess the amount of constructed knowledge as much or little. We wanted to say something about the proportion between units decoded as knowledge construction and non-knowledge construction. In literature, no standard or guidelines to determine a standard for this proportion were found. Therefore, we choose a standard by ourselves:

- *Little*: {units knowledge $construction_N$ = ≤25%; units non-knowledge $construction_N$ = >75%}
- *Reasonable*: {units knowledge $construction_N$ = 25% -≤50%; units non-knowledge $construction_N$ = 50% -≤75%}
- *Much*: {units knowledge $construction_N$ = ≥50%; units non-knowledge $construction_N$ = <50%}

The quality of the constructed knowledge was assessed by using the coding scheme based on the SOLO-taxonomy (see section 4.4.2) including levels D to A. Biggs (1999) said about filling in his framework: The best that can reasonably be expected becomes level A. Probably next, we would define that which is minimally acceptable, and that becomes level D. Level B and level C fall in between (see also section 4.4.2). Again, we needed a standard to assess the proportion between the four levels assigned to students' notes written during the four analyses courses. Biggs (1999) did not give guidelines to judge the quality of students' constructed knowledge in the way we do in this PHdissertation. Biggs (1999) only said that to reach a high level of understanding, both qualitative contributions and quantitative contributions are needed. Biggs (1999) used the metaphor of a pyramid to explain that A must be built on B, B on C and C on D. Apparently, the idea is not to aim at only level A and/or B. We chose the standard as follows:

- *Very low*: {$\sum$ level A_N + level B_N = ≤ 10%; $\sum$ level D_N + level C_N = > 90%}
- *Low*: {$\sum$ level A_N + level B_N = 10% -≤25%; $\sum$ level D_N + level C_N = 75% -≤90%}
- *Reasonable*: {$\sum$ level A_N + level B_N = 25% -≤45%; $\sum$ level D_N + level C_N = 75% -≤55%}
- *High*: {$\sum$ level A_N + level B_N = ≥ 45%; $\sum$ level D_N + level C_N = < 55%}

5.4 The connections between the four studies

This section will explain how the four studies are connected. In other words, the similarities between the four studies are described. Besides, the section gives a description of the CSCL-system used.

5.4.1 Background issues

Although the four studies differ in many aspects, the educational context is comparable. All studies were conducted at a university and took place as part of a real course in which students had to work collaboratively on complex tasks by the use of a CSCL-system. All four studies were planned in the final phase of the educational programmes. In the studies, no coaches were involved in the CSCL-system. In other words, students regulated their own learning processes and were not moderated by a teacher. Another similarity is the CSCL-system used, namely Knowledge Forum. In none of the studies, students were charged with rules concerning the use of Knowledge Forum. They were expected to log in regularly, but were not obliged to read all notes or to write a certain numbers of notes.

5.4.2 CSCL-system: Knowledge Forum

Knowledge Forum (KF, 2001) is an asynchronous CSCL-system developed by the Ontario Institute for Studies in Education (OISE). KF is called a second generation Computer-Supported Intentional Learning Environment (CSILE) product. Scardamalia and Bereiter (1994) started developing CSILE in the Eighties and are still improving their system in collaboration with their team of researchers. Two versions of Knowledge Forum are available: the Knowledge Forum Client (KF) and the Web Knowledge Forum (WebKF), which is accessible from the Internet. We mostly used the Web version, but in one study the Client version was used as well. The Client version is more advanced and has some additional options comparable to the Web version. In both systems, students can write new contributions (new notes) as well as reply notes (build-on notes) and authors can edit their written notes.

It is possible to write alone or with co-authors. Furthermore, in KF as well as in WebKF, students can make links or reference notes. In WebKF, students have to click on a button and insert the number of the note they want to link or reference to. In KF, students can draw lines between notes or add the number of the referenced note. Besides writing notes, students can read all the notes placed in the system. Furthermore, it is possible to see who read a note and how many times. Notes are organised in a view or folder, a thematic discussion list, created by a teacher. In WebKF, notes in a view are structured by a thread (see Figure 5.2), but it is also possible to structure notes by author or by date. In KF, notes are graphically structured (see Figure 5.3). Students can drag notes with their mouse and cluster them any way they want. Additional options in KF are using a reader to organise notes, writing rise-above notes, publishing notes, annotations or collections. In WebKF, two directories are implemented to upload larger documents. Each participant has a personal directory and, moreover, there is a shared directory that is accessible for everyone. Finally, in WebKF there is an option to order WWW-sources.

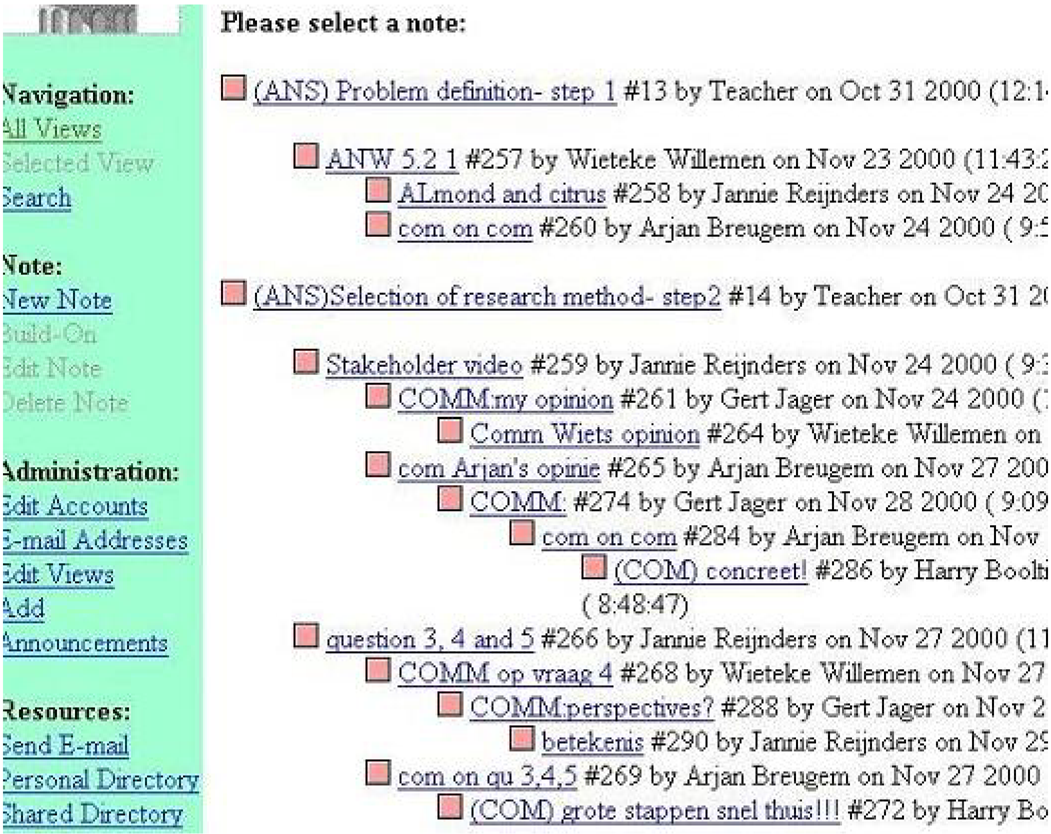


Figure 5.2. Screendump of the WEB Knowledge Forum system: Notes in a view are structured by a thread.

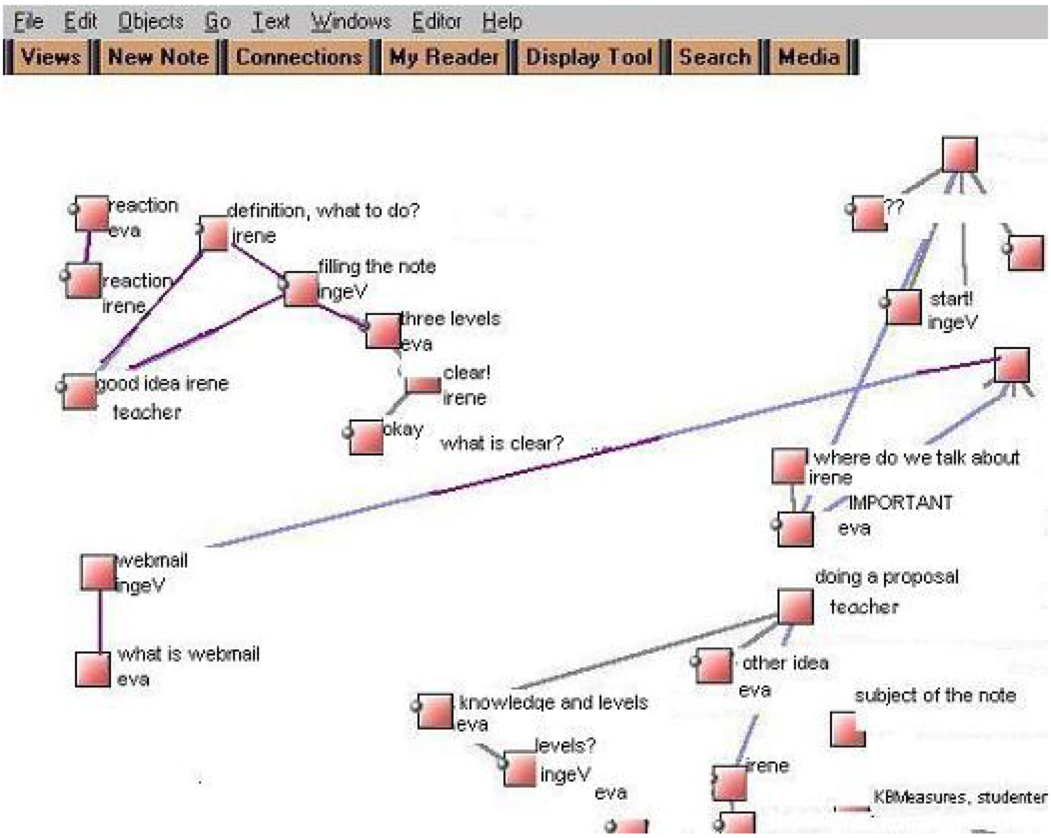


Figure 5.3. Screendump of the Client Knowledge Forum system: Notes in a view are graphically structured.

The organisation of the forums was identical. In all executed studies a view was created to welcome students, a view was created to debate technical issues, a view was created to talk non-task related and some views were created to work on the task. In all Dutch courses, students were instructed to use clear titles reflecting the content of the note. Furthermore, they were asked to use a keyword to indicate the nature of the note. In the title, students had to type between brackets one of the following abbreviations: (NI) New Information, (QU) Question, (ANS) Answer, (COM) Comment, (MT) My theory, idea or solution, and (ARG) Argument.

5.5 Study 1: Agrification

Section 5.5.1 will describe the method of the Agrification study. Next, section 5.5.2 will present the results in sequence of the main research questions: participation/interaction, use of learning activities, and the amount and quality of the constructed knowledge. Next, the section will pay attention to a specific question focusing on possible effects of group size on students' learning. Finally, section 5.5.3 will discuss the results and the conclusions that were drawn concerning the use of the CSCL-system in this course.

5.5.1 Method

The first study is called Agrification and was integrated as a part of the optional course "Processing of Agricultural Raw Materials for Non-Food Products" at Wageningen University (WU). The following learning objectives were formulated: (a) based on end-use product specifications a student must be able to analyse the functional properties requested and translate these to a possible raw material and process, (b) based on the properties of components present in agricultural raw materials a student must be able to analyse possibilities for end-uses and required modifications, and (c) a student must be able to determine the economic feasibility of non-food applications by comparing agronomic, environmental and cost factors of agri-based products with those of oil-based chemicals.

The six-week course was given twice: in March-April 1999 and in March-April 2000. Students worked in WebKF for two weeks only. They were expected to spend about twenty hours on the course weekly. In WebKF, students had to solve an open-ended problem. The subject of the case differed over the years. An example of a case is: "A company producing boats for recreational purposes is specialised in the production of canoes. The canoes are made of polyester reinforced by glass fibre. The company wants to innovate and the ultimate goal is the production of a canoe, completely made from renewable resources. The company wants to start with an evaluation of the various mid-term and long-term possibilities. For the short term replacement of glass fibres by natural fibres is seen as a viable possibility. For the long term the company is interested in using an alternative polymer made from renewable resources (e.g. a monomer produced via fermentation). Another aspect is the use of solvents in the current process. Styrene is often used now as a solvent in the processing of polyesters for boat building. The company is asking your group for an evaluation of these options."

Four face-to-face (F2F) meetings were organised to present information needed to solve the cases and to coach the students' learning processes. The teacher called these meetings 'cheering-up' talks. He had difficulty in letting the students go their own way. At the first meeting, students were informed about the course, the idea of problem based learning, the digital learning environment, the concept of CSCL and the practical use of WebKF. Students could use WebKF to solve the problem and to write a joint report, but they were not obliged to use the CSCL-system. Most of the time students worked in a reserved room; sometimes they worked on the task at home. The task was not structured at all; no subtasks, exercises or schedule were given. The joint report was assessed on content criteria. Participation and involvement in the course were not especially considered. All members of a group received the same mark.

Restricted by the limited numbers of students that subscribed to the Agrification course, we collected data in the two years the course was offered. Across the years comparable types of students participated in the study (according to their age, sex and phase of their study) and the educational setting was identical. No courses were prerequisite and no data were collected concerning prior knowledge, but all students were in the final year of their study Food Science. In total 15 undergraduate students were involved in the study. To create groups, students were selected at random. In 1999, it was a group of four students and a pair. The teacher was interested in the differences in collaboration and results between a pair and a small group. The teacher was more satisfied with the group of four students, and therefore, there were two groups of respectively four and five students in 2000. Each group had one problem, formulated in a case, to solve. To all students, CSCL was a new form of education and none of the students was familiar with WebKF. Furthermore, these students were not used to being educated by means of problem-based learning.

Hinssen (1998) studied the effect of group sizes in groupware on quality of product, time to deliver product, satisfaction with the group, openness of communication and degree of co-operation. For the range of group sizes (three categories: 2-3 members, 4-5 members, >5 members) Hinssen (1998) studied, group size was not a relevant factor. Based on his research, we did not expect to find differences in results between the four groups because of group size. However, because of the different topics of the cases, it would be illogical to combine the results. Therefore, we will first analyse the results within groups and next compare the results between groups. The additional research question in this second study is formulated as: *What are the effects of different group sizes on students' participation, use of learning activities and knowledge construction in an asynchronous CSCL-system?* Based on literature described in chapter 3, we expected to find no effect of group size on students' learning processes in terms of participation, use of learning activities, and amount and quality of knowledge construction.

5.5.2 Results

In this first study, the views of the four different groups were analysed. The topics of the cases were: renewable resources, bioremediation, detergents, and non-food products. Except for the topics of the cases, the four tasks were identical. Table 5.1 shows an overview of the means and standard deviations of new, build-on and read notes and the cluster sizes of the four analysed discussions. A cluster is defined as a note followed by a number of build-on notes. When a new note is contributed to the discussion thread, a new cluster is started (see figure 5.4).

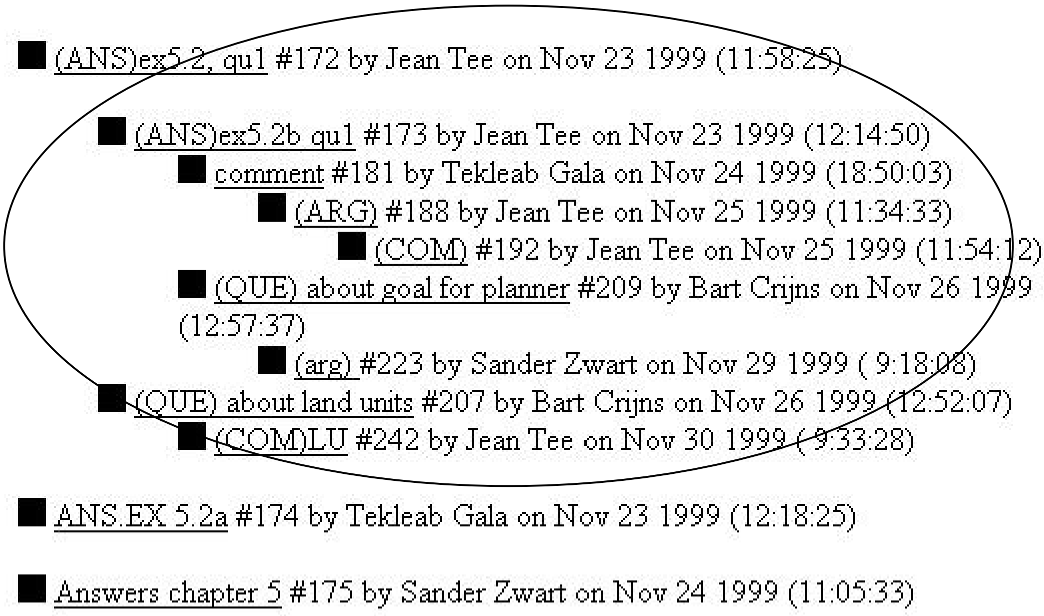
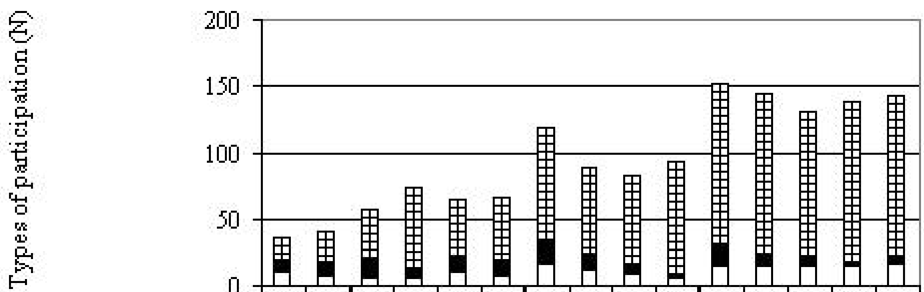


Figure 5.4. An example of a cluster in a thread.

Table 5.1. Overview of the four analysed views in the Agrification study (mean and standard deviation of new, build-on and read notes; cluster sizes)

	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
Group 1 (N=2)			4	15	0	0	0	0
New	9.50	2.12						
Build-on	8.00	1.41						
Read	20.50	3.54						
Group 2 (N=4)			11	9	3	1	1	0
New	7.25	1.89						
Build-on	9.50	3.87						
Read	48.50	10.54						
Group 3 (N=4)			11	13	6	2	0	0
New	10.75	4.27						
Build-on	8.00	6.78						
Read	77.00	11.05						
Group 4 (N=5)			24	24	4	1	0	0
New	15.20	0.48						
Build-on	6.80	5.26						
Read	119.80	5.50						
Sum Group 1-4 (N=15)			50	61	13	4	1	0
New	11.13	3.96						
Build-on	8.00	4.72						
Read	76.13	37.43						

We see about the same pattern of participation in each of the four groups. It appeared that the larger the group, the more notes were contributed in WebKF (except for group 1) and the more notes were read[1]. Except in group 2, students wrote on average more new notes than build-on notes (difference 8.90). The mean number of new notes varies between 7.25 and 15.20; the mean number of build-on notes varies between 6.80 and 9.50. Although students in group 4 produced most new notes (difference 7.95), they wrote least build-on notes compared to the other groups (difference 2.7). A small number of build-on notes refers to many unconnected notes (see cluster size 1). In none of the groups very large threads were built; only 4% of all clusters contained seven or more notes. 39% of all clusters consisted of isolated notes. Of all clusters, cluster size 2 < 3 (47%) was counted most frequently.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
⊞ # read notes	18	23	38	63	45	48	87	66	69	86	122	122	110	122	123
■ # build-on notes	7	9	13	4	10	11	16	11	4	1	15	8	6	1	4
□ # new notes	11	8	6	6	10	7	16	12	9	6	15	15	15	15	16

Figure 5.5. Students' participation in the Agrification study.

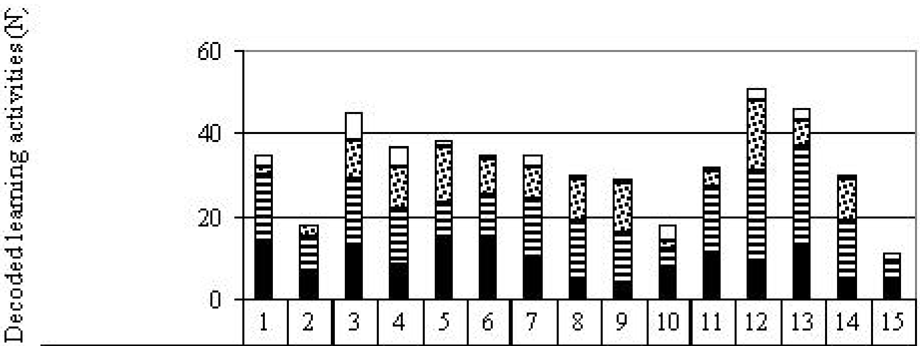
Figure 5.5 shows the participation per student and per group (distinguished by a bold line). At first sight, frequencies of reading and writing look to be quite different between the four groups. We can see that these differences are stronger between groups than within groups. However, because of different group sizes, we could not compare the absolute numbers. Therefore, the proportion between active and passive activities were compared. In the largest group (N=5) the proportion write/read is 0.18/1; in the smallest group (N=2) the proportion write/read is 0.85/1. Although students rather differ in the proportion of reading and writing notes, we can see that all students participated in the process.

The second part of the first main research question concerns the interaction between students in a group. To get an indication of the overall linkage of students in the discourse, density was measured by social network analysis, based on the ATK reports (the dichotomised case-by-case matrices can be found in Appendix II). In all four groups, density based on read notes was 1.0, which means that 100% of the students in the group read at least one note of their fellow students. Density based on linked notes varied between .40 and .75. Density of groups 2 and 3 was equal, namely .75. This means that 75% of all students interacted with each other. In groups 1 and 4, density was lower:

[1] Notice that by read notes we mean different read notes. If a note was read more times, it was counted only once. Furthermore, although the Analytic Toolkit records a student's notes as being read by the author of that note, we left these notes out of the analyses. As a consequence, read notes are notes written by fellow students but they could also be written by a teacher. This rule applies also to studies two, three and four in this chapter.

.50 and .40, consecutively. As might be expected, density in the different groups and the number of units decoded as 'CIL' (Linking facts, ideas or remarks presented in the discourse/ Referring explicitly to a contribution in the discourse - see section 4.3.2.1) correlated positively ($r=.88$; $p < .01$).

Figure 5.6 summarises the learning activities of the four groups. Within the 287 notes, 490 meaningful units were identified. In this first study, the largest part of students' notes concerned metacognitive activities, namely 41%. 28% was decoded as cognitive, 24% as affective and 7% could not be decoded according to the used coding scheme. No (Pearson) correlations were found between the three types of learning activities ($r_{cognitive,\ metacognitive}=.40$, $p=.14$; $r_{cognitive,\ affective}=.00$, $p=1.00$; $r_{metacognitive,\ affective}=.22$, $p=.41$).



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Students
□ Rest	3	0	7	5	1	1	3	1	1	4	1	3	3	1	2	
Affective	2	3	9	10	14	9	8	10	12	2	4	17	6	10	0	
Metacognitive	16	8	16	14	9	10	15	14	13	5	16	22	25	14	5	
■ Cognitive	14	7	13	8	14	15	9	5	3	7	11	9	12	5	4	

Figure 5.6. Students' cognitive, metacognitive and affective learning activities in the Agrification study.

Figure 5.7 shows the learning activities divided into subcategories. Students contributed many Internet sources and references or copied text on the forum; on average, 54% of all cognitive activities were decoded as using external information. 14% of all cognitive units concerned linking, which means that two or more messages in the discourse were connected. 66% of the metacognitive units referred to planning activities. Students had less difficulty to keep the database structured or to explain their ideas; only 9% of the metacognitive activities concerned the subcategory keeping clarity. In 25% of the metacognitive units, students monitored their learning processes.

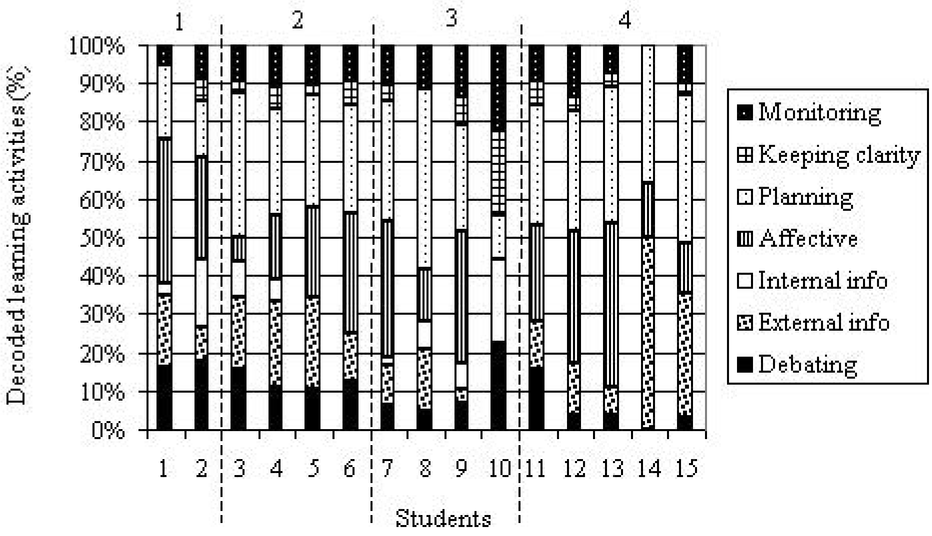
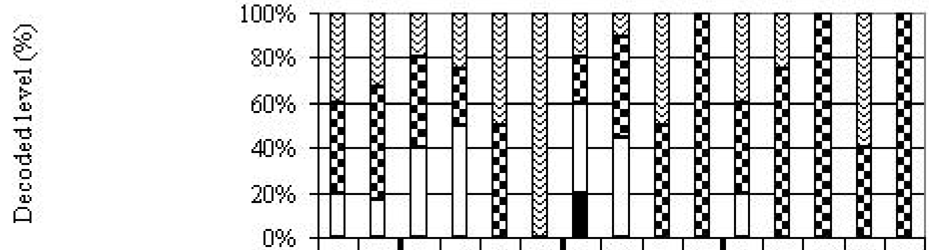


Figure 5.7. Students' learning activities in the Agrification study divided into subcategories.

In total, 64 of the 490 units (=13%) concerned expressions of knowledge construction, using the selection of codes given in section 5.3 of this chapter (see also section 4.4.1). 78% of these expressions were decoded as level D or C: in terms of Biggs (1999) the quantitative phase or low academic level. Measured by our standard (see section 5.3), students in the Agrification course constructed little knowledge. Looking at the quality of the knowledge, Figure 5.8 shows that only once level A was assigned to a unit. In addition, level B was found 13 times. In total, 22% of the units were decoded as qualitative. Measured by our standard (section 5.3), this means that Agrification students constructed knowledge of low quality.



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Low	D: Unistructural	2	2	1	1	1	2	1	1	2	0	2	1	0	3	0
	C: Multistructural	2	3	2	1	1	0	1	4	2	3	2	3	1	2	4
	B: Relational	1	1	2	2	0	0	2	4	0	0	1	0	0	0	0
High	A: Extended abstract	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Students

Figure 5.8. Quality of students' constructed knowledge in the Agrification study, expressed as levels of understanding.

After looking at the activities of all students in the course, we will now focus on the differences between groups. The number of cases was too small to run statistical analyses. Therefore, we will give a description of the mean and standard deviation per group (see Table 5.2).

Table 5.2. Overview of the decoded learning activities, the amount and quality of the constructed knowledge per group

	1 (N=2)		2 (N=4)		3 (N=4)		4 (N=5)	
Learning activities	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Cognitive activities	14.50	0.71	10.50	3.51	7.50	3.70	7.00	3.16
Debating	6.00	0.00	3.75	1.26	2.25	0.50	1.60	1.95
External	5.00	2.83	5.75	2.36	3.25	3.30	5.40	3.13
Internal	3.50	3.54	1.00	1.41	2.00	0.82	0.00	0.00
Metacognitive activities	9.50	0.71	13.50	3.79	16.50	8.96	12.60	4.39
Planning	6.00	1.41	9.25	3.10	11.00	8.29	9.20	2.59
Clarity	1.00	1.41	1.25	0.50	1.50	1.00	1.00	0.71
Monitoring	2.50	0.71	3.00	0.82	4.00	1.41	2.40	1.52
Affective activities	11.50	3.54	6.00	4.08	8.25	7.14	7.20	4.15
Knowledge construction	5.50	0.71	3.25	1.50	5.0	2.71	3.80	1.64
Levels								
Level A (high) ↓	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Level B	1.00	0.00	1.00	1.15	1.50	1.91	0.20	0.45
Level C	2.50	0.71	1.00	0.82	2.50	1.29	2.40	1.14
Level D (low)	2.00	0.00	1.25	0.50	1.00	0.82	1.20	1.30

The students working in a pair produced most cognitive activities per student as opposed to the largest group that produced least cognitive activities per student (difference= 7.50). Besides, students in the pair used least metacognitive activities to execute the task compared to the other groups (difference= 7.00). In the pair, by far most affective expressions were found (difference=5.50). Groups vary little in the amount of constructed knowledge (difference=2.25). Concerning the levels we see less differences between the groups as well. Level A was found only once in group 3. The range in level B was small, namely 1.30. In addition, the ranges between the quantitative levels were small, too. The ranges in level C and D were 1.50 and 1.00, consecutively.

5.5.3 Conclusions and discussion

Concerning the first main research questions the conclusion is that although none of the students were used to work with a CSCL-system or to learn by a case-based approach, students were willing to devote their energy to execute the task in collaboration with fellow-students. All students participated regularly in the database. To all students, the number of read notes was larger than the number of written notes. Furthermore, except in group 2, students wrote on average more new notes than build-on notes. The extent of interaction, calculated by density, varied between .40 and 1.0. In none of the groups, very large threads were built; only 4% of all clusters contained seven or more notes. 39% of all clusters consisted of isolated notes. In all groups, students had much difficulty in solving the problems. Although the aim of the task was clear, students did not know how to approach the task and were busy making plans. The period (two weeks) was very short to brainstorm about the subject of the case, to write ideas, to read others' notes and to create a collective solution; we think it was too short. Results showed that the largest part of students' notes were decoded as metacognitive activities. Less than one third of all units concerned cognitive activities. Furthermore, more than half of these cognitive activities concerned contributing Internet sources and references or contributing copied text. Students did not debate and elaborate on ideas thoroughly. When analysing the explicit or statable knowledge saved in the databases, we have to conclude that students did not learn on a deep level.

Concerning the third main research question, we have to conclude that little knowledge was constructed and that the constructed knowledge was of a low quality. Finally, returning to the last, specific research question, we have to conclude that this study gives no reason to assume that group size affects students' learning processes and students' knowledge construction in one way or another.

Although students in the course participated regularly, in our opinion CSCL was not used as was intended beforehand. Because of the necessity of regulating the task execution, students hardly got involved in constructing knowledge. Students put a lot of references and Internet sources on the forum, but it often was not clear how this external information was useful to write the report. Additionally, we have already cited the aspect of lack of time and unfamiliarity with CSCL and case-based learning. It would have been useful to structure the task by giving for example a model of problem solving. We expect that a well-organised task would decrease the number of metacognitive activities and would help to produce more cognitive activities. This idea clashes with the idea described in chapter 2, namely that using metacognitive learning activities enables individual learners to manage their cognitive skills and to determine problems (De Jong, 1992; Schraw, 1998). Therefore, presenting a structured, well-organised task combined with a longer period to work at the task would be necessary in the beginning. When students are familiar with CSCL and solving open-ended problems, less structure is preferable.

To end with, the technical use of WebKF was no problem; students found it very easy to learn to use the forum. Strikingly, in contrast to our experiences, the teacher was satisfied with the students' results. In the beginning, he had some aversion to the use of WebKF; he was uncertain. Finally, he used WebKF in his course for three successive years. He called time-saving and insight into the learning process as most important positive aspects.

5.6 Study 2: Land Evaluation I

First, this section will describe the methods of the Land Evaluation I study. Next, section 5.6.2 will present the results sequenced by the main research questions: participation/interaction, use of learning activities, and the amount and quality of the constructed knowledge. Besides, attention is paid to the additional question concerning the effect of working in multidisciplinary teams. Finally, section 5.6.3 will discuss the results and present some conclusions that were drawn about the use of the CSCL-system in this course.

5.6.1 Method

In November-December 1998 as well as in November-December 1999, CSCL was implemented in an optional six-week course on "Land evaluation and variability for explorative land use studies" (Land Evaluation I) at Wageningen University (WU). Students were expected to spend about twenty hours on the course weekly. The formulated learning objectives of the course were: (a) to perform a process of land evaluation: stakeholder analysis, problem definition, choice and application of models, evaluation and presentation; (b) to know the characteristics of various models for land evaluation and be able to apply them, supported and linked with a GIS, and (c) to gain experience in working in multidisciplinary groups and be able to critically reflect on research methods.

During the introductory meeting, students were informed about the course, the various tasks, the digital learning environment, the concept of collaborative learning and the practical use of WebKF. WebKF took a central place in the whole course. Students mostly worked in one room, which was reserved to make sure there were enough computers. The teacher was in the room about once a week, to 'keep in touch' with his students and to give help if needed. In the first two weeks, students made some exercises in WebKF and attended a few lectures on land evaluation tools and models. Subsequently, students worked collaboratively to solve two open-ended problem cases: Alora and Wieringermeer. In the Alora case, students viewed the problem from a particular perspective (regional planner, local politician, tourism, citrus farmer) and they worked in a multidisciplinary team. In the Wieringermeer case, no roles were given. In both cases, students had to reformulate the problem first and then they had to solve the problem by using the models studied in the first two weeks. The problem-solving process was subsequently supported by subtasks, exercises and a planning schedule. First, students had to do subtasks and exercises individually; next, they had to respond to each other's contributions. Finally, they had to evaluate different problem solutions and make a shared decision about the best solution. The assessment was based on two tests that were done during the course. The tests consisted of a case, comparable to the open-ended cases solved in the CSCL-system. Participation and involvement in the course were also considered (33% of the assessment).

Except for the sequence of the two open-ended problem cases the design of the courses was exactly the same. From a questionnaire students filled in during the first week of the course (Appendix V), we know that across the years, comparable types of students participated in the study (according to their age, sex and prior knowledge and in terms of numbers of followed courses that were a prerequisite to participate in the Land Evaluation I course). For that reason, it is possible to combine the data collected in the two courses in one study to increase the number of students. In total, 13 undergraduate students were involved in the study. The course was meant for students from various disciplines. Three courses were recommended as prior knowledge. Three students (23%) followed the three recommenced courses, six students (46%) followed two of the three courses, four students followed one or none of the recommended courses (31%). In 1998 six students formed one group and in 1999 seven students formed one group. To all students CSCL was a new form of education and none of the students was familiar with WebKF. However, they were used to solving problems formulated in a case; either face to face or on paper.

Besides the three main research questions formulated in 5.2, in this Land Evaluation I study, we focus on the following specific research question: *What are the effects of working in a multidisciplinary group on students' participation, use of learning activities and knowledge* *construction in an asynchronous CSCL system?* In this study, the multidisciplinary groups were expected to participate to a larger extent and to construct more knowledge than groups not solving the case from different perspectives. Bielaczyc and Collins (1999) and Kirschner (2000) emphasised the meaningfulness of exchanging information and negotiation of ideas in multidisciplinary teams. Contradictory interests provoke students to share information and to negotiate ideas. In literature, no indication was found to assume that students in multidisciplinary teams would construct knowledge of better quality.

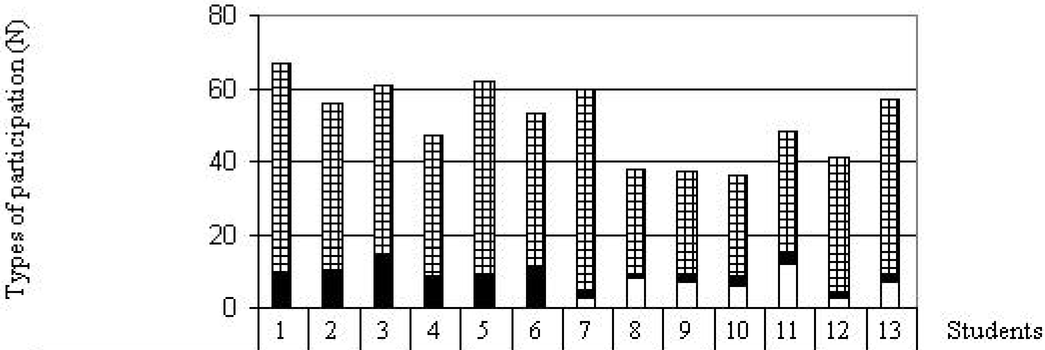
5.6.2 Results

We analysed the four views, which were meant to work out two different cases. Because of joining the results of the two groups, results are presented of two discourses: Alora and Wieringermeer. Alora and Wieringermeer were analysed separately because there was a specific role in Alora as opposed to the Wieringermeer case in which students did not argue from a certain perspective. A total of 118 notes were contributed in the Wieringermeer discourse, and 178 in the Alora discourse. Table 5.3 shows means and standard deviations split up into new, build-on notes and read notes. The views consisted of clusters of different sizes.

Table 5.3. Global overview of the two analysed views in the Land Evaluation I study (mean and standard deviation of new, build-on and read notes; cluster sizes)

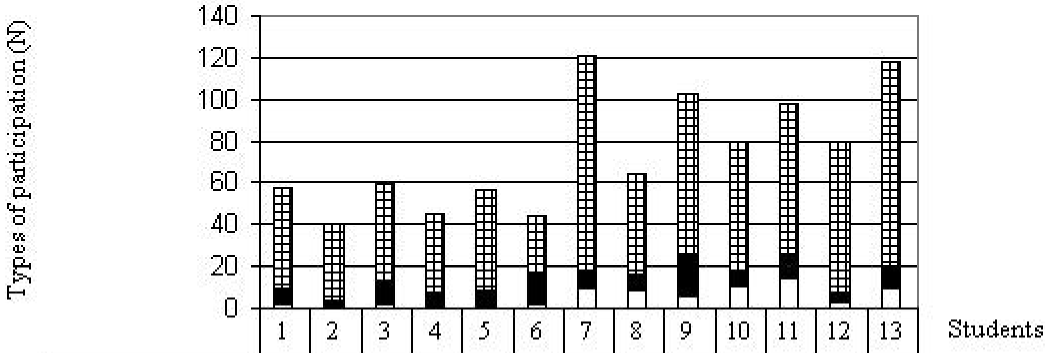
	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
Wieringermeer case (N=13)			22	10	4	0	0	0
New	3.53	4.05						
Build-on	5.54	4.58						
Read	41.90	10.60						
Alora case (N=13)			22	15	12	1	1	0
New	5.38	4.82						
Build-on	8.31	4.35						
Read	60.69	23.52						

Not surprisingly, in both cases students read more notes than they wrote. Although the students worked an equal period in both cases, they wrote 1.5 (178/118) as many notes in the Alora case compared to the Wieringermeer case. We see the same pattern in reading notes. Students read nearly 1.5 (789/545) as many notes in the Alora case as in the Wieringermeer case. The notes in Alora were organised in larger clusters. None of the clusters was larger than fourteen notes. Figure 5.9 shows the participation of each student in the Wieringermeer case. Figure 5.10 shows the participation of each student in the Alora case.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13
⊞ # read notes	58	46	47	39	54	42	56	29	28	28	33	37	48
■ # build-on notes	9	10	14	8	8	11	1	1	2	2	3	1	2
□ # new notes	0	0	0	0	0	0	3	8	7	6	12	3	7

Figure 5.9. Students' participation in the Land Evaluation I study (Wieringermeer case - no roles).



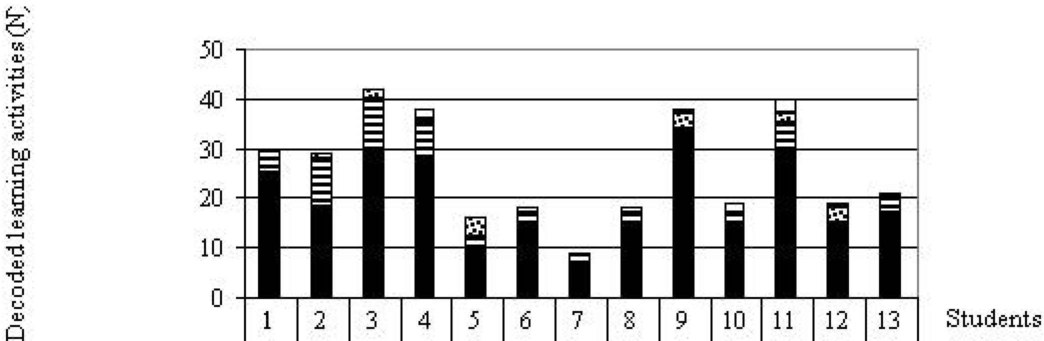
Students	1	2	3	4	5	6	7	8	9	10	11	12	13
⊞ # read notes	49	37	47	38	49	29	104	49	78	64	73	73	99
■ # build-on notes	7	2	10	7	8	13	7	6	19	5	11	4	9
□ # new notes	2	1	2	0	0	2	10	9	6	11	14	3	10

Figure 5.10. Students' participation in the Land Evaluation I study (Alora case - multidisciplinary team).

We see that each student read more notes than he/she wrote. However, the standard deviation of reading and writing is rather large. The minimum of read notes in Wieringermeer was 28; in Alora, the minimum of read notes was 29. The maximum number of read notes in Wieringermeer was 58; in Alora it was 104. Concerning the activity writing notes we see large differences in participation. In Wieringermeer, the minimum of written notes was 4 and the maximum was 15 notes (range=11). In Alora, the difference between the minimum and maximum number of written notes was even larger, 3 and 25 notes (range=22), consecutively. In Wieringermeer, 6 of the 13 students only wrote build-on notes as opposed to 2 of the 13 students in Alora. Overall, the figures show that students participated to a larger extent in the Alora case compared to the Wieringermeer case.

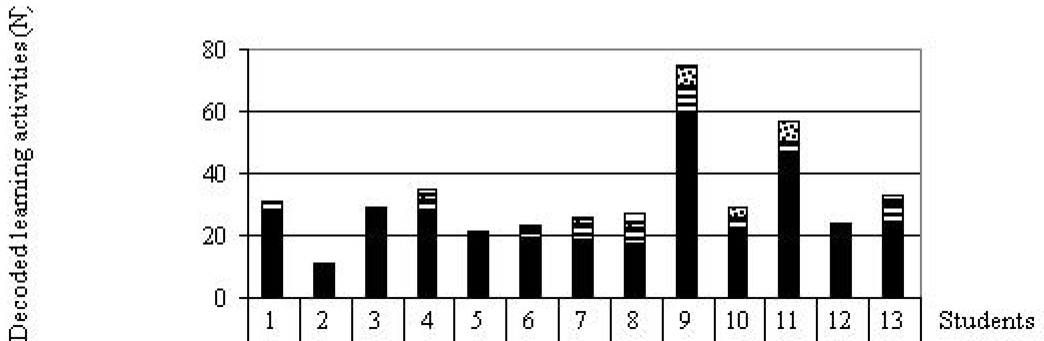
Again, density was calculated to gain insight into the extent of interaction between the students (see Appendix II for the case-by-case matrices). Density based on read notes was 1.0 in both cases and in both groups. This means that each student read at least one note of his or her fellow students in the group. The interaction among students in group 1 was highest in the Wieringermeer case, .67 against .45 in the Alora case (difference 0.22). In group 2, it was just the other way around, density in the Wieringermeer case was .19 against .60 in the Alora case (difference 0.41). As in the Agrification study, the extent of density and use of internal linking by students in the different groups correlated positively (Pearson: $r = .35$; $p < .10$). No correlation was found between type of case and density (Pearson: $r = .32$; $p =.11$).

Figure 5.11 shows the number of cognitive, affective and metacognitive learning activities per student in the Wieringermeer case. Figure 5.12 shows the use of these learning activities per student in the Alora case. In Wieringermeer, 337 meaningful units were decoded against 421 in Alora. It is striking that by far most of the activities were cognitive, namely 76% in the Wieringermeer case and 80% in the Alora case. Students were not busy regulating the task and they did not have social talks; they were solving the cases, focused on the content.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13
Rest	0	0	0	2	0	1	0	1	1	2	3	1	0
Affective	0	1	2	1	4	0	0	0	3	0	2	3	1
Metacognitive	5	10	10	7	2	2	2	2	1	2	5	1	3
Cognitive	25	18	30	28	10	15	7	15	33	15	30	14	17

Figure 5.11. Students' learning activities in the Land Evaluation I study (Wieringermeer case - no roles).



Students	1	2	3	4	5	6	7	8	9	10	11	12	13
Rest	0	0	0	2	0	1	1	3	1	0	0	0	2
Affective	0	0	1	2	0	1	2	2	6	4	7	1	1
Metacognitive	3	0	1	3	1	2	5	5	10	3	4	2	7
Cognitive	28	11	27	28	20	19	18	17	58	22	46	21	23

Figure 5.12. Students' learning activities in the Land Evaluation I study (Alora case – multidisciplinary team).

Figure 5.13 and 5.14 present the division of learning activities between the several subcategories per student working at the Wieringermeer case and the Alora case, consecutively. The columns show that the proportion of the subcategories between the two cases does not differ very much, the patterns are rather identical. As we have already shown in Figures 5.11 and 5.12, students used a large amount of cognitive activities. Focusing on these cognitive activities, we see in both cases that students were mostly debating compared to the activities using external information and internal linking. In the Wieringermeer case, 52% of all cognitive activities concerned debating activities against 54% in the Alora case. Besides, students often used their experiences or information found outside the database to elaborate on their ideas; 34% in the Wieringermeer case against 33% in the Alora case.

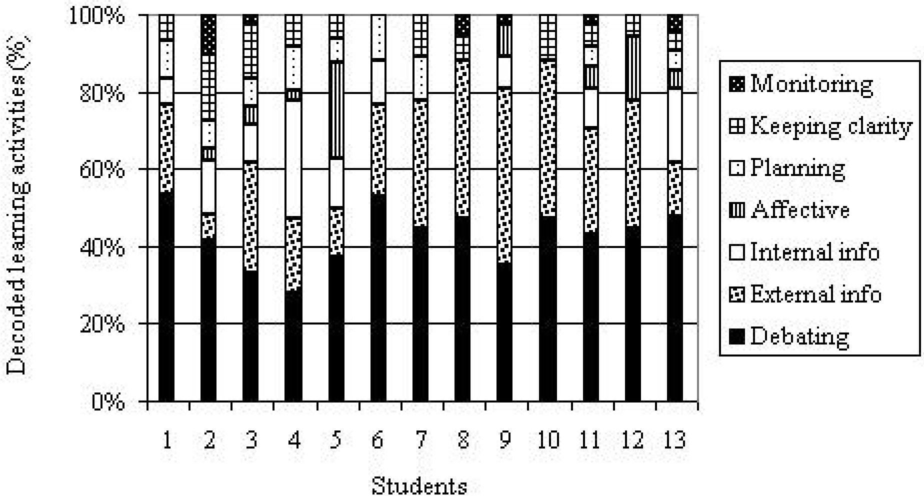


Figure 5.13. Students' learning activities in the Land Evaluation I study (Wieringermeer case - no roles) divided into subcategories.

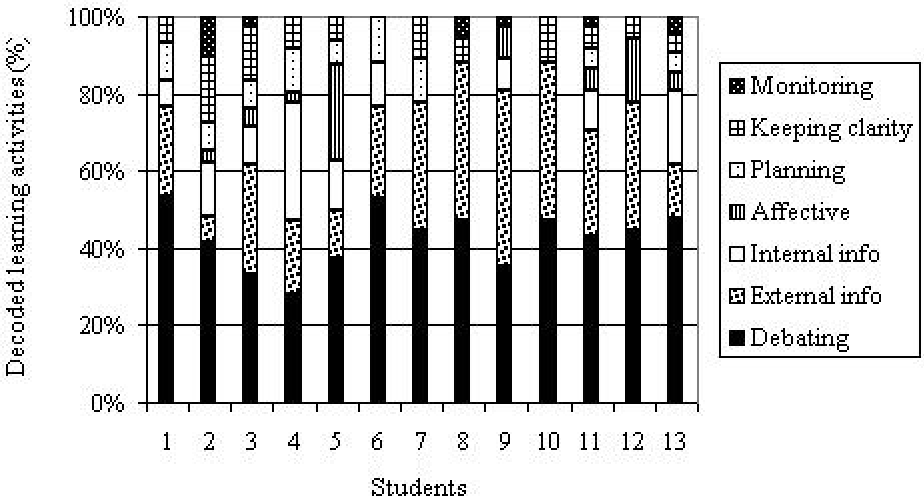
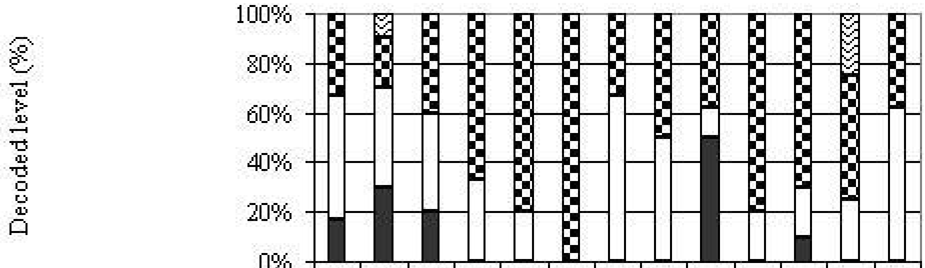


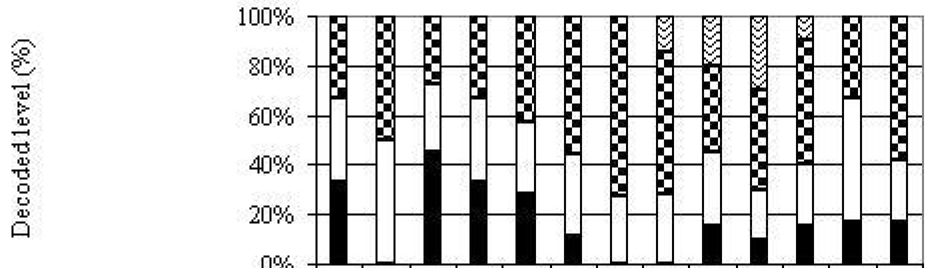
Figure 5.14. Students' learning activities in the Land Evaluation I study (Alora case - multidisciplinary team) divided into subcategories.

Figure 5.15 summarises the levels assigned to the selected meaningful units in Wieringermeer; 26% of the units were decoded against 31% in Alora (see Figure 5.16). Measured by our standard (see section 5.3), students in both cases constructed a reasonable amount of knowledge. Using the qualification developed by Biggs (1999), we see almost the same percentage of qualitative and quantitative units in both cases. In Wieringermeer 46% were decoded as qualitative and 54% as quantitative. In Alora these percentages were 47% and 53%, consecutively. Referring to our standard (section 5.3) this means that students in both cases constructed knowledge of high quality. Looking at the two groups, in both cases the quality of the constructed knowledge was equal, but in the case with using roles, students constructed more knowledge on average. Focusing on individual students, we see that a larger percentage of the students constructed knowledge on the highest level in Alora (77%) than in Wieringermeer (38%).



	Students	1	2	3	4	5	6	7	8	9	10	11	12	13
Low	D: Unistructural	0	1	0	0	0	0	0	0	0	0	0	1	0
↓	C: Multistructural	2	2	4	4	4	6	1	3	3	4	7	2	3
↓	B: Relational	3	4	4	2	1	0	2	3	1	1	2	1	5
High	A: Extended abstract	1	3	2	0	0	0	0	0	4	0	1	0	0

Figure 5.15. Quality of students' constructed knowledge in the Land Evaluation I study (Wieringermeer case - no roles) expressed as levels of understanding.



	Students	1	2	3	4	5	6	7	8	9	10	11	12	13
Low	D: Unistructural	0	0	0	0	0	0	0	1	4	3	2	0	0
↓	C: Multistructural	3	1	3	2	3	5	8	4	7	4	10	2	7
↓	B: Relational	3	1	3	2	2	3	3	2	6	2	5	3	3
High	A: Extended abstract	3	0	5	2	2	1	0	0	3	1	3	1	2

Figure 5.16. Quality of students' constructed knowledge in the Land Evaluation I study (Alora case - multidisciplinary team) expressed as levels of understanding.

To check whether the differences found between the two groups were significant, the two groups were compared on participation, use of different types of learning activities, amount of knowledge construction and quality of the knowledge constructed (see Table 5.4).

Table 5.4. Participation, learning activities and amount and quality of constructed knowledge in the two cases

	Wieringermeer (N=13) Mean	SD	Alora (N=13) Mean	SD	T (df=24)	p-value
Participation						
# Written notes	9.00	3.16	13.69	6.86	2.21	.04*
# New notes	3.54	4.05	5.38	4.82	1.06	.30
# Build-on notes	5.46	4.65	8.31	4.35	1.58	.13
# Read notes	41.92	10.60	60.69	23.51	2.62	.02*
Learning activities						
Cognitive activities	19.77	8.42	26.00	12.71	1.52	.14
Debating	10.31	3.71	14.08	7.00	1.72	.10
External information	6.69	4.33	8.54	3.18	1.24	.23
Internal information	2.77	2.98	3.38	3.96	0.57	.58
Metacognitive activities	4.00	3.19	3.54	2.73	-0.40	.70
Planning	1.46	1.33	1.62	1.56	0.27	.79
Keeping clarity	1.92	1.80	1.61	1.32	-0.50	.62
Monitoring	0.62	0.31	0.31	0.63	-1.03	.31
Affective activities	1.31	1.38	2.08	2.25	1.05	.30
Knowledge construction	6.69	2.32	10.00	5.2	-2.10	.05*
Levels						
Level A (high)	0.85	1.34	1.77	1.48	1.664	.11
Level B	2.23	1.48	2.92	1.32	1.258	.22
Level C	3.46	1.66	4.54	2.70	1.226	.23
Level D (low)	0.15	0.38	0.78	1.36	1.569	.13

As shown in table 5.4 active as well as passive participation in the group with roles, Alora, was significantly higher than in the group without roles, Wieringermeer (p=.04 and p=.02, consecutively). Besides, the two groups differed significantly in the amount of constructed knowledge (T=-2.10; p≤.05). When students had to solve the problem from a specific perspective defending their importance, they constructed more knowledge than in the case without having a specific role. Concerning learning activities and level of understanding no significant differences were found.

5.6.3 Conclusions and discussion

As expected, students in the Alora case (multidisciplinary team) participated more than in the Wieringermeer case (without roles), namely 1.5 times as much. Each student was actively involved in the course. However, the standard deviation of reading and writing was rather large. Concerning the proportion of reading and writing notes, no differences were found between the two cases. Thus, having a role seems to stimulate the extent of participation. In 1998, Alora was the first case students had to work at; in 1999, Alora was the second case. Therefore, it cannot be a kind of 'warming-up effect' which explains the difference in participation. Furthermore, the same students participated in both cases and therefore student characteristics cannot explain the difference found. In the evaluation, Students said that having a role invites them to discuss. It was necessary to share information and motivating to solve the problem as a multidisciplinary team. However, no (Pearson) correlation was found between type of case and density. On average, density in the multidisciplinary groups was higher than density in the groups without roles.

Concerning the third research question we have to conclude the following: little time was wasted on regulating the execution of the tasks and little time was lost because of technical problems. Students produced many cognitive units (78% on average in two cases): they were solving the cases, focused on the content. They were not busy regulating the task. Because of formulating clear learning goals, presenting a clear design of the course, giving a planning schedule and supporting the solving process by subtasks there was no need to regulate. Besides, students did not have social talks. In both cases, students wrote few affective notes. Mostly, students worked in the same room. The social atmosphere was very pleasant; students were helpful and friendly to each other. They regularly had a coffee break together and then they talked socially. We assume therefore that it was not necessary to write much affective notes.

The large amount of cognitive units resulted into knowledge of high quality (main research question 3). However, the amount of constructed knowledge was reasonable; on average, 29% of all units contained expressions of knowledge construction. Although the groups did not differ in the use of different types of learning activities, the two groups differed as expected in the extent of knowledge construction. Students in the multidisciplinary teams constructed more knowledge than students in teams without roles. Apparently, sharing information and negotiation of knowledge does not automatically imply a growing number of notes sent to each other.

To sum up: in both cases, the proportion of learning activities used between the two cases was comparable, but in the cases with roles students participated to a larger extent, which resulted into more knowledge. The factor of having different roles did not affect he quality of the constructed knowledge.

In our opinion, CSCL was implemented successfully in the Land Evaluation I course. Students were enthusiastic about using WebKF and motivated to work on the tasks. In the evaluative questionnaires, students praised the course. It was clear what was expected of them and how the course was designed. They were also positive about the use of WebKF. It was simple to use the system and students found it also useful to share ideas and to build knowledge together. "Working collaboratively results into more ideas than working alone", "It is interesting to read other students' ideas. In other courses we do not know very well what fellow students think", "It is motivating to see that other students are also working on the task; sometimes I was on WebKF even in the weekends!". Students found the course rather time intensive, but not too hard. Students said they learned a lot and all students finished the course with good marks (mean on a 10-point scale = 7.6). In addition, the teacher was satisfied; as the teacher of Agrification, the teacher of Land Evaluation I also used WebKF for three successive years.

5.7 Study 3: Psychology

First, this section will describe the methods of the Psychology study. Next, section 5.7.2 will present the results sequenced by the main research questions: participation/interaction, use of learning activities, and the amount and quality of the constructed knowledge. Besides, this section will pay attention to a specific research question focusing on the relation between students' learning style on the one hand and learning in a CSCL-system on the other. Next, results will be discussed and conclusions drawn about the use of the CSCL-system in this course.

5.7.1 Method

In November 1998 the twelve-week course "Psychology of the teaching and learning process" (Psychology) started at the University of Nijmegen (KUN). Students were expected to spend about twenty hours on the course weekly. It concerned a regular course, which resulted in a larger number of students compared to the optional courses Agrification and Land Evaluation I: 24 undergraduate students participated in the Psychology course. The following learning objectives were formulated: sharpening educational ideas, practising CSCL, and writing an educational management report in collaboration with fellow students. In this course, students were also informed about the design of the course, the use of WebKF, and the idea of CSCL. The course could be subdivided into two phases. In the first phase students studied specific educational subjects (recent theories, instructional models, the learning process, applied active instruction one and two, the teacher as a coach, the learner, and self-reflection). For each subject a separate view was created; a so-called perspective view. At first, no groups were formed; students were free to visit and participate in the eight views. Because of a flow of notes in the first week resulting in ill-structured views, it was decided to divide the students into small groups (1 * 5 students; 2 * 6 students; 2 * 8 students; 1* 10 students; 1* 12 students; 1* 15 students), by using the jigsaw method (see for example Erkens, 1997). Notice that students discussed in more than one view. After two weeks of 'brainstorming' and contributing own ideas and theories on WebKF, students were asked to write a collective publication note based on a summary of the notes in the different views. Based on that summary, students were expected to formulate a research question and to describe the approach they would follow to answer their question. The first phase of the course took 6 weeks in total. During the last six weeks, students worked on the final task in subgroups. The final task was to write an educational management report to advise a school on how to implement and how to use ICT in their education. Different persons of each perspective group formed the subgroups (1 * 2 students; 2 * 3 students; 4 * 4 students). Students had to use WebKF to work at the task. During the course, nine meetings were organised in order to coach the students' learning processes. Progress, problems and plans were discussed in these meetings. Students could also ask for more information about a subject. A traditional lecture was given only twice. The assessment was based on the written management reports. One mark was given to all group members. Participation and involvement in the course were also considered (rounding off the mark).

Besides answering the main research questions we will answer the following specific question: *What is the relationship between students' learning style on the one hand and students' participation, learning processes and knowledge construction in an asynchronous CSCL-system on the other hand?* Therefore, students were asked to fill in part of the Inventory of Learning Styles (Vermunt, 1992) (Appendix IV). In this third study no correlations were expected between students' learning style and their participation. Concerning the content of their written contributions, we expected students scoring high on the scale meaning-directed learning style to debate more and construct more knowledge than students scoring low on this scale. The category debating of the coding scheme refers to cognitive activities such as asking content-related questions, checking information, presenting ideas, elaborating on these ideas, and giving feedback. We thought students with a meaning-directed learning style would attach importance to use these kinds of activities because they use deep processing strategies and view learning as knowledge construction. Another expectation was that students scoring high on the scale reproduction-directed learning style would construct knowledge of a lower quality than students who scored low on this learning style. Students scoring high on the application-directed learning style were expected to use more metacognitive learning activities than students who did not score high on this learning style, because of their use of concrete processing strategies. We thought they wanted to know precisely how to use the acquired knowledge to execute the task and that was expected to trigger the use of metacognitive regulation strategies.

5.7.2 Results

The data were analysed according to the two phases: the brainstorming/deepening phase (week 1-6) and the writing phase (week 7-12). We decided not to split the results per group, because in the first phase groups were especially formed because of practical reasons (preventing chaos) and not because of sharing expertise. Students did not have to solve a problem collaboratively as in the first two studies. Additionally, students did not visit their 'own' view strictly, but also had a look at other views. In the second phase we did not find it meaningful to split the results of the small groups, either. Notice that we left one view out of the analyses, namely the publication view. Notes in this view were prepared in the eight perspective views and they were copied and pasted from a perspective view. To prevent double counting we left this view out.

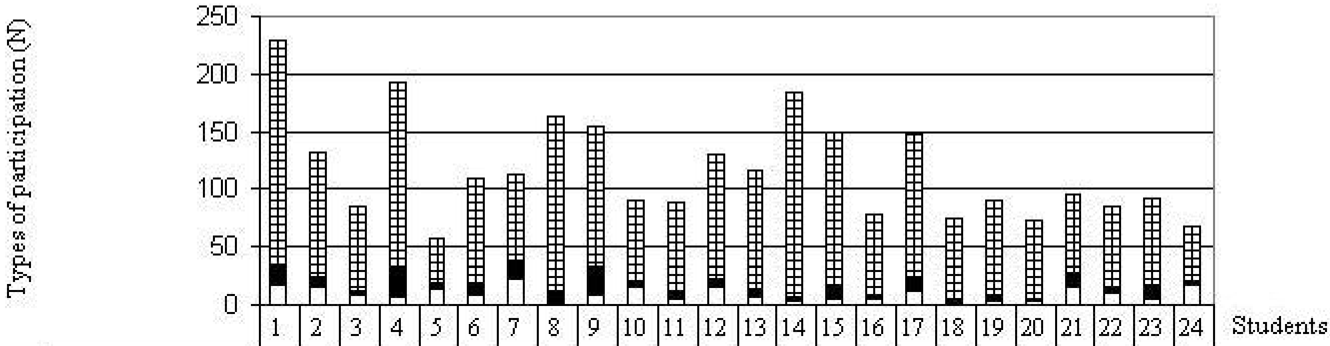
Table 5.5. Global overview of the 15 analysed discussions in the two phases of the course Psychology (mean and standard deviation of new, build-on and read notes; cluster sizes)

	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
Phase 1 (N=24)			39	20	5	9	4	3
New	9.58	5.94						
Build-on	7.25	6.34						
Read	99.92	41.01						
Phase 2 (N=24)			52	5	1	1	0	0
New	3.33	5.20						
Build-on	0.46	1.14						
Read	17.13	12.57						

As shown in Table 5.5, students' participation differed a lot in the two phases. In the first phase of the course, the mean of written notes was 16.83 notes as opposed to the second phase in which students only wrote 3.79 notes on average. As a consequence, fewer notes were read in the second phase, as well 17.13 notes on average against 99.92 in the first phase.

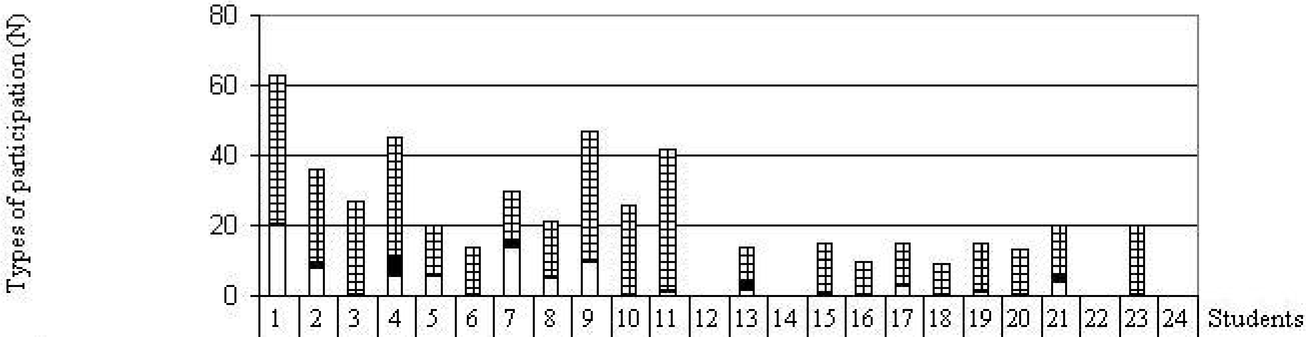
As shown in Figures 5.17 and 5.18 all students except one used build-on notes in the first phase; in the second phase only five students (=21%) used build-on notes. Four students even did not participate in WebKF at all; eight of the participating students only read notes. Furthermore, the standard deviation of new, build-on and read notes was high (5.94, 6.34 and 41.01 in phase 1 and 5.20, 1.14 and 12.57 in phase 2, consecutively) which indicates a large difference between students.

Looking at the cluster size in the two phases, we see a large number of isolated notes in the second phase; 88% of all clusters consisted of single, isolated notes. In the first phase, this percentage was 49%. Furthermore, in the first phase there were rather long threads of 10 to 14 notes or even more than 14 notes, in contrast to the second phase in which the largest cluster contained $7 \leq 9$ notes.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
⊞ # read notes	197	110	75	163	41	94	76	153	123	71	77	111	104	178	135	71	126	72	84	70	69	72	77	49
■ # build-on notes	15	6	2	22	3	6	13	10	24	4	6	5	6	2	9	1	10	1	4	0	11	3	10	1
□ # new notes	18	16	8	7	14	9	23	1	8	15	5	15	7	4	6	6	12	2	3	3	15	10	5	18

Figure 5.17. Students' participation in the Psychology study (phase 1).



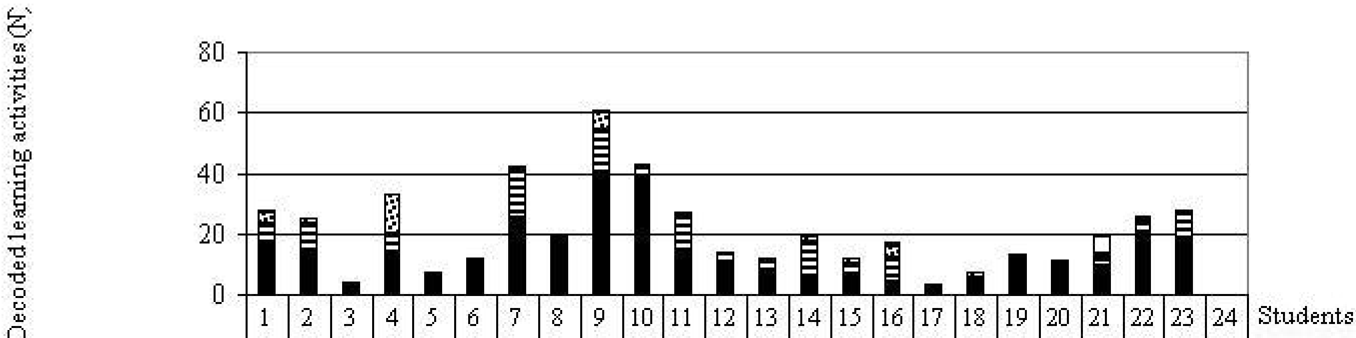
Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
⊞ # read notes	43	27	27	34	14	14	15	16	37	26	41	0	10	0	15	10	12	9	14	13	14	0	20	0
■ # build-on notes	0	1	0	5	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0
□ # new notes	20	8	0	6	6	0	14	5	10	0	1	0	2	0	0	0	3	0	1	0	4	0	0	0

Figure 5.18. Students' participation in the Psychology study (phase 2).

To calculate density, case-by-case matrices were created for both phases. The four case-by case matrices (see Appendix II) were based on the notes read by students and the notes linked between the students in the same phase. Although students did not work in one group but in several views, results were combined again because of our interest in the difference between the two phases. Density based on read notes was .88 in the first phase of the course. In other words, 88% of all students read at least one note of a fellow student. Concerning the second phase, density was much lower, namely .34. Density based on linked notes was .22 and .03 in the first phase and second phase, consecutively.

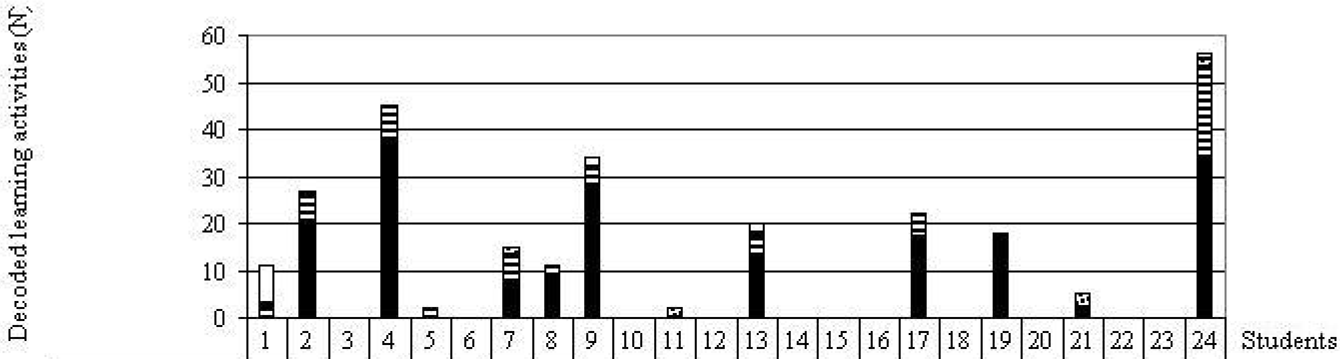
Comparable to the two studies described above, these are not very dense interactions. Again, density and use of internal linking correlated positively (Pearson: $r = .60$; $p < .00$).

Figure 5.19 summarises the decoded learning activities of students in phase 1; Figure 5.20 summarises students' learning activities in the second phase of the course. Concerning the first phase, a total of 483 units were decoded with the coding scheme. This resulted in 64% cognitive, 25 % metacognitive and 9% affective activities; 2% of the units were decoded as rest activities. The second phase differed in absolute number of learning activities produced; 268 units were decoded. Relatively speaking we see a pattern comparable to that of the first phase: 68% of these units were decoded as cognitive, 22% as metacognitive and 4% as affective; 6% of the units was decoded as a rest activity. In the second phase, it is striking that 54% of all students did not use cognitive, affective or metacognitive learning activities at all.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
□ Rest	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	6	1	0	0
⊠ Affective	4	2	0	13	1	0	1	0	6	1	1	0	1	2	2	4	1	2	0	1	1	1	1	0
⊟ Metacognitive	6	9	1	6	2	0	16	0	14	3	12	4	4	11	4	8	0	0	0	1	3	4	10	0
■ Cognitive	17	14	3	14	3	12	25	20	40	39	14	10	7	6	6	4	2	5	13	9	9	20	17	0

Figure 5.19. Students' cognitive, metacognitive and affective learning activities in the Psychology study (phase 1).



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
□ Rest	8	1	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1
⊠ Affective	1	0	0	0	0	0	2	0	0	0	2	0	1	0	0	0	0	0	0	0	3	0	0	2
⊟ Metacognitive	2	6	0	8	2	0	6	2	4	0	0	0	4	0	0	0	5	0	0	0	1	0	0	19
■ Cognitive	0	20	0	37	0	0	7	9	28	0	0	0	13	0	0	0	17	0	17	0	1	0	0	34

Figure 5.20. Students' cognitive, metacognitive and affective learning activities in the Psychology study (phase 2).

Figures 5.21 and 5.22 present an overview of the subcategories within the three main categories of the learning activities. With regard to phase 1, we see that on average 41% of the cognitive activities referred to debating activities, 36% to the use of external information and 24% to linking or repeating internal information. In the second phase, the percentages of debating, use of external information, and linking or repeating internal information (as proportion within cognitive activities) were 36%, 55% and 9% consecutively, on average per student. Within the category metacognitive activities the mean percentages of subcategories were as follows: 43% planning, 32% keeping clarity, 25% monitoring activities (phase 1) and 73% planning, 17% keeping clarity, and 10% monitoring activities (phase 2).

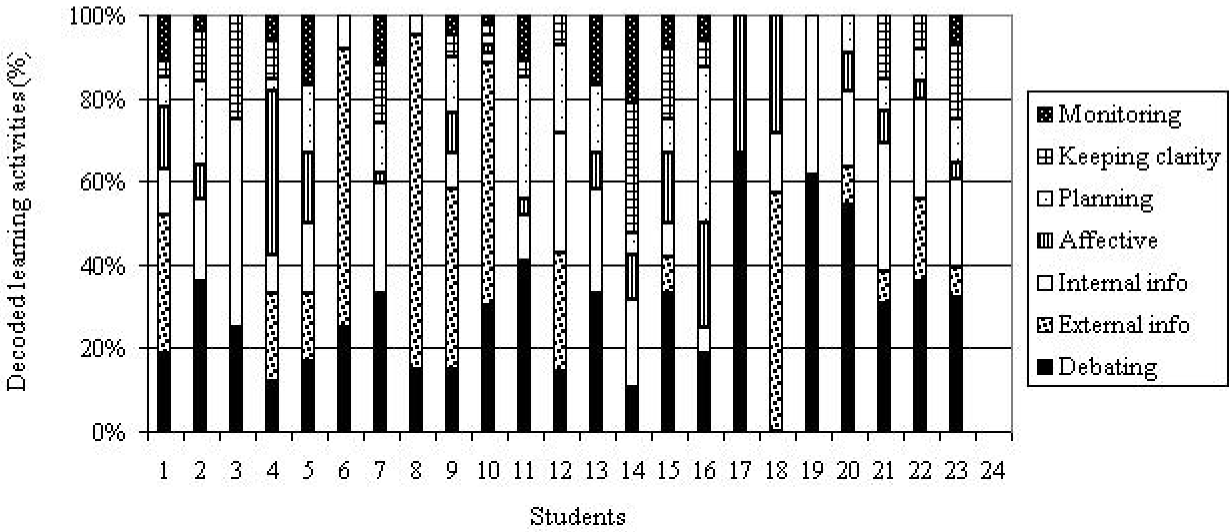


Figure 5.21. Students' learning activities in the Psychology study subdivided into subcategories (phase 1).

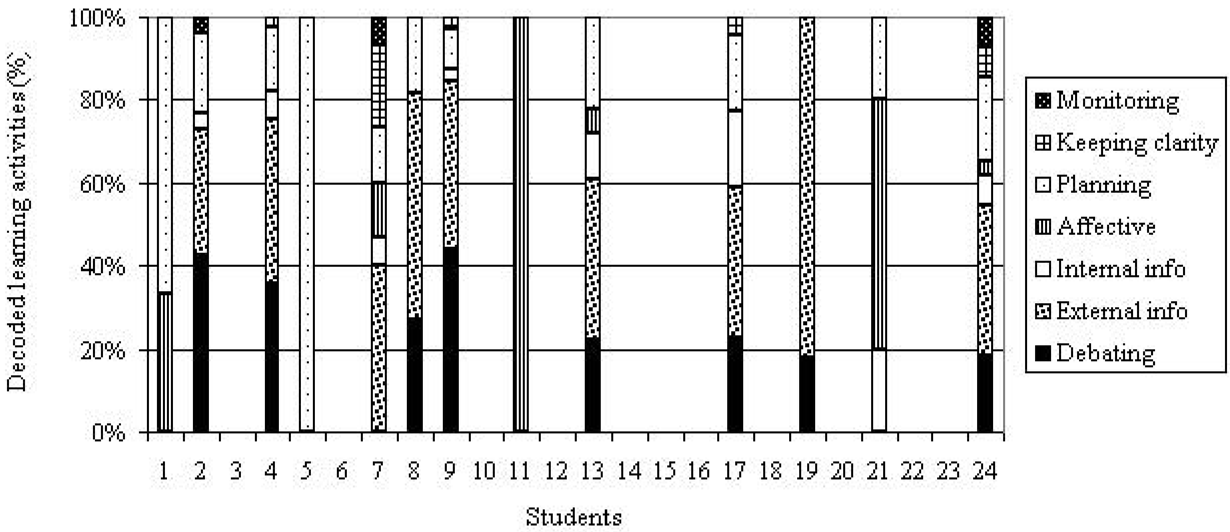
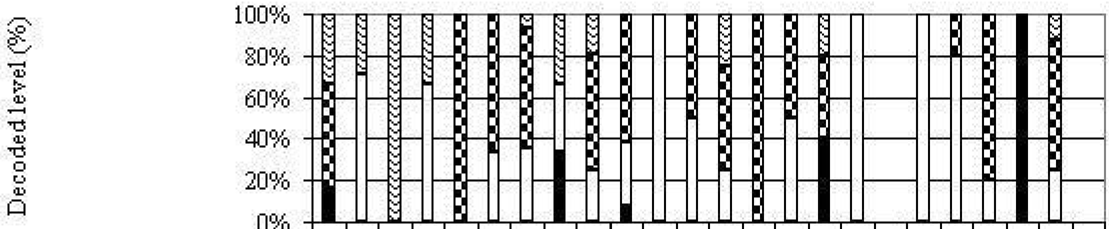


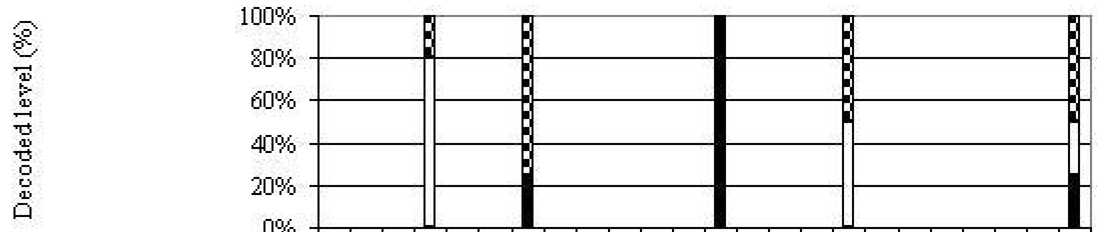
Figure 5.22. Students' learning activities in the Psychology study subdivided into subcategories (phase 2).

With regard to knowledge construction we see a strong difference between the two phases. In the first phase knowledge was constructed in 24% (114) of the units; in the second phase only 6% (16) of the units comprised expressions of knowledge construction. Although in the first phase more expressions of knowledge were produced on average per participating student than in the second phase (difference 3.95), measured to our standard, in both phases little knowledge was constructed. In the first phase, 22 students were responsible for this constructed knowledge, in the second phase only five students (see Figures 5.23 and 5.24). 41% and 56% of these units were assessed to be qualitative, consecutively. Therefore, by our standard the quality of the constructed knowledge was considered to be reasonable in the first phase and high in the second phase.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Low ↓ D: Unistructural	2	2	1	1	0	0	1	1	3	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0
C: Multistructural	3	0	0	0	4	2	8	0	9	8	0	1	2	2	2	2	0	0	0	1	4	0	5	0
B: Relational	0	5	0	2	0	1	5	1	4	4	3	1	1	0	2	0	1	0	3	4	1	0	2	0
High A: Extended abstract	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	2	0	0

Figure 5.23. Quality of students' constructed knowledge in the Psychology study (phase 1), expressed as levels of understanding.



Students	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Low ↓ D: Unistructural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C: Multistructural	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
B: Relational	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
High A: Extended abstract	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Figure 5.24. Quality of students' constructed knowledge in the Psychology study (phase 2), expressed as levels of understanding.

To measure the relationship between students' learning style on the one hand and students' participation, use of learning activities, and amount and quality of knowledge constructed in a CSCL-system on the other hand (specific research question), a Pearson correlation test was executed. Therefore, the results of the two phases were combined. Twenty students filled out the Inventory of Learning Styles (response = 83%). Figure 5.25 shows students' individual mean scores on the four learning styles. Students' learning styles tended towards the application-directed and meaning-directed style (Vermunt, 1998). However, according to the scores on the ILS, most students did not have an explicit learning style and scored average on all styles. The reproduction-directed learning style correlated significantly with the undirected learning style ($r=.59$; $p < .01$). The application-directed learning style correlated significantly with the meaning-directed learning style ($r=.68$; $p < .01$). The learning styles were derived from composition scores on the dimensions within the cognitive processing strategies (deep, stepwise and concrete processing), regulation strategies (self-regulation, external regulation and lack of regulation), students' mental models of learning (memorising, building, applying, stimulating and collaborative learning) and their learning orientations (profession, personal interest, certificate, test, and ambivalent) (Vermunt, 1992). The scores on the four learning styles were corrected for the number of items per scale.

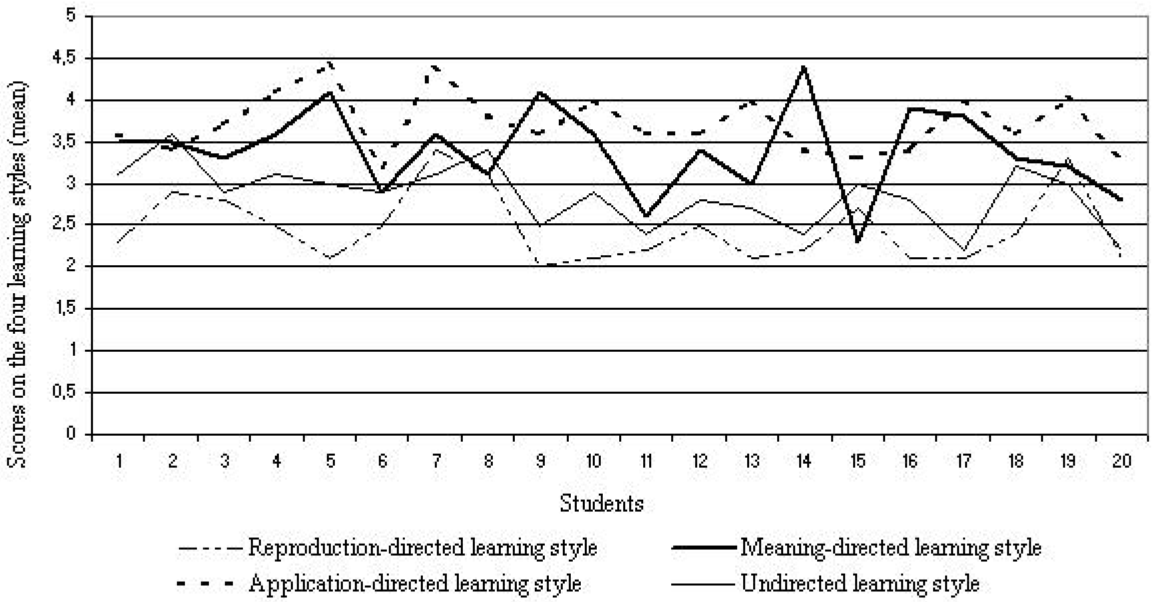


Figure 5.25. Students' individual mean scores on the four learning styles (corrected for number of items).

No correlations were found between students' learning style and their participation [($r_{reproduction\text{-}directed,read}=.16$; $p=.52$), ($r_{reproduction\text{-}directed,\ write}=.08$; $p=.78$), ($r_{application\text{-}directed,\ read}= -.15$; $p=.54$), ($r_{application\text{-}directed,\ write}=.24$; $p=.32$), ($r_{meaning\text{-}directed,\ read}=-.08$; $p=.75$), ($r_{meaning\text{-}directed,\ write}=.28$; $p=.23$), ($r_{undirected,\ read}=-.07$; $p=.78$) and finally ($r_{undirected,\ write}=.26$; $p=.27$)]. Between students' learning style and their learning activities as well as the quality of their notes, a few correlations were found (see Table 5.6).

Table 5.6. Significant correlations between students' learning style and students' learning activities and decoded levels

Learning styles ILS Categories coding scheme	Reproduction-directed	Meaning-directed	Application-directed	Undirected
Cognitive				
Debating				
External information				
Internal information				
Affective				
Metacognitive			.57**	
Planning				
Keeping clarity		.54*	.62* *	
Monitoring			.79* *	
Knowledge construction Levels				
Level A (high)				
Level B				
Level C		.59*		
Level D (low)				

* Correlation is significant at the .05-level; ** Correlation is significant at the .01-level.

First, we will return to the correlations expected beforehand. A correlation was expected between the scores on the meaning-directed learning style on the one hand and the number of used debating units and the amount of knowledge construction on the other hand. Furthermore, we expected that students scoring high on the reproduction-directed learning style would construct knowledge of a lower quality than the students who did not score high on this style. The final expectation was that students scoring high on the application-directed learning style would use more metacognitive learning activities than students who scored low on this style. Only the last expectation was confirmed. Indeed, a positive correlation was found between students' score on the application-directed learning style and their use of metacognitive activities ($r=.57$; $p<.01$). Within the category metacognitive activities, the application-directed learning style correlated positively with the subcategories monitoring and keeping clarity ($r=.79$; $p < .01$ and $r=.62$; $p < .01$, consecutively). The score on the meaning-directed learning style and the activity keeping the discussion clear correlated positively as well ($r=.54$; $p < .05$). This learning style also correlated with units decoded as level C. The undirected learning style correlated with none of the learning activities or decoded levels. Because of the lack of explicit learning styles of most students, it was decided to execute the Pearson correlation test on the level of scales as well. Table 5.7 shows the significant results of this test.

Table 5.7. Significant correlations between scores on the scales of the ILS and students' learning activities and decoded levels

	Cognitive Processing			Regulation			Model of learning/ knowledge					Learning orientation				
Dimensions ILS / Categories coding scheme	Deep	Stepwise	Concrete	Self	External	Lack of	Memorising	Building	Applying	Stimulating	Collaborative	Profession	Personal	Certificate	Test	Ambivalent
Cognitive											.48*					
Debating		-.46*														
External information											.51*					
Internal information						-.77**										
Affective	.47*										.47*	.45*				
Metacognitive	.56*		.46*												.44*	
Planning						-.48*					.48*					
Keeping Clarity	.51*		.55*													
Monitoring						-.46*									.46*	.70**
Knowledge Construction	.50*															
Level A (high)																
Level B																
Level C	.54*				.54*											
Level D (low)			.46*													

* Correlation is significant at the .05-level; ** Correlation is significant at the .01-level.

In general, correlations on all three kind of learning activities were found, but most correlations concerned metacognitive learning activities. Looking at the sixteen scales of the learning styles, most (positive) correlations were found with regard to the scores on the scales collaborative learning and deep processing. Students who attached importance to collaborative learning wrote more cognitive units ($r=.48$; $p < .05$), especially contributing external information ($r=.51$; $p < .05$); they also wrote more affective units ($r=.47$; $p < .05$) than students who scored low on the scale collaborative learning. Furthermore, these students were busy planning ($r=.48$; $p < .05$) in contrary to students who lacked on regulation; they correlated just negatively ($r= -.48$; $p < .05$) with the planning activity. The cognitive processing strategy concrete correlated with the metacognitive activity keeping clarity ($r=.55$; $p < .05$). This positive correlation was also found with regard to the cognitive strategy deep processing ($r=.51$; $p < .05$). Students who scored high on the scale deep cognitive processing were more busy keeping the discussion in the database clear than students who scored low on this scale. Although we did not find the expected correlation between the meaning-directed learning style and knowledge construction, we found a positive correlation between the scale deep cognitive processing (part of the meaning-directed learning style) and amount of knowledge construction. Students who scored high on the scale deep cognitive processing constructed more knowledge than students who scored low on this scale ($r=.50$; $p < .05$). Students who are used to learning stepwise correlated negatively with the amount of debating units ($r=-.46$; $p < .05$). There were no correlations between the category learning orientation and cognitive activities. Only students who scored high on the scale profession-oriented, correlated positively with the number of affective units ($r=.45$; $p < .05$) in their notes. Students who scored high on the scale test-oriented wrote more metacognitive units ($r=.44$; $p < .05$) than students who did not score high on this scale. These metacognitive activities especially concerned monitoring ($r=.46$; $p < .05$). A strong relation also consisted between monitoring and the learning orientation ambivalent ($r=.70$: $p < .01$).

Concerning quality of knowledge, only some correlations were found with the dimensions cognitive processing and regulation. Students with a high score on the scale deep processing wrote more units on level C than students with a low score on cognitive processing ($r=.54$; $p < .05$). Concrete cognitive processing correlated positively with units on level D ($r=.46$; $p < .05$). Finally, a positive correlation consisted between scores on the scale self-regulation and units decoded as level C ($r=.54$: $p < .05$).

5.7.3 Conclusions and discussion

The first main research question concerned students' participation and interaction in the used CSCL-system, WebKF. The results showed a strong difference in participation between the two phases. In phase 1 of the course, students were rather active; on average students wrote 4.4 as many notes as in phase 2 and they read 5.8 as many notes. Both phases took six weeks and thus the period cannot explain the difference in participation. Besides, the students were the same, although the composition of the groups had changed. However, each group differed in participation in the way described above and there is no reason to assume that group composition affected the number of read and written notes. These two phases were distinguished because of the different tasks, brainstorming and writing a report, and we assume that the nature of the task determined the strong difference in participation between the two phases. The difference between the two phases can be summarised as follows: in the first phase students learned collaboratively, in the second phase students worked co-operatively. With co-operative working, we mean that students divided the task into subtasks. The report was divided into parts, for example the introduction, the theoretical background, suggestions and the conclusion. Each student was responsible for a part and one student took care of the lay-out and put the document on the forum. The density of the interaction confirms this idea. In the first phase, density based on read notes was .88; density based on read notes in the second phase was much lower, namely .34. Apparently, in the beginning of the course, students were interested in each other's contributions, but during the course, their interest decreased with their participation. In both phases, density based on written linked notes was low, compared to the studies described above. In the first phase, 22% of all students linked at least one note to a fellow student (density= .22). In the second phase, density was extremely low, namely .03.

Looking at the learning activities (main research question 2), we see that students hardly differed in the proportion of types of main learning activities used (cognitive, affective, and metacognitive). Within these main categories, the difference in planning activities is most remarkable, 43% of all metacognitive activities in phase 1 were decoded as planning activities against 73% in the second phase. In the second phase, planning activities especially concerned issues such as reaching agreement about dividing the task. Overall, students did not differ very much in the use of different

types of learning activities. However, from experience we know that the use of WebKF was rather different in both phases. Analysing the contributions on amount and quality of knowledge construction (main research question 3) illustrates the difference. Therefore, this study emphasises the importance of step three of the methods used to analyse CSCL-data in this PHdissertation.
In our opinion, WebKF was not used as intended in phase 2. It is not surprising that in phase 2 little knowledge was constructed. Of course, it cannot be excluded that students constructed more knowledge during the course, but if so, the knowledge was not constructed in WebKF, which was not what we aimed at. Although students constructed little knowledge, the quality of the knowledge constructed in the second phase was high. Students placed parts of the report, which they had thought about and worked out thoroughly, on the forum. In the first phase, students constructed much more knowledge than in the second phase (a total of 114 units and 16 units, consecutively). However, measured by our standard, the amount in both phases was assessed to be little (main research question 3). As we have mentioned before, both phases took six weeks and the same students participated in both phases. Apparently, the first task triggered students better to construct knowledge than the task in phase 2. Student put their ideas with regard to the given subjects (recent theories, instructional models, the learning process, applied active instruction one and two, the teacher as a coach, the learner, and self-reflection) on WebKF, reacted to contributions, gave counter-arguments, used information found elsewhere and so on. However, the quality of the knowledge constructed in the first phase was assessed to be reasonable. It is true that students placed more notes than in the second phase, but in this phase, students did not elaborate their ideas very thoroughly.

The added specific research question concerns the relationship between students' learning style on the one hand and students' participation, learning processes and knowledge construction in an asynchronous CSCL-system used in this course on the other hand. No correlations were found between students' learning style and their participation. Furthermore, the reproduction-directed learning style and the undirected learning style did not correlate with learning activities or knowledge construction, either. The meaning-directed and application-directed learning styles correlated with some metacognitive learning activities. Because of the lack of explicit learning styles of most students, Pearson correlation tests were also executed on the level of scales. There, the results showed a number of interesting correlations. Below, we will discuss some of the correlations we found. In our opinion, the most interesting correlation found is the correlation between the scale deep processing and the amount of constructed knowledge. Students scoring high on the scale deep cognitive processing constructed more knowledge than students scoring low on this scale. Deep processing means that students search for relations within subject matter and relations between the subject matter. Students using a deep learning strategy try to create a general impression of the subject matter by restructuring separate parts. A third part of this scale is thinking critically while reading information, views and ideas (Vermunt, 1992). Besides, the scale deep processing correlated positively with affective and metacognitive activities (keeping clarity, monitoring).

Students with a high score on the meaning-directed learning style were busy keeping the database clear. We interpret this correlation by the idea that students who are directed at getting meaning want to understand what the communication is about and therefore, keeping the database clear will help them to understand what is going on. We interpret the correlation between the application-directed learning style and the amount of metacognitive activities as follows. Students

with this style have much characteristics of the strategy concrete processing (Vermunt, 1992). In WebKF these students wanted to know what they had to do, how they could execute the task and how the knowledge was usable; in other words, they monitored the learning process (see also Table 5.7).
An interesting correlation on scale level was the relation between student's preference to learn collaboratively and the cognitive activities (especially external information), affective activities and planning. It seems that students who like collaborative learning are more involved in the CSCL-process and put more effort in executing the task than students who do not attach importance to learning in a group. Other interesting correlations were found between the scale lack of regulation and the activities internal information, planning and monitoring. These three correlations were significantly negative. Students who have difficulty with regulating their learning process in more traditional education also seem to have problems regulating their learning process in a CSCL-system. Students scoring high on the scale lack of regulation contributed less plans and monitored the original planning, aim or time schedule less than students who scored low on this scale. Students scoring high on the scale lack of regulation hardly linked information within the database, either. In other words, they did not refer much to other students' notes and did not link facts, ideas or remarks read elsewhere in the discourse. Our conclusion is that students not being self-regulated or not being accessible to external regulation will have difficulty to learn by CSCL. However, those students will have problems in other forms of education, too.

To summarise: In the Psychology study, the task was very relevant for succeeding in or failing the course. Using WebKF in the second phase of the course was not successful. Writing a collective report did not stimulate collaborative knowledge construction. In the first phase of the course, in which students had to brainstorm about educational theories resulting in formulating a research question and thinking out a solving strategy, WebKF was used adequately. In this context adequate means that the students participated regularly, interacted, showed concern and support for the group (Collison, Elbaum, Haavind & Tinker, 2000) and constructed knowledge. No significant correlations were found between students' learning style and their participation. A few significant correlations between students' learning style and their learning activities were found. To keep the discussion clear and to monitor the task, it seems to be good to have students with an application-directed learning style or meaning-directed learning in the group. Furthermore, it will bear fruit to stimulate a positive attitude towards collaborative learning. Students who lack regulating strategies will have some problems in working with CSCL. However, the results do not give reason to assume that CSCL is only useful for students with a specific learning style. Finally, no interesting correlations were found between levels of understanding and learning styles or scales within these learning styles. In other words, there is no reason to assume that students with a specific learning style will construct knowledge of better quality.

5.8 Study 4: Canadian Study

The aim was to execute a number of studies to increase the external validity of the results. When we started the PhD-project, CSCL was still in its infancy in the Netherlands. For that reason we also searched for additional possibilities to collect data. At the Ontario Institute for Studies in Education (OISE), CSCL had already been used for many years. A research contract was signed giving us permission to analyse Canadian data; our Dutch data were supplemented with these Canadian data.

In this section, first the methods of the Canadian study will be described. Next, results will be presented in section 5.8.2, sequenced by the main research questions: participation/interaction, use of learning activities, and the amount and quality of the constructed knowledge. Next, in section 5.8.3, results will be discussed and conclusions drawn about the use of the CSCL-system in this course.

5.8.1 Method

At the Ontario Institute for Studies in Education (OISE), the graduate course 3502S - from now on called 'Canadian study' - was given from January till May 1998. The objective of the course was to gain insight into current educational theories and developing one's own view of learning and teaching in interaction with fellow students. Although more students logged in sometimes, seven students really followed the course. Contrary to the other three studies, in this study the students were not full-time students, but part-time students and teachers at a primary school besides. In their education, they were used to teaching by CSCL and they were also familiar with Knowledge Forum. In the Canadian study, students used both the Client and the Web version (see section 5.4.2). Every week the teacher put an article on the forum. The articles were in the area of education. To illustrate some titles of views were: instructional design, problem-based learning, how schools work, schools as knowledge building organisations, and principles of learning. Students worked parallel in different views and no subgroups were formed. Thus, seven students were allowed to work in each view. A total of 33 case-reading views were created, which were accessible during a few months. Students were expected to spend between two and four hours weekly. Students were expected first to read the article thoroughly and next, to react to the contributions in the created view. For example, students could react by formulating a question, evaluating the content critically, summarising the article or creating their own theories. Besides this reading activity, no assignment was given. Students' participation and their contributions to Knowledge Forum were not assessed. In alternate weeks, a short meeting was planned with the teacher, especially meant to see each other in real life and keep feeling with the group.

5.8.2 Results

Because of pragmatic reasons, a selection was made of views to be analysed. The mean number of contributions in the 33 case-reading views was 12.4. We decided to analyse all views with 12 or more notes. This resulted in 13 views to be analysed[2]. Although this was a pragmatic choice, we think it can also be theoretically justified. All views were similar concerning content and method. We assume that students learned in the other views in a similar way. Of course, we have to keep in mind that students participated and interacted more and constructed more knowledge in the complete course. However, there is no reason to believe that the proportions between the different kinds of activities would have changed by analysing all views. Table 5.8 shows an overview of the means and standard deviations of new, build-on and read notes and the cluster sizes of the 13 analysed discourses.

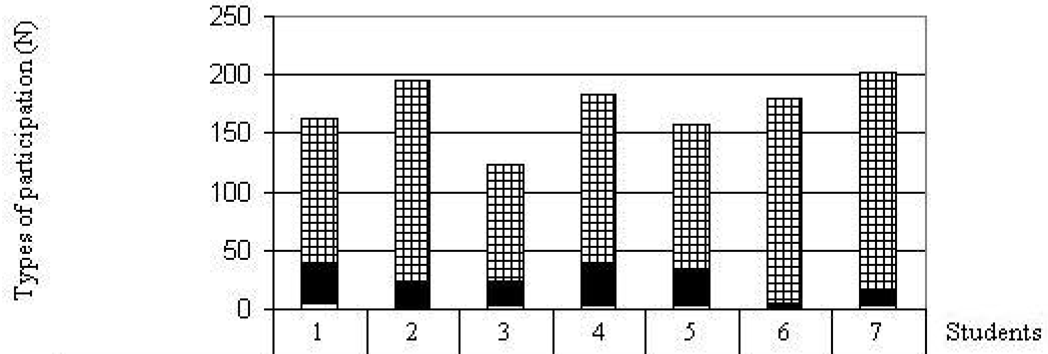
[2] With help of the ATK we analysed whether students used the additional options of KF (not available in WebKF). None of the additional options of KF were used by the students. In other words, they did not use rise-above notes, publishing notes, annotations or collections, but notes were labelled by a keyword.

Table 5.8. Global overview of the 13 analysed views in the Canadian study (mean and standard deviation of new, build-on and read notes; cluster sizes)

	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
(N=7)			13	13	10	3	6	2
New	2.86	1.57						
Build-on	21.14	11.73						
Read	148.14	32.24						

Nearly all produced messages were read at least one time (M_{read} =148; Sum_{write}= 168). These notes were organised in rather large clusters, eight clusters of 10 notes or more. Only 8% of all notes was not linked to other notes. Therefore, it is not surprising that relatively many notes are build-on notes (81%).

Figure 5.26 shows students' individual participation. No (Pearson) correlation consisted between passive participation (reading) and active participation (writing) (r= -.60; p=.16). The minimum number of written notes was 3; the maximum number was 38 notes (range 35). The minimum number of read notes was 102 notes, the maximum number was 189 notes (range= 87).

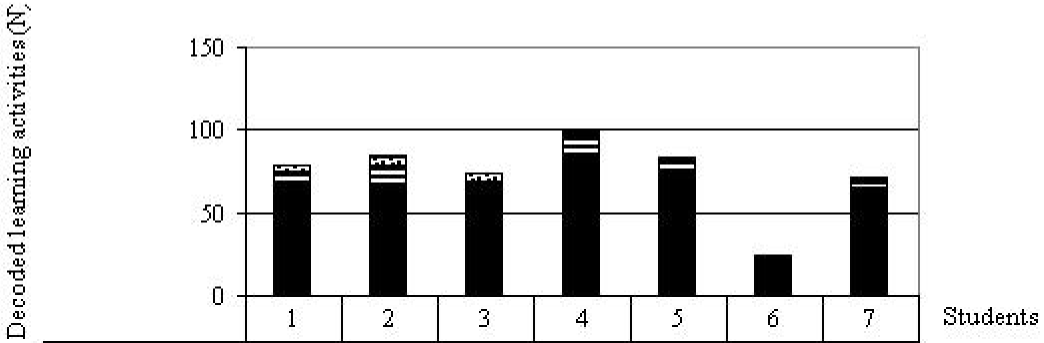


	1	2	3	4	5	6	7
⊞ # read notes	124	172	102	146	127	177	189
■ # build-on notes	33	21	19	35	27	3	10
□ # new notes	5	2	3	3	4	0	3

Figure 5.26. Students' participation in the Canadian study.

In this fourth study, density was measured to gain insight into the extent of interaction between the students in the group, too. Density based on reading notes was .95; density based on linked notes was .67 (for case-by-case matrices see Appendix II). The correlation between density and use of internal linking could not be computed; the variable density is constant because there was one group, one phase and one task.

Figure 5.27 summarises the number of cognitive, affective and metacognitive learning activities per student in all analysed views. Within the 168 students' notes, 516 units were regarded to be meaningful enough to be analysed on learning activity. The percentage of cognitive activities was very high: 86%. Next, 10% of all decoded units concerned metacognitive learning activities and 4% of the units contained affective expressions. Less than 1% of the notes could not be decoded as cognitive, affective or metacognitive and was called rest activities.



	1	2	3	4	5	6	7
□ Rest	0	1	0	1	0	0	0
⊡ Affective	5	6	6	2	3	0	2
⊟ Metacognitive	8	14	4	12	7	0	5
■ Cognitive	66	64	64	84	74	24	64

Figure 5.27. Students' cognitive, metacognitive and affective learning activities in the Canadian study.

Figure 5.28 focuses on the subcategories within the main categories.

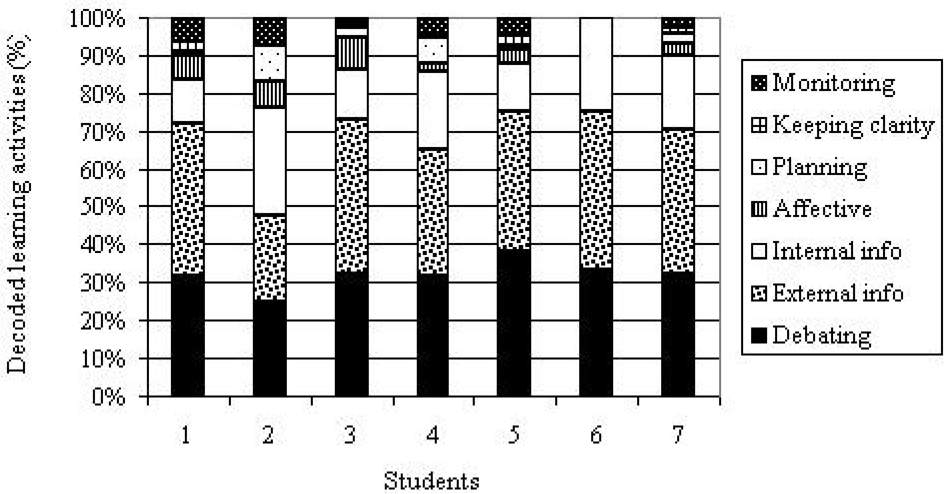
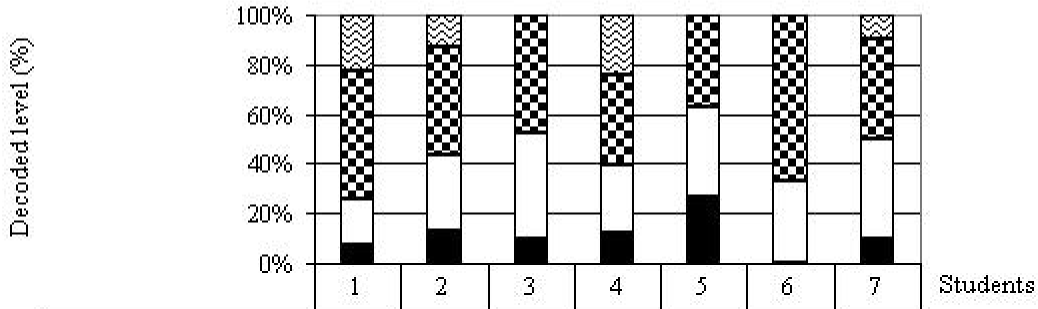


Figure 5.28. Students' learning activities in the Canadian study subdivided into subcategories.

37% of all cognitive units concerned debating; 41% referred to the use of external information and in 22% internal information was linked. Within the category metacognitive, 42% referred to planning activities, 14% concerned keeping the discourse clear and 44% were monitoring activities. In 6% of the units, students' motivated each other or had social, non-task-related talks. No (Pearson) correlation consisted between the three types of learning activities ($r_{cognitive,\ metacognitive}$= .36; p=.43); ($r_{cognitive,\ affective}$=.20 ; p=.66); ($r_{affective,\ metacognitive}$= .40; p=.37).



		1	2	3	4	5	6	7
Low	D: Unistructural	6	3	0	8	0	0	1
	C: Multistructural	14	10	10	12	7	2	4
	B: Relational	5	7	9	9	7	1	4
High	A: Extended abstract	2	3	2	4	5	0	1

Figure 5.29. Quality of students' constructed knowledge in the Canadian study, expressed as levels of understanding.

Figure 5.29 depicts the levels assigned to the notes that contained units of knowledge construction. In this Canadian study, 136 units (=26%) contained expressions of knowledge construction. Measured by our standard (see section 5.3) that is a reasonable amount. A total of 43% of these units was assessed as qualitative and 57% as quantitative. These percentages agree with a reasonable quality of knowledge; notice that these percentages border on the scale of high quality.

5.8.3 Conclusions and discussion

All students contributed notes, but the standard deviation of writing notes was rather large. In other words, students differed in the extent of active participation. The proportion between new and build-on notes is striking. The written notes were organised in rather large clusters; only a small percentage of all notes was isolated. Students read many notes; nearly all produced messages were read at least once. As expected, these part-time students were highly motivated to follow the course. They did not participate because of getting credits, but because of personal interest. Students were interested in the contributions of fellow students. The density of interaction, based on read as well as linked notes, confirmed the existence of an animated discussion.

Concerning the second main research question we can conclude the following. Only 10% of the learning activities were decoded as metacognitive. Students had no difficulty in keeping the database structured and in keeping the discussions clear. We think the discussion in the several views went smoothly because of the following factor: students were used to learn by CSCL. No time was wasted in trying out the technical use of WebKF/KF and students did not need time to approve of the idea of CSCL. Another factor is the clarity of the task. Students knew what they had to do: reading articles and reflecting on the content of the articles. Because this activity asked for little metacognitive learning activities, the percentage of cognitive activities was high, namely 86%. The proportion of using external information and debating was almost 1:1. Students often used literature to support their ideas and elaborate their thoughts. They had enough time to work in Knowledge Forum; the forum was accessible during a few months. The articles put on the forum were rather large and students needed time to read them thoroughly. As a consequence, it was quiet on the forum in some weeks, but in other weeks students contributed and read notes. A total of 4% of all units were decoded as affective; in our opinion, that is not much. In all cases, affective units were part of a note that also consisted of cognitive and/or metacognitive units; affective units never formed a note on their own. We think that the CSCL-systems used did not stimulate students to express feelings in notes and that students preferred to talk socially and motivationally face to face.

Referring to the third main research question, in 26% of all units students constructed knowledge. Using our standard (see section 5.3), this means that a reasonable amount of knowledge was constructed. However, notice that the amount of constructed knowledge bordered on the scale of little knowledge construction. Concerning the quality of the knowledge, we see that 43% of the units decoded as knowledge construction were assessed to be qualitative, thus as level A or B. Therefore, using our standards, the quality of the constructed knowledge was assessed as reasonable, too.

To end with, we will emphasise the importance of being motivated while learning by CSCL. We think students really have to learn how to use a CSCL-system. However, not only students, but also teachers must be motivated to use CSCL and they have to know how to implement CSCL in their education. This Canadian course was given by Marlene Scardamalia, among others. She was involved in developing the CSCL-system and had already been using the system in her education for years. In this study, CSCL was used rather successfully. Students were highly motivated and active in the CSCL-system and the system was used the way it was intended. However, little knowledge was constructed and the quality of the constructed knowledge was assessed to be reasonable. It would be interesting to continue this line of research in the future to gain more insight into ways to stimulate the amount of knowledge construction in CSCL and to increase the quality of the constructed knowledge.

5.9 Overall conclusions and discussion

Four studies were presented above in which CSCL was implemented. In section 5.4.1, we cited a number of aspects being similar in these four studies. Summarised, these similar aspects were: a university setting, a real course, the phase of the educational programme, a complex task, no coaching in the CSCL-system, the use of Knowledge Forum and a lack of rules concerning the use of Knowledge Forum. However, the studies differed in the following characteristics: institution, group size, familiarity with CSCL, full-time or part-time students, period of using CSCL (in terms of number of weeks and the number of hours per week that students were expected to investigate), number of face-to-face (F2F) meetings during the course, nature of task, and assessment. Table 5.9 gives an overview of these characteristics per study.

Table 5.9. Overview of the main characteristics of the four studies

	Study 1: Agrification	Study 2: Land Evaluation I	Study 3: Psychology	Study 4: Canadian study
University	WU	WU	KUN	OISE
Students {N, group size full/part-time, familiarity CSCL}	N=15 (1*2; 2*4; 1*5)	N=13 (1*6; 1*7)	N=24 1e ph: (1*5; 2*6; 2*8; 1*10; 1*12; 1*15) 2nd ph: (1*2; 2*3; 4*4)	N=7 (1*7)
	full-time not familiar	full-time not familiar	full-time not familiar	part-time familiar
Period of using CSCL {weeks, expected time per week}	2 weeks 20 hours	6 weeks 20 hours	12 weeks 20 hours	17 weeks 2-4 hours
F2F meetings {mean per week}	2	0.5	0.75	0.5
Task {type, objectives}	Problem task/writing task	Problem task	Brainstorm task/ writing task	Discussion task
Assessment	Report (100%)	Two tests (67%) Participation WebKF (33%)	Report (100%) Participation WebKF (rounding)	-
CSCL-system	WebKF	WebKF	WebKF	WebKF, KF

Although the four studies differed in group size, types of student, period of using the CSCL-system, number of F2F-meetings, task and assessment, we analysed all databases in the same way, which allows us to make some comparisons. By comparing the different studies, we learn more about using CSCL in university education compared to analysing results within the studies only.

The following three main research questions were addressed in this chapter:

1. How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?
2. How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?
3. Do students construct knowledge and what is the quality of the knowledge constructed by students in an asynchronous CSCL-system?

The remainder of this section will summarise and discuss the results in the order of these questions. Figure 5.30 shows an overview of students' mean participation (new notes, build-on notes and read notes) in the four studies. Notice that in the figures given below the results of different phases, tasks or groups within a study were joined; in this section, general conclusions are drawn.

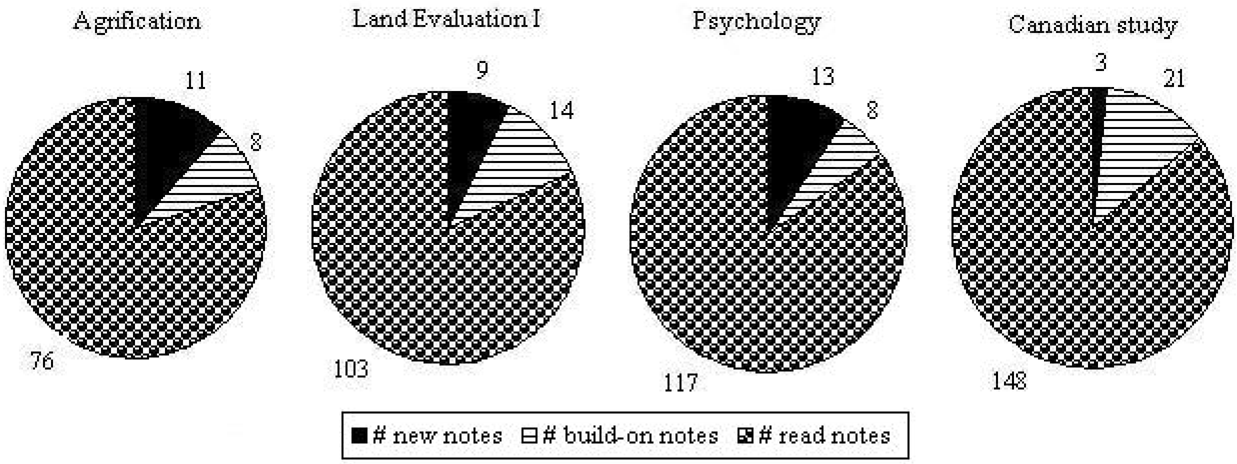


Figure 5.30. Students' mean participation, active as well as passive, in the four studies.

The results showed that, first of all, the proportion between reading and writing notes was comparable in the four studies (study 1 - 4:1; study 2 - 4.5:1; study 3 - 5.6:1; study 4 – 6.2:1). In each study, students read much more notes than they wrote. Remember that read notes in the graphs only concerned notes of other participants (see Footnote 1). Reading notes of others shows concern and support for the group and refers to a healthy community (Collison *et al.*, 2000). In this context, density was calculated to indicate the general level of linkage among the students in the different discourses. Table 5.10 presents an overview of the densities in each study (mean per class). The high extent of interaction among the Canadian students with regard to both reading and linking notes is striking. Students in the Psychology course interacted least (reading as well as linking) compared to students in the other three courses.

Table 5.10. Overview of density based on read and linked notes in each study

Density	Agrification	Land Evaluation I	Psychology	Canadian study
Read	1.0	1.0	.61	.95
Linked	.60	.48	.13	.67

In view of the differences in number of weeks that students used Knowledge Forum, the differences in absolute number of read and written notes are rather strong. In the Canadian course, students could work in the CSCL-system for 17 weeks. The shortest period of using CSCL was in the Agrification course; students could use the CSCL-system for only two weeks. However, Canadian students read 148 notes and wrote 24 notes on average; Agrification students read 76 notes and wrote 19 notes on average. In our opinion, it is not very useful to give a standard for assessing participation in the view of absolute numbers of actions. The results of all four studies showed that the number of read notes was on average much larger than the number of written notes. In view of the time needed to read or to write notes and besides, the aim to learn collaboratively, this is not a striking result. Therefore, we only used results concerning participation to give an overall impression of activity in the CSCL-systems (see also chapter 3). We wanted to know whether students were involved in the course and in our opinion, except in phase 2 of the Psychology study, students were involved.

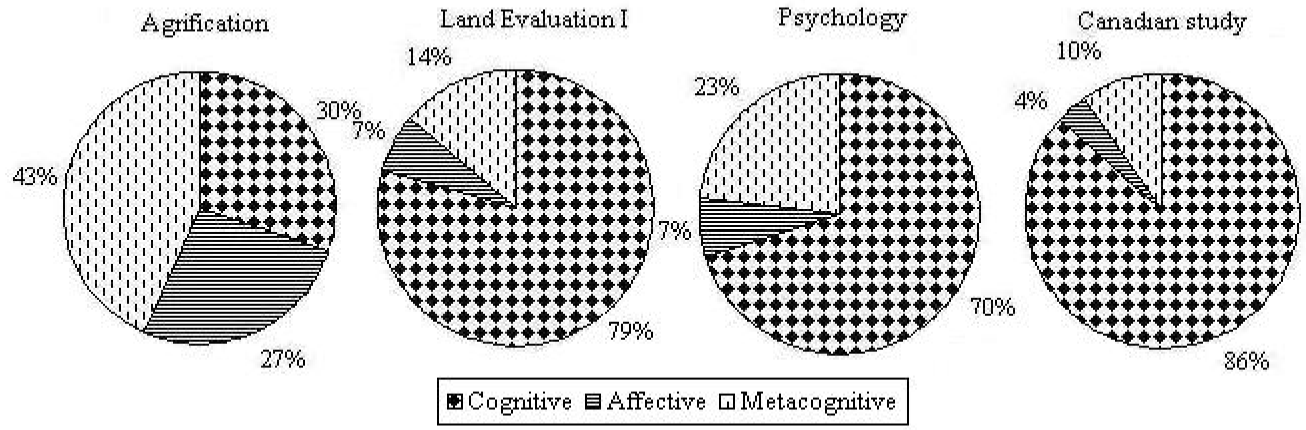


Figure 5.31. Proportion of cognitive, affective and metacognitive learning activities in the four studies (mean per student).

Comparing the learning activities used, we see a large difference between the four studies (see Figure 5.31). Canadian students were most cognitively oriented (86%). Students in the Land Evaluation I and Psychology courses produced many cognitive units as well (79% and 70%, consecutively). However, the Agrification course showed a totally different picture: only 30% of the decoded units concerned cognitive codes. On the contrary, Agrification students were especially metacognitively oriented: 43% of all units were decoded as metacognitive.

In this perspective, it is interesting to compare the four studies and to look at the mean number of units per note (see Table 5.11). In the Canadian study and in the Land Evaluation I study, the two studies in which students were most focused on cognitive activities, we see a larger number of units per note, which refers to a larger density of information in the sense that students used more different types of learning activities per note.

Table 5.11. Number of written notes and number of analysed units per study

	Agrification		Land Evaluation I		Psychology		Canadian study	
	#	*Proportion*	#	*Proportion*	#	*Proportion*	#	*Proportio n*
Notes	287	*1*	296	*1*	495	*1*	168	*1*
Units	490	*1.7*	758	*2.6*	751	*1.5*	516	*3.1*

Affective activities were found most in the Agrification study, 27%. We wrote in section 5.5.3 that reaching a collective goal would have stimulated the use of affective units. However, students in the Psychology study also had to write a collective report in phase 2 of the course and in this study only

4% of all units were decoded as affective. Therefore, there must be another reason to explain the use of relatively much affective units in the Agrification study, but we have not found it. However, in general, we can conclude that students express few affective feelings in the CSCL-systems used. In none of the studies, a (Pearson) correlation was found between number of affective units and amount of constructed knowledge (Agrification study: $r=-.24$; $p=.39$, Land Evaluation I study: $r=.33$; $p=.11$, Psychology study: $r=.32$; $p=.13$, and Canadian study $r=.44$; $p=.33$). Apparently, expressing affective feelings is no prerequisite for constructing knowledge.

The students in the different courses differed enormously in the absolute amount and quality of constructed knowledge. On average, students in the Agrification course produced 4.33 units decoded as knowledge construction, students in the Land Evaluation I course 16.69 units, students in the Psychology course 5.75, and students in the Canadian course 19.43 units. Looking at the proportion of knowledge construction to non-knowledge construction in the four studies, the difference is much smaller (see Figure 5.32). The standard to assess the amount of knowledge was formulated as follows (see section 5.3):

- *Little*: {units knowledge construction$_N$ = $\leq$25%; units non-knowledge construction$_N$ = >75%}
- *Reasonable*: {units knowledge construction$_N$ = 25% -$\leq$50%; units non-knowledge construction$_N$ = 50% -$\leq$75%}
- *Much*: {units knowledge construction$_N$ = $\geq$50%; units non-knowledge construction$_N$ = <50%}

It is obvious that, measured by our standard, in none of the four studies much knowledge was constructed. Comparing the four studies, students constructed most knowledge in the Land Evaluation I and the Canadian study, absolutely as well as relatively.

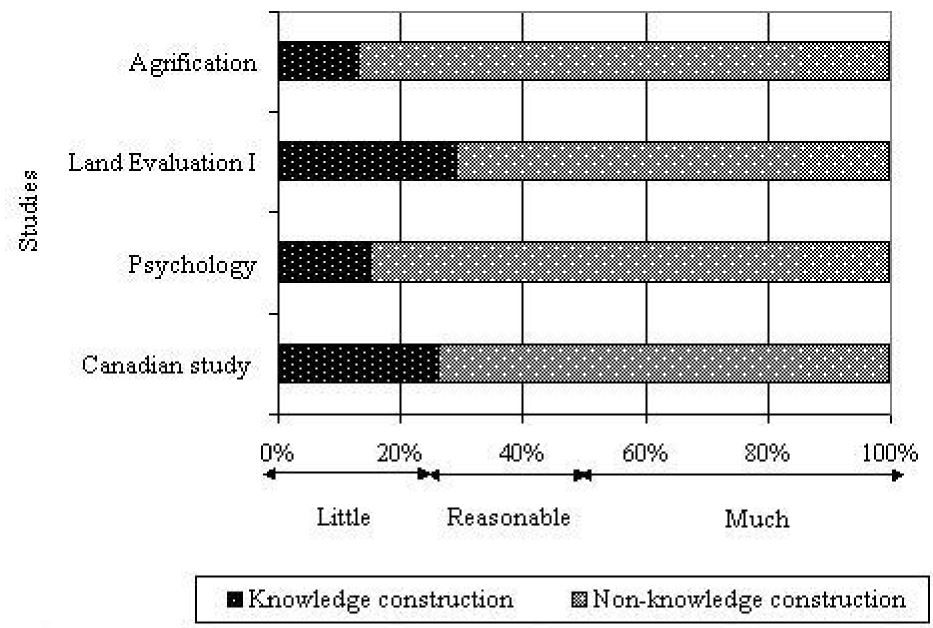


Figure 5.32. Percentage of units decoded as knowledge construction in the four different studies.

To assess the quality of knowledge, the following standard was formulated (see section 5.3):

- *Very low*: $\{\sum \text{level } A_N + \text{level } B_N = \leq 10\%; \sum \text{level } D_N + \text{level } C_N = > 90\%\}$
- *Low*: $\{\sum \text{level } A_N + \text{level } B_N = 10\% - \leq 25\%; \sum \text{level } D_N + \text{level } C_N = 75\% - \leq 90\%\}$
- *Reasonable*: $\{\sum \text{level } A_N + \text{level } B_N = 25\% - \leq 45\%; \sum \text{level } D_N + \text{level } C_N = 75\% - \leq 55\%\}$
- *High*: $\{\sum \text{level } A_N + \text{level } B_N = \geq 45\%; \sum \text{level } D_N + \text{level } C_N = < 55\%\}$

Figure 5.33 shows an overview of the quality of the knowledge constructed by students in the four studies. The charts give the division over the four assigned levels as percentage of all units of knowledge construction. In the Agrification study, 22% of the knowledge constructed was assessed to be qualitative (level A and/or level B). Measured by our standard (see section 5.3), this means that the quality of the constructed knowledge was low. In the Canadian study, the quality of knowledge constructed was assessed to be reasonable. In the other two studies, Psychology and Land Evaluation I, the quality of knowledge constructed was assessed to be high.

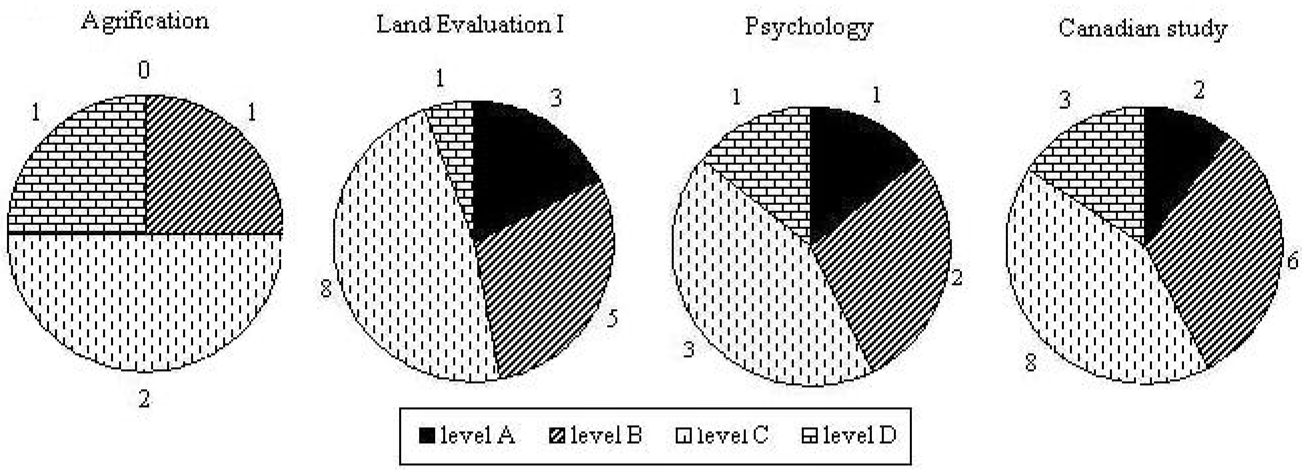


Figure 5.33. Overview of the quality of students' constructed knowledge in the four studies, expressed as levels of understanding (mean per student).

Concerning the results of both amount and quality of knowledge construction, we have to conclude that CSCL was implemented most successfully in the Land Evaluation I course. In the preceding pages, we have given the following arguments to explain the success in the Land Evaluation I course: the learning goals and the design of the course were very clear, a planning schedule and dividing the task into subtasks supported the learning process, students were familiar with case-based education, students did not have to write a joint report but the need to debate and negotiate about knowledge was implemented in the types of questions and sort of problem they had to solve, and finally, students had to work first on their own and next had to react to each other (students were forced to think critically). An additional finding was that working in multidisciplinary teams stimulated students' participation as well as their amount of knowledge construction (see also Veldhuis-Diermanse, 1999a; Veldhuis-Diermanse & Mulder, 2000). Below, we will briefly reflect on these findings.

We started this PHdissertation with a reflection on CSCL and the student. We claimed that students could exchange arguments, reformulate their ideas, criticise their own and the other students' arguments, retrieve prior knowledge and to link ideas and information in a CSCL-system. We also explained that students would be reluctant to publish unfinished work because they were not used to do so, and that students would be a little uncertain, because of the absence of a teacher who would have said whether something was correct or not. However, we expected students to become enthusiastic about CSCL because of the innovative aspect and the influence on their own learning process. Among others, we quoted Lethinen *et al.* (2001) who concluded that CSCL seemed to be a promising way of using information technology to put forward desired changes in educational practice in conformity with the constructivistic view. Studying literature, they found a reasonable amount of published experiments indicating positive learning effects when CSCL-systems have been applied in education. Furthermore, several arguments were given to support the idea that CSCL stimulates shared knowledge building by the learners (Scardamalia & Bereiter, 1994): group learning, writing as an effective tool for learning and the existence of a 'conversation history'.

Although studying literature formed a rather positive notion of using CSCL in education as a way to provoke debating, sharing of information and negotiating of knowledge, resulting into knowledge construction, this chapter showed that the use of CSCL does not guarantee students will construct knowledge. Knowledge construction was operationalised as adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas. Focusing on the most important goal of CSCL, knowledge construction, we have to conclude that in the Agrification project CSCL was not used successfully. Concerning the second phase of the Psychology study, we have to conclude the same; students did not use the possibilities to learn that CSCL offers. On the contrary, students in the first phase of the Psychology course, students of Land Evaluation I and the Canadian course did use the CSCL-system as was intended in theory. Although not much knowledge was constructed, students contributed ideas, elaborated on these ideas, and negotiated about knowledge. The results gave rise to the assumption that it is necessary for students to learn how to use a CSCL-system. Not in the sense of practical use of technical possibilities, but in the sense of sharing their knowledge, thinking critically, not accepting information as automatically true and giving and receiving feedback. The research indicates that students with experience with CSCL and/or solving complex tasks profit by using CSCL compared to students who are not used to solving a complex task, let alone CSCL.

Furthermore, results show the importance of pre-structuring a task and clearly formulating a task. Students have to know what is expected of them to prevent wasting time and getting irritated. Besides, the studies emphasise the importance of working on a task which provokes collaboration. In the Agrification study and in the second phase of the Psychology study, students were expected to write a collective report. In both courses, the task led to subdividing the report into sections; students wrote their section on their own computer and next put it on the forum. Students did not learn collaboratively. The CSCL-system was not used as a knowledge building system, but as a system to manage the exchange of documents. We suppose that in the Agrification course and in the second phase of the Psychology course, the use of e-mail would have been adequate, too. In the Agrification study, the report concerned the solution of a complex problem formulated in a case. In addition, in the Land Evaluation I study, students had to solve complex problems, but they learned collaboratively and constructed knowledge. In this study, students only had to elaborate interim steps on the forum and did not have to publish the final report in WebKF.

The task in the Canadian course provoked the students to construct knowledge, to debate and share ideas. However, it is just a question whether this task would have been adequate in our Dutch settings, either. We expect that the experiences of the Canadian students were of much importance; they would have used CSCL adequately, whatever the task.

The Land Evaluation I study showed that working in a multidisciplinary team (having roles) stimulates students to participate more and to construct more knowledge and therefore we prefer working in multidisciplinary teams.

A last remark concerns the period of using CSCL. In the Canadian study, students could use the system for 17 weeks; Agrification students had only two weeks to perform the task. When a course takes too long we see periods of silence in activity. Students in the Psychology course were very quiet in some weeks. With the prospect of finishing the report the number of notes increased enormously. During the six-week course Land Evaluation I, students were busy all the time, but were glad to finish the course. It was time-intensive and six weeks is rather long, then.

In chapter 3, we cited Webb and Sullivan Palinscar (1996) and Dillenbourg (1999) who argued that because of the multiple interactions between factors such as group size and task characteristics, it is very difficult to set up initial conditions guaranteeing the effectiveness of collaborative learning. This research also confirmed the complexity of factors in setting up a successful course. In the next chapter, three studies comparable to the studies described in this chapter will be presented. The main difference is the presence of a moderator, which the studies described in this chapter lacked. CSCL-data will be analysed on participation, learning activities, and amount and quality of knowledge construction again, but beyond that effects of teacher interventions on the learning process will be analysed.

Chapter 6 - Moderating CSCL in university education: Analysis of two courses

"If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving those outcomes…It is helpful to remember that what the student does is actually more important in determining what is learned than what the teacher does." (Shuell, 1986, p.429)

6.1 Introduction

In the previous chapter, four studies have been described in which CSCL was used. In all courses, students regulated their own learning processes; a teacher did not moderate them. Although teachers were allowed to write notes, they seldom did. However, students regularly asked their teachers for help. They wanted to know if they were learning the right way, searched for specific information, needed help to get started or asked for their teacher's opinion. Besides, it was difficult to let students' questions unanswered or to see students being stuck and the discussion volume getting down. At other moments we wished to ask questions to trigger students to discuss on a deeper level. In addition, after analysing the databases on learning processes, the results were not always satisfying. Because of these experiences, we decided to set up new courses in which the teachers had to take a more active role in the CSCL-system. We expected moderated discussions to be more animated and more productive than self-regulated discussions. In other words, we expected teacher interventions to be a useful tool to increase the quantity as well as the quality of students' contributions. Therefore, in this chapter, we will focus on the following main research problem:

What are the effects of moderating a CSCL-discussion on students' learning?

Students' learning was operationalised as extent of passive and active participation (number of read and written notes, consecutively), use of cognitive, affective and metacognitive learning activities and amount and quality of constructed knowledge.

Section 6.2 will outline the theoretical framework of moderating CSCL relevant to the two studies described in this chapter. This framework results in guidelines for moderating asynchronous discussions used in our studies. In section 6.3 the research questions will be formulated and operationalised. In section 6.4, some background information will be given about similarities between the two studies, the CSCL-system used and the method of analysing data. Studies one and two will successively be described in sections 6.5 and 6.6. For each study, first the methods will be described, next results will be given and finally some conclusions will be drawn and the findings will be discussed. Finally, in section 6.7 the results of the two studies will be discussed in relation to each other in order to draw some more general conclusions.

6.2 Moderating CSCL

This section consists of two parts: a theoretical framework about moderating CSCL (section 6.2.1) and the guidelines, based on this theoretical framework, which were used to instruct teachers about how to moderate students in the courses in our research (section 6.2.2).

6.2.1 Theoretical framework: Moderating CSCL

In chapter 2 of this PHdissertation, we discussed the problem of a changing role of the teacher when using CSCL compared to the teacher's role in more traditional education. The shift from a traditional role as information deliverer to a role as facilitator was discussed. Besides, it was argued that a teacher must facilitate collaboration between students, encourage them to monitor their understanding, communicate with them and carefully examine knowledge produced by students. Ideally, a teacher was expected to trust students' independence and share responsibility, take care of a safe learning climate in the group and create conditions in which students dare to and can collaborate, help students to negotiate about knowledge by giving useful indications when students get stuck, offer meaningful tasks such as problem cases, keep students motivated by being interested and giving feedback on their actions, evaluate, judge, value and validate not only the product but also the learning process, and take care of the basic conditions to make education possible as well as he is able to (see chapter 2). Although this enumeration is valuable and illustrates the essence of the changing role, it is necessary to make these guidelines concrete; teachers need guidelines on how to moderate a CSCL-group (Veldhuis-Diermanse, 2001).

In recent years, educators have become increasingly interested in the question about how to moderate on-line or electronic learning. Salmon (2001a) developed the Five Step Model for computer-mediated communication (CMC) in education and training (see Figure 6.1). This model is also useable in the context of CSCL, a specific type of CMC.

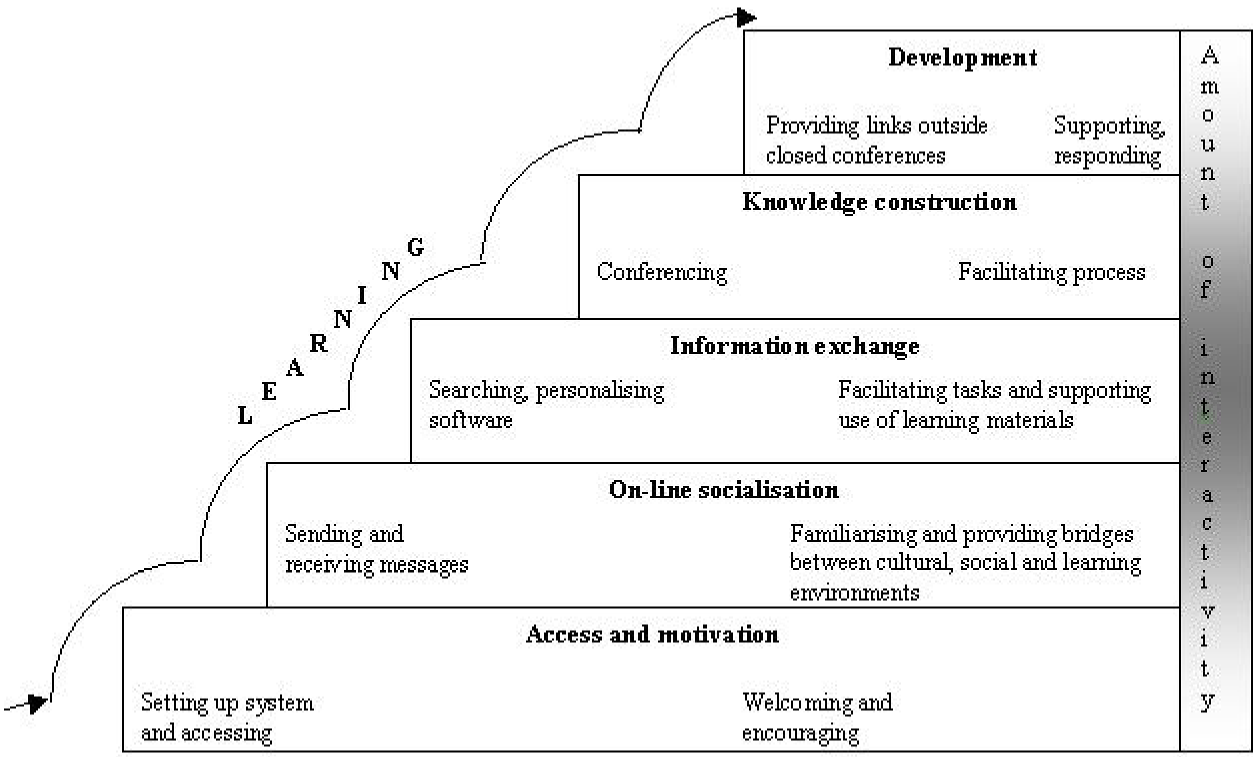


Figure 6.1 The Five Step Model (Salmon, 2001a).

This model can be summarised as follows: "Individual access and the ability of participants to use CMC are essential prerequisites for conference participation (stage one, at the base of the flights of steps). Stage two involves individual participants establishing their on-line identities and then finding others with whom to interact. At stage three, participants give information relevant to the course to each other. Up to and including stage three, a form of co-operation occurs. At stage four, course-related group discussions occur and the interaction becomes more collaborative. The interaction occurring at this stage is around content or sharing of information. In stage five, participants respond to each others' messages; many become involved in active learning. The communication depends on the establishment of common understandings.

Each stage requires participants to master certain technical skills (shown in the bottom left of each step). Each stage calls for different e-moderating skills (shown in the bottom right of each step). The 'interactivity bar' running along the right of the flight of steps suggests the intensity of interactivity that you can expect between the participants at each stage. At first, at stage one, they interact only with one or two others. After stage two, the numbers of others with whom they interact, and the frequency, gradually increases, although stage five often results in a return to more individual activities" (Salmon, 2001b).

At stage five, moderators and students are essentially using a constructivist approach to learn. Constructivism calls for participants to explore their own thinking and knowledge-building processes (Salmon, 2001b; Biggs, 1996). This personal knowledge includes not only ideas about the topic area under study, but also the teachers' and participants' responses to the experiences of teaching and learning themselves (Salmon, 2001b). In CSCL, we aim at knowledge construction supported by interaction between students and therefore stages four and five are most relevant in the context of this PHdissertation. In these two stages, the teacher's skills are called facilitating and supporting the process.

Berge (1996) also developed a classification of facilitation skills. He distinguished four types of strategies: (1) didactical, (2) social, (3) managerial and (4) technical. In a didactical role the facilitator uses questions and probes for student responses that focus discussions on critical concepts, principles and skills (Berge, 1996; Veerman, 1997). He stimulates students to think creatively, critically and constructively and helps them to keep the discussion well organised. In a social role the facilitator tries to create a social environment in which learning is promoted. This social role is also found to be essential for successful moderating and suggests 'promoting human relationships, keeping the discussion alive, developing group cohesiveness, maintaining the group as a unit, and in other ways helping members to work together in a mutual cause'. In a social role, the facilitator brings students' contributions to each other's attention, gives feedback about the group processes, discusses the progress and problems and supports to find information. In short, he stimulates students to learn collaboratively in a friendly, social environment. The managerial role involves setting the agenda for the course: the objectives of the course and the discussion, the timetable, the organisation of the learning environment, procedural rules, decision-making norms and agreements. This aspect of the facilitator's role is especially important before the start of the course. The facilitator must make participants comfortable with the system and the software the discourse uses. The ultimate technical goal for the instructor is to make the technology transparent; the learner can concentrate on the academic task. If necessary, it is also a task of the technical facilitator to answer questions concerning the software during the course (Berge, 1996). In literature, the terms facilitator and moderator are used interchangeably. However, in accordance with Collison, Elbaum, Haavind and Tinker (2000) we see moderating as a part of facilitating a course or on-line task: one key role for the facilitator is to moderate discussions, thus focusing and deepening the work of the group and enhancing outcomes or products of the communal effort (Collison *et al.*, 2000). Following this line of reasoning, in the fourth stage of the five step model, the teacher's skill has to be called moderating the process. Figure 6.2 shows a more traditional model; the teacher is in the centre and interacts directly with all students. Figure 6.3 illustrates the idea of a moderator as an outside observer serving a group.

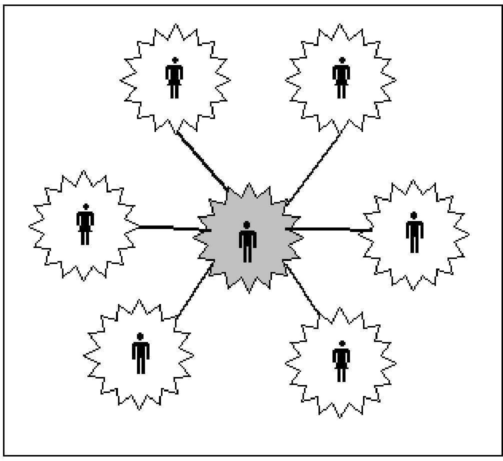


Figure 6.2 Teacher centred model: the moderator is the focal point of all communication (Collison *et al.,* 2000).

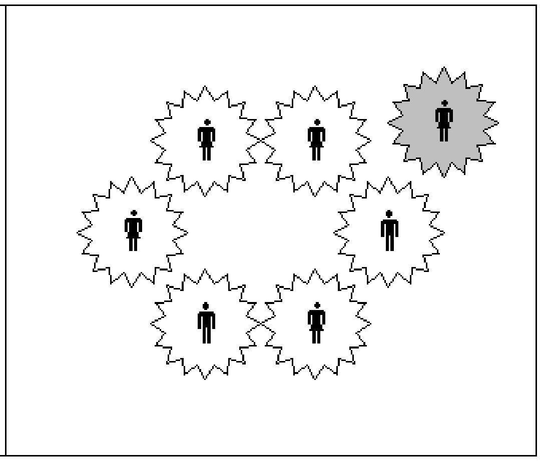


Figure 6.3 Seminar model: the moderator supports learning and communication among the participants themselves (Collison *et al.*, 2000).

In the seminar model, students form a team of experts discussing a topic or working on a task. The teacher encourages interactions between students by monitoring and shaping conversations with targeted interventions and by refraining from extensive direct interaction (Collison *et al.*, 2000). The moderator is called a 'guide on the side'; he does not participate in the content of the discussion. In the teacher centred model, the teacher interacts directly with all students and is viewed as the moving spirit to keep the learning process going. The teacher-centred model is not feasible because it takes too much time; time teachers normally do not have. Moreover, this model is not desirable from a constructivist view of learning, either. Learning is viewed as an active, constructive, cumulative, goal-directed, self-directed and independent process in which the learner builds up internal knowledge representations that form a personal interpretation of his of her learning experiences (see chapter 2, section 2.3.2).

In our studies, the teacher was a guide on the side (seminar model), too. The teachers never took part in the discussion in the sense of formulating their own ideas and viewpoints. By targeted interventions Collison *et al.*, (2000) mean critical-thinking strategies. They argue that the critical-thinking strategy used has a direct impact on the discussion. They identify two classes of critical-thinking strategies: (1) strategies sharpening the focus of the discussion and (2) strategies helping students to dig deeper into the discussion. For each general class three sub-strategies are defined (see Table 6.1)

Table 6.1 Critical-thinking strategies formulated by Collison *et al.*, (2000)

Critical-thinking strategies	
Sharpening the focus (1)	Deepening the discussion (2)
Identifying direction	Full-spectrum questioning - "So what?" questions - Questions that clarify meaning - Questions that explore assumptions and sources - Questions that identify cause and effect - Questions that plan a course of action
Sorting ideas for relevance	Making connections
Focusing on key points	Honouring multiple perspectives

6.2.2 Guidelines for moderation used in our studies

In this chapter, the focus is on the key role as formulated by Collison *et al.* (2000) for the facilitator: moderating discussions. The managerial and technical role distinguished by Berge (1996) are assessed to be important. However, we see these roles as requirements; a course must be organised very well and, of course, the CSCL-system used must be transparent and user-friendly. During the preparation of the course, attention was paid to a clear organisation of the course, setting the agenda for the course, availability of computers and a user-friendly CSCL-system. Although certainly important, these requirements are not object of the research.

In this PHdissertation, moderating discussions was formulated as: *focusing and deepening the work of the group and enhancing outcomes or products of the communal effort* (based on Collison *et al.*, 2000). Both the categories distinguished by Berge (1996) and the five-step model of Collison *et al.*, (2000) are relevant in our research. In our opinion, the social role distinguished by Berge (1996) is related to the first stage (access and motivation) and second stage (on-line socialisation) of the five-step model and the didactical role described by Berge (1996) is related to stage three (information exchange), stage four (knowledge construction) and stage five (development) of the five-step model. In theory, a distinction between the didactical and social role can be made. However, we have to be aware of the difficulty to distinguish between these two roles in practice sometimes.

Based on the social and didactical moderation skills, guidelines were developed to instruct teachers in the different studies. The two types of moderation used in this PHdissertation were called (1) social and (2) critical. Social moderation is directed at keeping the discussion alive and enhancing outcomes or products of the communal effort. Critical moderation is directed at deepening ideas; students are triggered to think critically and to clarify their concepts.

To operationalise the moderation strategies, two schemes were created organised by 'when?', 'what?' and 'how?' based on the theory presented above, King (1992), Muilenburg and Berge (2000), Veerman (2000) and experiences with CSCL in earlier courses. Table 6.2 shows the guidelines for social moderation. Table 6.3 illustrates the guidelines for critical moderation. Notice that when a teacher wanted to use a certain action on another moment than suggested in the column 'when', of course he was allowed to do so.

Table 6.2. Guidelines for social moderation

Social moderation		
When?	What? (action)	How? (example)
Students get stuck; students ask for information	• Help to resume the discussion/ identifying direction (Collison *et al*., 2000) • Motivate students • Help students getting started • Specify where or how to find support (e.g. in literature or by e-mailing to experts) (Veerman, 2000)	*"What do we already know about...? "* *"We have already found..."* *"Susan, you can find information in..."* *"Did you look at the information module on the WWW, John?"* *"Send an e-mail to... he is an expert and will help you"*
The intensity of the discussion is down; certain period of impasse	• Emphasise the need for contributions • Call for personal participation (Veerman, 2000)	*"It is important to participate more. I only see three active stud*ents." *"Karin, I have not seen you on the forum last week. Where are you?* "
Students do not react to each other, but work individually	• Refer to notes of students concerning the same subject • Link coherent notes • Emphasise students to read each other's notes	*"Michael and Susan both chose for option three. but the arguments are different; compare their arguments"* *"See notes 54. 67 and 35".* *"Before writing your own answers, start with reading Peter's notes (number 83 and 72). Is it right what he claims? Is his suggestion complete or can you elaborate on his idea?"*
At random; when students contribute very well	• Give positive feedback • Refer to excellent notes	*"Great solution, Susan!"* *"Thomas, it looks good. You are working very well!"* *"Note 98. Does not need any comments; excellent summary!!!"*
Students are working nonchalant	• Give negative feedback	*"Remember the schedule. You have only two weeks to finish the task!"* *"You ought to be much more critical?"*
Students ask the teacher a question	• Pass the question on to fellow-students	*"Susan asked for an explanation of the procedure... which of you can help her?"* *"Mijke, you wrote about...Can you illustrate your idea to Peter?"*
The discussion runs the risk of becoming unordered	• Emphasise the use of clear titles and labelling notes • Create new views	*"Remember the use of thinking types."* *"Concerning the titles: try to formulate the central issue of your note in a few words."*

Table 6.3. Guidelines for critical moderation

Critical moderation		
When?	What? (action)	How? (example)
Students agree or disagree without explanations or arguments	• Check answers (Collison *et al.*, 2000; Veerman, 2000)	*"Why do you think that?"* *"What source have you used?"* *"What about...? Support your answer"*
Different options/possibilities are given	• Ask to select the most suitable option/possibility (Collison *et al.*, 2000)	*"What are the strengths and weaknesses of...?"* *"What are the differences between... and...?"* *"What is the best...and why? "* *"Compare...and...with regard to…"* (King, 1992)
Students give very brief answers You doubt whether students really understand what they write	• Ask to elaborate (King, 1992; Collison *et al.*, 2000) • Continue to ask	*"Can you give an example? "* *"But what about the...and the quality of the ... How would you rate that? "* *"What would happen if...? "* *"How does...affect...? "* *"Could you also add your final verdict in terms of …? "* *"Can you explain what you mean by... Please elaborate."* (King, 1992)
The discussion volume is down	• Put a statement on the forum • Ask to comment • Give suggestions on how to execute the task • Support use of learning materials (Salmon, 2001) • Give additional information	*"In the Wieringermeer Case, the only model which generates accurate as well as reliable results is the Wave mode. "* *"The national government has to stimulate precision agriculture by means of legislation. This is the only way to minimise the negative effects of nitrogen leaching."* *"As I have said before, first you have to look at the development of crop and then at the other factors. Based on that aspects it is better possible to estimate… "*
Once/twice a week	• Summarise contributions	*"To summarise, we agree on (...)."* *"The main points for further discussion are (...)."* *"Most of us appear to disagree on (...)."*
Students mostly agree with each other or students are 'too nice' to each other	• Give a counter-argument or counter-evidence • Ask provoking questions • Ask to elaborate; explain (Collison *et al.*, 2000)	*"Do you agree or disagree with this statement?"* *"What are some possible solutions for the problem of...? "* *"As I read in many research proposals lots of people advocate stakeholder involvement. The procedure and pathways to follow are often lacking. Could you please indicate how stakeholder involvement could be established?"*
Students are not clear in their notes or something is not correct	• Ask for explanations or illustration	*"Can you explain what you mean?"* *"Explain how you..."* *"A somewhat strange contradiction. In the first line you state agriculture and tourism cannot be combined whereas all the examples you mention indicate that these have to be integrated. Please clarify."*

Besides instructing teachers, these schemes could also be used to check teachers' interventions after the courses; did teachers moderate in accordance with the guidelines? Therefore, it was necessary to determine the inter-rater reliability of the schemes. After constructing the two schemes, twenty teachers' notes were analysed independently by two raters on type of action to calculate Cohen's Kappa. Cohen's Kappa was satisfactory, namely .88, which means that 90% of all decoded types of actions were decoded identically. Notice that it could be possible that a teacher used different types of actions in one note. For example, a teacher makes a compliment first and next asks a question. Therefore, the unit of analysis is not a note, but a meaningful unit (see also chapter 3; Chi, 1997; Gunawardena, Lowe & Anderson; 1997). As a consequence, the number of written notes is not similar to the number of actions.

Keeping these guidelines in mind, some other relevant aspects must be considered when moderating a CSCL-discussion. Moderators have to judge continuously the appropriate pace of responding to students' notes. Technical issues and questions about assignments or process-related queries are especially time-sensitive. A moderator needs to respond to these types of questions as quickly as possible. "Prevent that students may not be able to progress at all until they hear back from you. When students are stuck in this way, they can start feeling isolated and frustrated at having to wait a long time for a response that will get them back on track" (Collison *et al.*, 2000). In our opinion, it is also preferable to react rather quickly to notes focussed on content. A CSCL-course often demands more disciplined time management and independent motivation from students than a traditional face-to-face course. Therefore, showing involvement is of great importance. If students think no one is reading or responding to their notes, they may become discouraged from contributing further notes. In literature, no standard was found for a 'quick response'. Therefore, we chose a standard by ourselves: a response is called quick when it is sent maximally two days after the student's note it reacts to. A response is called slow when it is sent more than two days after the student's note it reacts to.

Skill in setting tone and infusing personality and humour into on-line courses is essential for anyone seeking to moderate on-line discussions (Collison *et al.*, 2000). In a course without any face-to-face meetings, we think humour and personal style are essential. However, we think it is important for a moderator to use his own style. Moderators should not be forced to intervene in a way that strikes against their personal, educational style; the moderator would not be able to maintain it and students would not accept interventions that feel unnatural to them. In preparation of the courses, teachers were asked for their educational style and then the teacher could choose to moderate socially or critically. Although self-evident, all moderators' notes should be respectful and thoughtful. Moreover, this does not mean that notes always should be positive; more negative feedback could sometimes be useful, too. It is important to select the right tone to help the students see their own thinking and to motivate them to participate (Collison *et al.*, 2000).

6.2.2.1 Instructing the teachers

In our research, teachers were instructed by presenting and discussing the guidelines for moderating. Teachers could ask questions if the guidelines were not clear. Besides, students' notes from earlier courses were given to try out the guidelines and to evaluate possible intervening actions. Besides the 'rules of moderation' like described above, we emphasised not to use e-mail but only to communicate on-line by WebKF. We asked teachers to use clear titles in their notes. Furthermore, teachers were not obliged to write a certain number of notes or to read a certain percentage of notes, but we asked them to participate frequently. Between times, we evaluated the way of moderation to check whether teachers got on with the guidelines and to correct it if necessary.

6.3 Research questions and expectations per study

In recent years, educators and researchers have become increasingly interested in moderating on-line discussions. In the final phase of this PhD project, many interesting books have been published about the question how to moderate on-line groups optimally. The theoretical framework outlined above presents a selection of relevant ideas and models, used to develop practical guidelines for moderating asynchronous discussion groups. Our interest is in the question whether moderating discussions will affect students' learning. In this PHdissertation, students' learning was characterised in terms of participation, learning activities and (quality of) knowledge construction. Participation referred to the number of written and read notes. Written notes were subdivided into new and build-on or reply notes. Read notes were only notes written by fellow-students or by the moderator and not students' own notes, and each read note was counted once, even if a note was read more often. Learning activities were subdivided into three main categories: (1) cognitive learning activities, (2) affective learning activities and (3) metacognitive learning activities. Next, these main categories were subdivided into several subcategories: debating, using external information and experience, linking or repeating internal information, planning, keeping clarity and monitoring (see chapter 4). Knowledge construction was operationalised as adding, elaborating and evaluating ideas, summarising and evaluating external information and linking different facts and ideas (see chapter 4). Quality of the constructed knowledge was assessed in terms of level of understanding, derived from the SOLO-taxonomy (Biggs & Collis, 1982). The lowest level (D) was defined as unistructural, level C means multistructural, level B means relational and the highest level A was defined as extended abstract.

This chapter describes two studies in which different moderational approaches were used in two university courses. Notice that in each study half of the students were moderated and the other half was self-regulated. Therefore, results will be compared between the groups within the studies. In study 5, the teacher moderated the discussion on social aspects: stimulating the process of collaboration and motivating students to work at the task. The research question (4a) was formulated as: *What are the effects of socially moderating a CSCL-discussion on students' learning?* In the first study of this chapter, we expected social moderation to motivate students to participate and to collaborate, to enhance communal effort. We expected moderated discussions to be more productive in terms of number of contributed and read notes compared to unmoderated discussions. Considering learning activities, we expected to find more metacognitive and affective activities in the moderated discussions because these types of learning activities refer to interaction between students. No effects were expected on cognitive learning activities or knowledge construction.

In study 6, the teacher moderated the discussion on critical aspects: stimulating the process of critical thinking. The research question (4b) was formulated as: *What are the effects of critically moderating a CSCL-discussion on students' learning?* In the second study of this chapter, we expected critical moderation to help students to focus on the content of the task and to deepen their cognitive learning activities. We expected moderated discussions to be more productive in terms of using more cognitive learning activities and constructing more knowledge compared to the unmoderated discussions. The quality of the knowledge was also expected to be better. Considering affective and metacognitive learning activities, we expected not to find effects. No effects were expected on the extent of participation. However, because of the expected increase of debating activities, we expected to find an effect in the number of used build-on notes. The moderated group was expected to use more build-on notes than the self-regulated group.

Besides these two research questions we analysed moderators' activities to survey how the moderation was executed. Therefore, each study deals with the following sub-questions:

a) Which types of actions, as formulated in the guidelines, did the moderator use in the discourse?
b) What is the percentage of students' notes read by the moderator?
c) How many notes did the moderator contribute to the discourse, divided into new and build-on notes?
d) What is the percentage of students to whom the moderator directed one or more notes?
e) Were moderator's notes followed by one or more build-on notes written by students?
f) Did the moderator reply quickly or slowly to students' notes?
g) Do the number of students' and moderator's notes, contributed per week, relate to each other?

6.4 Two studies

This section will first explain how the two studies are related (section 6.4.1) and next, section 6.4.2 will explain how the data were analysed.

6.4.1 Background issues

Just as the four studies presented in chapter 5, the studies described in this chapter were conducted at a university, too, and took place as part of a real course in which students had to work collaboratively on tasks by means of a CSCL-system. Other similarities between the studies are the place in the study programme (final phase) and the absence of rules concerning the use of the CSCL-system. Students were expected to log in regularly, but were not obliged to read all notes or to write a certain numbers of notes. The studies described in this chapter differ from the studies described in the previous chapter in having a moderator. The teachers who organised the course moderated only half of the discussions because we had a control group. In all courses the CSCL-system Web Knowledge Forum was used. This system has already been described in chapter 5 (see section 5.4.2).

6.4.2 Data analyses

Both students' and moderators' notes were automatically logged as text files on the computer. Students' notes were analysed on participation, type of learning activities, and amount and quality of the constructed knowledge. Again, we used the methods described in chapter 4. Moderators' notes were analysed on quantity as well as on types of intervention (action), focusing on the sub-questions as formulated in section 6.3. Before executing T-tests to answer the main research questions (4a and 4b), we decoded the moderators' types of actions during the discourses to check whether the teachers moderated the discourses in conformity with the guidelines (sub-question a). Next, the percentage of read notes (sub-question b) and the number of written (new and build-on) notes were analysed using the ATK (sub-question c). Concerning sub-question d, by counting build-on notes we calculated the percentage of students to whom the moderator directed one or more notes. Besides, the number of notes replied to moderators' contributions was analysed. In other words, did students react to a moderator's note and did the moderator's note lead to a discussion or did students read the note and go on with their activity (sub-question e)? The moderators' reaction time, operationalised as the number of days between a student's note and the moderator's note built on that student's note was of interest as well (sub-question f). The last sub-question (g) concerned the relation between the number of students' and moderator's notes contributed per week. Therefore, a Pearson correlation test was conducted.

6.5 Study 5: ICT in education

This section will report on the study ICT in education. The aim of this study is to analyse possible effects of social moderation on students' learning in a CSCL-system. Section 6.5.1 will describe the method used in the study ICT in education. Section 6.5.2 will show the results of students' learning processes in the moderated and self-regulated groups. Finally, section 6.5.3 will discuss the results of the present study.

6.5.1 Method

In 2001, the study ICT in education was integrated as part of a regular eleven-week undergraduate course on the use of ICT in education and training at the University of Nijmegen (KUN), which involved 20 undergraduate students. In the first meeting, students were informed about the design of the course, the use of WebKF, and the idea of CSCL. None of the students had used a CSCL-system before; WebKF was unknown. However, after a practical introduction about WebKF, students did not have any difficulty in learning to use the system. Students were expected to spend about ten hours on the course weekly; three hours were planned for work in the CSCL-system. The formulated learning objectives of the course were: gaining insight into new applications of Information and Communication Technology in education and practising CSCL. Figure 6.4 shows the design of the course.

Task 1 Eight weeks Thematic group (N=7) Moderated	Task 1 Eight weeks Thematic group (N=11) Self-regulated
Task 2 Four weeks Deepening group (N=5) Moderated	Task 2 Four weeks Deepening group (N=5) Self-regulated

Figure 6.4. Design of the course ICT in education.

Because of the design of the course, the subjects to be discussed in WebKF were divided into thematic groups (task 1) and deepening groups (task 2). In a thematic group, students had to write an educational management note in collaboration. In a deepening group, students had to use WebKF to work out their ideas about one specific ICT-application and the use of that application in education. To finish this part of the course, students had to present orally their ideas to the other groups in the class. Students worked eight weeks on task 1 and four weeks on task 2. In neither task questions were formulated to guide the discussion and no rules or restrictions were given concerning the use of WebKF; students were free to discuss with each other. Half of the groups of students were moderated according to the social moderation guidelines (see Table 6.2); the other half were self-regulated teams. Students were assigned at random to one of these two conditions and did not switch during the course. During the course, six meetings were organised. These meetings were rather traditional; the teacher gave a course of lectures about one of the ICT-applications and demonstrated some programs. The assessment was composed of three parts: the written management notes, the oral group presentation and a test. All group members got the same mark. Participation and involvement in the course were used to round off the mark.

6.5.2 Results

Section 6.5.2.1 will describe students' participation and learning activities used in all groups and in all tasks globally. Section 6.5.2.2 will first summarise the results of the analyses of students' learning processes in more detail and next this section will compare the results of the moderated and self-regulated group in order to answer the first research question. Section 6.5.2.2.1 concerns the results of task 1 (thematic discussion); section 6.5.2.2.2 concerns the results of task 2 (deepening discussion). The final section, 6.5.2.3, will describe the activities of the moderator sequenced by the seven sub-questions.

6.5.2.1 Overview of participation and learning activities in all groups

In this study, two thematic groups and two deepening groups were selected to be analysed. In some groups, the teacher refused to moderate because of being too busy. These groups were not relevant for analysis and we decided to select only the groups in which the teacher really had moderated the process. Notice that each group worked in one view. The four analysed views were called ICT used in labour organisations (task 1; N=7), knowledge network at primary schools (task 1; N=11), educational media (task 2; N=5) and virtual classes (task 2; N=5). A total of 28 students participated in the four discussions. In view of the total number of students who followed the course (N=20), it is clear that eight students participated in a deepening group as well as in a thematic group. These discussions did not take place at the same time; therefore, it is not a problem to analyse these views. One thematic group as well as one deepening group was moderated (ICT used in labour organisations and educational media); the other two groups were self-regulated (knowledge network at primary schools and virtual classes).

Table 6.4 shows an overview of the four analysed discussions. Students wrote 16.76 notes on average; 37% of all written notes were build-on notes. The mean number of read notes was 65.44; this concerns fellow-students' or teacher's notes. A total of 469 notes was produced by students; 40 notes were contributed by the moderator (see Tables 6.9 and 6.10). Notes could be isolated, which means they have no connection to other notes. However, notes could also be organised in clusters. A cluster is defined as a note followed by one or more build-on notes (see also chapter 5). When a new note is contributed to the discussion thread, a new cluster is started. In the table, clusters contained both students' and moderator's notes. 44 notes were isolated, 45 clusters of two or three notes were found and 27 clusters (= 23% of all clusters) were larger than three notes.

Table 6.4. Global overview of the four analysed discussions (ICT in education study)

	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
(N=28)			44	45	12	12	3	0
New	10.48	7.75						
Build-on	6.28	5.53						
Read	65.44	41.39						

6.5.2.2 Analysing students' learning processes per task

The main research question of this study was formulated as: What are the effects of socially moderating a CSCL-discussion on students' learning? To answer this question moderated and self-regulated groups were compared. At first sight, we wanted to combine the results of the two tasks (see section 6.5.1). However, analyses of students' contributions gave rise to the execution of an analysis of variance (ANOVA, in GLM Multivariate), to check whether there were main and/or interaction effects concerning the factors task and group. The dependent variables were new notes, build-on notes, read notes, and cognitive, affective and metacognitive learning activities. The independent variables were task and group. A main effect was found for the factor task ($F=2.91$; $p < .05$) and besides, an interaction effect was found between the factors task and group ($F=3.01$; $p < .05$) (see also Table 6.5). Therefore, the moderated and self-regulated groups were compared per task.

Table 6.5. Results of a multivariate analysis of variance (F, df and p). Dependent variables: new notes, build-on notes, read notes, cognitive, affective and metacognitive learning activities. Independent variables: task, group

	Results of Analysis of variance (ANOVA, in GLM Multivariate)		
	F	df	p
Intercept	19.03	19	.00
Task (1 or 2)	2.91	19	.04*
Group (moderated or self-regulated)	1.67	19	.18
Task * group	3.01	19	.03*

Table 6.6 gives number of students, the means and standard deviations of the dependent variables new, build-on and read notes and cognitive, affective and metacognitive learning activities in the different conditions (task 1 * moderated, task 1 * self-regulated, task 2 * moderated, and task 2 * self-regulated). The Tests of Between-Subjects Effects shows that the main effect on task was caused by

the dependent variable cognitive activity (F=9.69; p < .01) and the interaction effect between the factors task and group by the dependent variable read notes (F=9.07; p < .01).

Table 6.6. Descriptive statistics (N, SD's and means of the dependent variables in each condition)

Descriptive statistics					
Dependent variables	Task	Group	Mean	SD	N
New notes	1	M	6.71	5.88	7
		SR	11.82	10.06	11
	2	M	14.00	6.60	5
		SR	9.40	3.21	5
Build-on notes	1	M	3.14	4.71	7
		SR	7.36	6.92	11
	2	M	8.00	5.00	5
		SR	6.60	2.07	5
Read notes	1	M	41.43	27.25	7
		SR	85.45	53.19	11
	2	M	89.80	3.77	5
		SR	45.00	5.70	5
Cognitive	1	M	6.43	5.68	7
		SR	3.73	3.38	11
	2	M	11.20	6.72	5
		SR	12.60	7.73	5
Affective	1	M	5.86	5.27	7
		SR	8.28	7.77	11
	2	M	4.80	1.92	5
		SR	6.60	4.83	5
Metacognitive	1	M	11.29	9.91	7
		SR	12.36	10.95	11
	2	M	14.00	5.34	5
		SR	12.80	6.69	5

Task 1= Thematic discussion M= moderated group
Task 2= Deepening group SR= self-regulated group

Figure 6.5 presents the means of the new and build-on notes written by students and the mean number of read notes per student in the four different conditions (task 1 * moderated, task 1 * self-regulated, task 2 * moderated, and task 2 * self-regulated). The two groups working on task 2 differed significantly in the number of read notes (p<.00). In task 1, the difference was only marginally significant (p<.10). However, the effect was the other way around. Now, students in the self-regulated group read more notes compared to students in the moderated group.

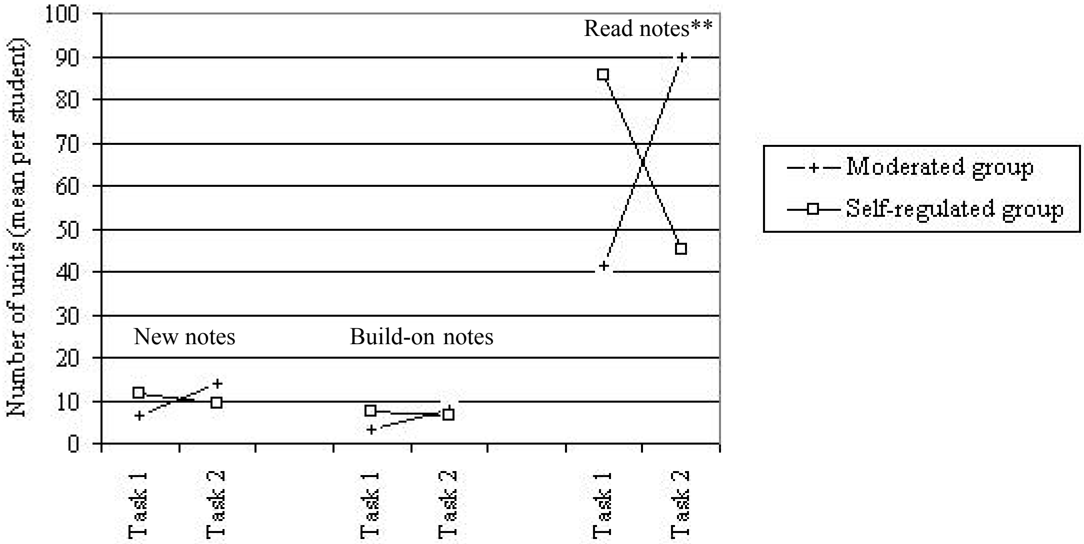


Figure 6.5. Mean participation per student (written, build-on and read notes) in the two tasks and in the two different groups (ICT in education study) (** p< .00).

Figure 6.6 presents the means of the used cognitive, affective and metacognitive activities per student in the four different conditions (task 1 * moderated, task 1 * self-regulated, task 2 * moderated, and task 2 * self-regulated). The two groups never differ significantly in the use of learning activities.

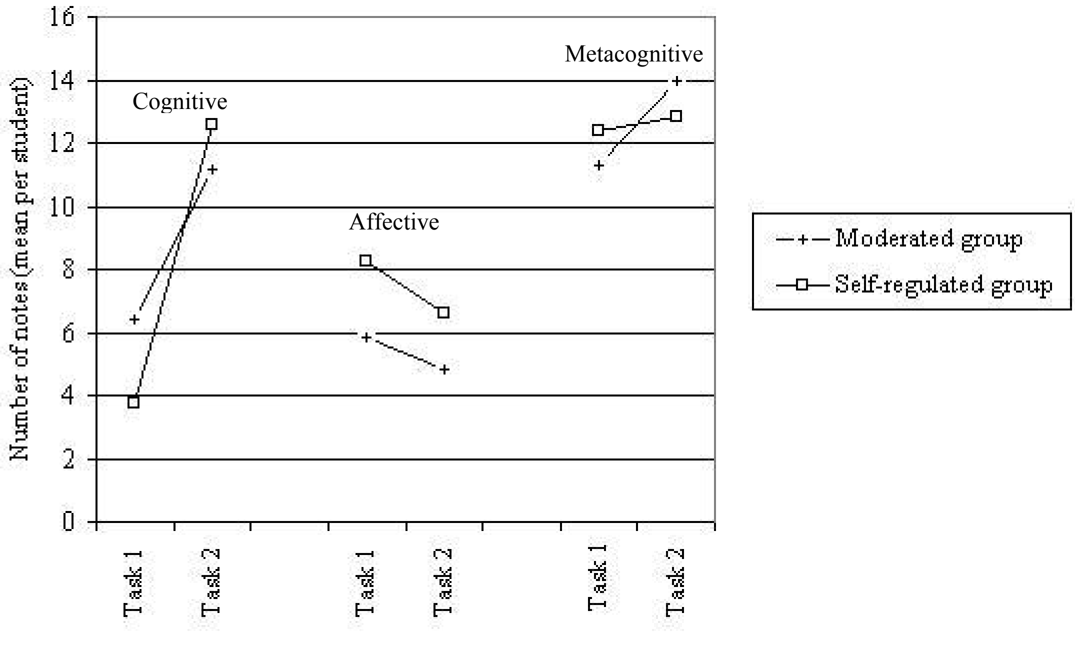


Figure 6.6. Mean of used learning activities per student (cognitive, affective and metacognitive) in the two tasks and in the two different groups (ICT in education study).

6.5.2.2.1 Task 1 *(thematic discussion)*

Table 6.7 shows students' participation, students' learning activities and the amount and quality of the knowledge they constructed while working at the first task in more detail. The results are presented per group (moderated and self-regulated) and means are compared in order to answer the first research question of this chapter: What are the effects of socially moderating a CSCL-discussion on students' learning?

Table 6.7. Overview of students' participation, the decoded learning activities and assigned levels, split up into the moderated and self-regulated thematic discussions (task 1 - study ICT in education)

Task 1	Socially moderated (N=7)		Self-regulated (N=11)		T (df=16)	p-value
	Mean	SD	Mean	SD		
Participation						
# Written notes	9.86	10.27	19.18	16.87	1.31	.21
# New notes	6.71	5.88	11.82	10.06	1.21	.24
# Build-on notes	3.14	4.71	7.36	6.92	1.41	.18
# Read notes	41.43	27.25	85.45	53.19	2.01	.06*
Learning activities						
Cognitive activities	6.43	5.68	3.73	3.38	-1.27	.22
Debating	2.57	2.51	1.37	1.03	-1.44	.17
External information	3.14	3.02	1.18	1.94	-1.69	.11
Internal information	0.71	0.76	1.18	1.60	0.72	.48
Metacognitive activities	11.29	9.91	12.36	10.95	0.21	.84
Planning	7.14	6.72	7.55	7.02	0.12	.91
Keeping clarity	0.71	1.11	1.00	1.55	0.42	.68
Monitoring	3.43	3.10	3.81	3.40	0.25	.81
Affective activities	5.86	5.27	8.27	7.77	0.72	.48
Rest	0	0	0	0		
Knowledge construction	2.87	2.27	5.55	6.90	-0.99	.34
Levels						
Level A	0.43	0.79	0.00	0.30	-1.30	.21
Level B	0.86	1.22	0.55	0.82	-0.65	.52
Level C	1.29	0.76	0.36	0.67	-2.70	.02**
Level D	0.29	0.49	4.55	6.58	1.69	.11

Concerning active participation and learning activities, no differences were found. We only see a marginally significant difference between the two groups in number of read notes ($p < .10$). However, this marginal effect is contrary to our expectations. Students in the self-regulated group read on average twice as much notes compared to students in the moderated group (difference 44.02). One effect was found concerning levels of knowledge construction. Moderated students produced on average more units on level C than self-regulated students ($p < .05$).

6.5.2.2.2 Task 2 *(deepening discussion)*

Table 6.8 shows students' participation, students' learning activities and amount and the quality of the knowledge they constructed while working at the second task in more detail. The results are presented per group (moderated and self-regulated) and means are compared in order to answer the first research question of this chapter: What are the effects of socially moderating a CSCL-discussion on students' learning?

Table 6.8. Overview of students' participation, the decoded learning activities and assigned levels, split up into the moderated and self-regulated deepening discussions (task 2 - study ICT in education)

Task 2	Socially moderated (N=5)		Self-regulated (N=5)		T (df=8)	p-value
	Mean	SD	Mean	SD		
Participation						
# Written notes	22.00	11.49	16.00	5.10	1.07	.32
# New notes	14.00	6.60	9.40	3.21	1.40	.20
# Build-on notes	8.00	5.00	6.60	2.07	0.58	.58
# Read notes	89.80	3.77	45.00	5.70	14.66	.00*
Learning activities						
Cognitive activities	11.20	6.72	12.60	7.73	-0.31	.77
Debating	4.60	3.58	4.00	2.24	0.32	.76
External information	4.60	3.05	5.80	3.90	-0.54	.60
Internal information	2.00	1.41	2.800	3.11	-0.52	.62
Metacognitive activities	14.00	5.39	12.80	6.69	0.31	.77
Planning	6.20	2.77	6.20	3.11	0.00	1.00
Keeping clarity	0.60	0.89	1.60	1.82	-1.10	.30
Monitoring	7.20	3.96	5.00	3.16	0.97	.36
Affective activities	4.80	1.92	6.60	4.83	-0.78	.46
Rest	0	0	0	0		
Knowledge construction	4.6	2.70	5.0	2.55	-0.24	.82
Levels						
Level A	0.00	0.00	0.20	0.45	-1.00	.35
Level B	0.40	0.89	2.20	1.64	-2.15	.06*
Level C	2.80	1.92	2.00	1.00	0.83	.43
Level D	1.40	0.55	0.60	0.89	1.71	.13

The two groups differ in the number of read notes ($p < .01$); twice as many notes were read by students in the moderated group compared to students in the self-regulated group (difference= 44.9). Concerning learning activities (cognitive, affective and metacognitive) and the amount of constructed knowledge, no differences were found. Concerning the quality of constructed knowledge, a marginally significant effect was found for the number of units decoded as level B. Students in the self-regulated group wrote on average more notes on level B than students in the moderated group (difference= 1.80; $p <.10$).

6.5.2.3 Analysing moderators' activities

Besides the main research question, seven sub-questions were addressed (see section 6.3) in order to gain insight into the activities of the moderator. We wanted to know whether the moderator acted according to the guidelines given beforehand (see section 6.2.2), and additionally, we wanted to survey moderator's participation. Section 6.5.2.3.1 will present the results of these analyses for task 1 and section 6.5.2.3.2 for task 2.

6.5.2.3.1 Task 1 *(thematic discussion)*

Table 6.9 summarises the moderator's contributions to the group discussing about the theme ICT used in labour organisations.

Table 6.9. Overview of the moderator's contributions to the thematic discussion group (task 1- ICT in education study)

Quantitative activities moderator	
Read notes (%)	100
Written notes (#)	11
Build-on notes (#)	9
Students reacted to (%)	71
S1	11
S2	11
S3	11
S4	33
S5	33
S6	0
S7	0
Reaction time in days (#)	
≤ 1	3
2	5
3	0
4	1
≥ 5	0
Notes following a moderator's note (#)	
0	10
1	0
2 ≤ 3	0
4 ≤ 6	1
≥ 7	0
Types of moderator interventions	
Content of notes – Number of social interventions (100%)	
Help to resume the discussion	1 (5%)
Motivate students/Help to get started	7 (32%)
Specify where or how to find support	2 (9%)
Emphasise the need for contributions	3 (15%)
Call for personal participation	1 (5%)
Refer to notes of students concerning the same subject/ Link coherent notes	0 (0%)
Emphasise students to read each other's notes	2 (9%)
Give feedback/Refer to excellent notes	6 (27%)
Pass a question on to fellow students	0 (0%)
Content of notes – Number of other interventions (100%)	
Social talk	0 (0%)

All units (N=22) could be decoded as a social intervention (sub-question a). By far, most units aimed at motivating students (32%). The moderator emphasised the need for contributions four times; three times directed at the group and one time it was a personal call. In 27% of all units, the moderator gave feedback or referred to good notes. The moderator read all students' notes (sub-question b) and he contributed 11 notes (sub-question c). 82% of all written notes were build-on notes; these were directed at five of the seven students (71%) (sub-question d). Only once a cluster followed on a moderator's note (sub-question e). Measured by our standard (see section 6.2.2), the moderator contributed 89% of the build-on notes quickly (sub-question f). Figure 6.7 shows the number of students' and moderator's notes contributed in the progress of the course. The mean number of notes contributed by students did not correlate with the absolute number of notes contributed by the moderator (r=.24; p=.57) (sub-question g).

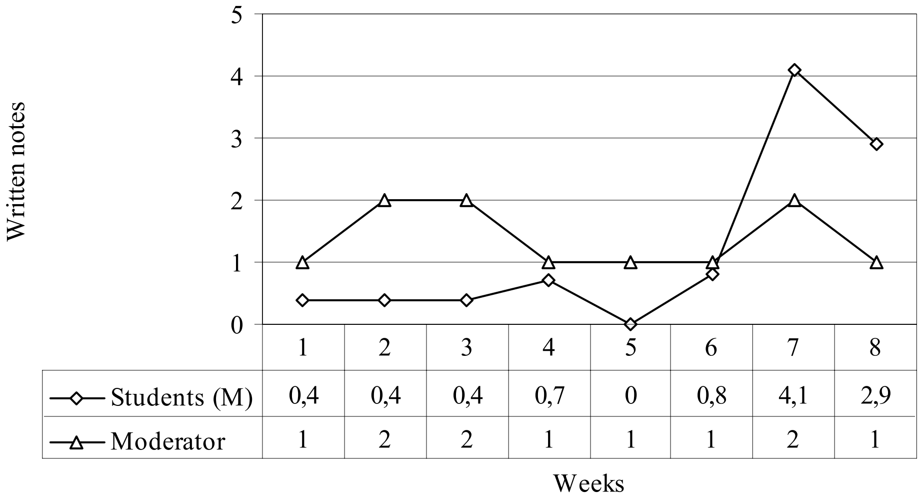


Figure 6.7. Pattern of students' and moderator's contributions (mean per student, absolute for the moderator) in the eight-week discussion about the theme ICT used in labour organisations in the ICT in education course.

6.5.2.3.2 Task 2 *(deepening discussion)*

Table 6.10 summarises the moderator's contributions to the deepening group discussing about the use of media in education.

Table 6.10. Overview of the moderator's contributions to the deepening group (task 2 - ICT in education study)

Quantitative activities moderator	
Read notes (%)	100
Written notes (#)	29
Build-on notes (#)	23
Students reacted to (%)	100
S1	17
S2	30
S3	26
S4	17
S5	9
Reaction time in days (#)	
≤ 1	9
2	9
3	0
4	2
≥ 5	3

Table 6.10 continued

Notes following a moderator's note (#)	
0	24
1	5
2 ≤ 3	0
4 ≤ 6	0
≥ 7	0
Types of moderator interventions	
Content of notes – Number of social interventions (100%)	
Help to resume the discussion	9 (16%)
Motivate students/Help to get started	6 (11%)
Specify where or how to find support	0 (0%)
Emphasise the need for contributions	5 (9%)
Call for personal participation	6 (11%)
Refer to notes of students concerning the same subject/ Link coherent notes	6 (11%)
Emphasise students to read each other's notes	3 (5%)
Give feedback/Refer to excellent notes	9 (16%)
Pass a question on to fellow students	3 (5%)
Content of notes – Number of other interventions (100%)	
Social talk	9 (16%)

Except for the action 'specify where or how to find support', each action was used at least once by the moderator (sub-question a). Most interventions aimed at resuming the discussion (16%) or concerned giving feedback (16%). The moderator was also busy motivating students (11%) and stimulating participation (emphasise the need for contributions and call for personal participation: 20%). Contrary to the thematic discussion, the moderator now also had social talks (16%) and linked coherent notes (11%). The moderator read all notes (sub-question b). In total, the moderator wrote 29 notes; 23 of those were build-on notes (79%) (sub-question c). These build-on notes were directed at least two times to each participating student (sub-question d). The maximum of build-on notes directed to one student was seven. A large number of moderator's notes were not followed by a student's note (83%). A cluster of notes never followed a contribution of the moderator (sub-question e). Measured by our standard, the moderated contributed 78% of the build-on notes quickly (sub-question f). Figure 6.8 shows the mean number of students' and absolute number of moderator's notes contributed in the progress of the course. The mean number of notes contributed by students correlated positive with the absolute number of notes contributed by the moderator ($r=.98$; $p< .02$) (sub-question g). The explosion of notes in the third week is striking; students wrote 52% of all their notes in week three against 62% by the moderator.

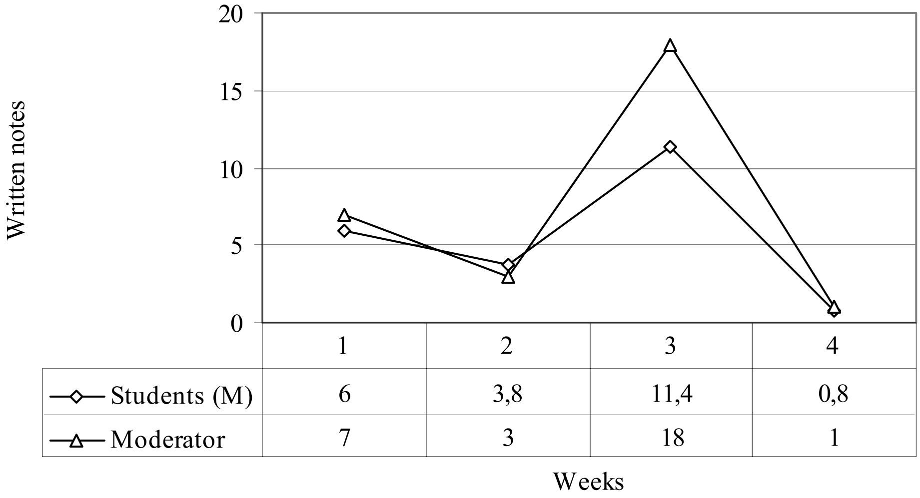


Figure 6.8. Pattern of students' and moderator's contributions (mean per student, absolute for the moderator) in the four-week discussion about the use of media in education in the ICT in education course.

6.5.3 Conclusions and discussion

We expected socially moderated discussions to be more productive in terms of number of contributed and read notes compared to unmoderated discussions. With regard to learning activities, we expected to find more metacognitive and affective activities in the moderated discussions. No effects were expected on cognitive learning activities or knowledge construction (see section 6.3).

With regard to participation, the two groups differed (marginally) significantly in number of read notes in each task. However, the effects found of the two tasks are contradictory. In task 1, students in the self-regulated group read on average more notes than students in the moderated group. In task 2, students in the moderated group read on average more notes than students in the self-regulated group. In both tasks, no differences were found concerning the number of written notes. Looking at the learning activities used, we see no effects in both tasks. We expected students to make more plans to approach a task collaboratively, to exchange information more often, to give more affective comments, and to link more notes to fellow-students' contributions compared to students who were unmoderated socially. In other words, we expected students to collaborate more intensively in the moderated groups than the students in the self-regulated groups.

However, students seemed not to be susceptible to the attempts of the moderator to stimulate collaboration processes and to keep the discussion alive in the sense that more metacognitive and affective contributions were produced. With regard to quality of knowledge, no effects were expected. However, in task 1, moderated students wrote on average more notes decoded as level C than self-regulate students. The self-regulated students working at task 2 wrote more notes decoded as level B than moderated students working at this second task.

In view of all this we have to conclude that our expectations were not confirmed in this study. Looking at both tasks, the study gives no reason to assume that moderating a discussion socially will increase collaboration between students. However, in task 2 a significant effect was found on passive participation; in task 1, the effect was only marginal. In order to explain why an effect was found on passive participation in one of the tasks, we will compare the performance of the moderation in the two tasks on both quantitative and qualitative aspects. Besides, we will reflect on the question why no effects were found on the number of metacognitive and affective learning activities used. We left the effects found on levels B and C out of the discussion and consider these effects to be coincidence, because the number of units decoded as B or C is very small.

Looking at Figures 6.7 and 6.8, we see quite a different pattern of students' and moderators' contributions in the progress of the task discussions. In task 1, no correlation was found between the mean number of students' notes and the absolute number of moderator's notes. In task 2, the correlation between the mean number of notes contributed by students and the absolute number of notes contributed by the moderator was significantly positive. We interpret this correlation as follows. In task 2, moderator's involvement, made concrete by contributing notes, resumed the discussion. Not in the sense of replying directly (in both tasks a large percentage of moderator's notes remained unanswered, 91% in task 1 and 83% in task 2, consecutively), but in triggering students to read each other's notes. In both tasks, the moderator posted the notes quickly (respectively 89% of all notes in task 1 and 78% of all notes in task 2). Therefore, response time cannot explain the small effect of resuming the discussion. In task 1, the moderator contributed a total of 11 notes against 29 notes in task 2. Taking the period of weeks into account, the teacher was more active in task 2; on average 1.38 notes per week in task 1 and 7.25 notes per week in task 2. Working at the second task, students were very quiet in the first half of the period. In the first five weeks, they only contributed 19% of all their notes. On the other hand, the moderator tried to motivate the students by giving feedback, emphasising the need for contributions and helping students to get started. The moderator posted 54% of all his notes in the first half of the period. Apparently, the moderator was not successful in provoking students to participate. Students chose the moment they worked by themselves and seemed to be unsusceptible to the interventions by the teacher. Comparison of the quantitative aspects of the moderation in both tasks gives no useful information to explain why the effect on reading notes was significant in task 2 only. Therefore, types of actions were compared as well.

Table 6.11 shows the types of actions used by the moderator in the two tasks (summary of Tables 6.9 and 6.10). There is a remarkable difference for social talks: the moderator never had social talks in task 1 and 16% of all actions in task 2 were decoded as social talk. Furthermore, the results show a high percentage of motivational actions in task 1 (32%) and a high percentage of feedback given by the moderator during the first task. In the second task, relatively many actions were directed at resuming the discussion (16%) and linking coherent notes (11%). In both tasks, the moderator emphasised the importance of reading each other's notes, but it is striking that the moderator did this more often in the first task.

Table 6.11 Comparison of types of action used by the moderator in the two tasks (% of all actions)

	Task 1 (%)	Task 2 (%)
Resume the discussion	5	16
Motivate students	32	11
Finding support	9	0
Call for contributing	20	20
Coherent notes	0	11
Emphasise reading	9	5
Giving feedback	27	16
Pass on question	0	5
Social talk	0	16

To conclude: in both tasks the teacher moderated according to the instructional guidelines, although some nuances in types of actions used can be noticed. Besides, the way in which the teacher moderated the discussions (with regard to number of actions, types of actions and response time) was nearly the same in both tasks and therefore there is no reason to assume that the differences found in extent of passive participation were a consequence of socially moderating the discussion. Although moderators were instructed beforehand, the practice of moderating and choosing types of actions is an interaction with the students. The moderator must react to students' expressions; moderator's interventions are related to and influenced by students' activities. As researchers, we can instruct teachers, but it depends on the teachers' quality how the moderation will be conducted. In spite of moderating according to the instructional guidelines, the moderator was not able to stimulate students to work at the task collaboratively. We assume that other factors played a role, factors we did not explicitly pay attention to during the instruction. Examples of factors are time needed to read all notes and to contribute to the discussion, lack of information about the students (interests, studying motives, experiences with collaborative learning), change of teachers in the course, and finding the right tone. Excluding the practical way in which teachers moderated the discussion (as discussed above) and based on our experiences with the course, we assume that especially the factor tone was of importance (see also section 6.2.1). Adding tone helps to address the potential for misinterpretations. Examples of tone are nurturing, imaginative, curious, informal, humorous, neutral, analytical and whimsical (Collison *et al.*, 2000). In this study, we know from experience that having social talks was a result of a positive group atmosphere. However, we aimed at affecting the group atmosphere positively; that is an important difference. We think the moderator in this study did not find the right tone to communicate with students on the same wavelength. Students in their turn were not willing to invest in the communication and interaction very much. Based on this study, we claim that by missing the right tone, moderating discourses is almost impossible.

6.6 Study 6: Land Evaluation II

This section will report on the study Land Evaluation II in which we search for effects of critical moderation on students' learning processes and their knowledge construction. First, the method of the Land Evaluation II course will be described in section 6.6.1. Section 6.6.2 will show the results of students' learning processes and the moderator's activities related to each other. In section 6.6.3, we will discuss the results of the present study.

6.6.1 Method

The design of the courses Land Evaluation I, described in chapter 5, and Land Evaluation II was comparable, except for the fact that in Land Evaluation II, students worked in multidisciplinary teams in both cases. To make it easy to read this chapter, we will repeat the course information and make it up to date where necessary. In November-December 2000, CSCL was implemented in the optional six-week course on "Land evaluation and variability for explorative land use studies" (Land Evaluation II) at Wageningen University (WU). Students were expected to spend about twenty hours on the course weekly. The formulated learning objectives of the course were: (a) to perform a process of land evaluation: stakeholder analysis, problem definition, choice and application of models, evaluation and presentation; (b) to know the characteristics of various models for land evaluation and be able to apply them, supported and linked with a GIS, and (c) to gain experience in working in multidisciplinary groups and be able to critically reflect on research methods.

During the introductory meeting, students were informed about the course, the various tasks, the digital learning environment, the concept of collaborative learning and the practical use of WebKF. WebKF took a central place during the whole course. Students mostly worked in one room, which was reserved to make sure there were enough computers. The teacher was in the room about once a week, to 'keep in touch' with his students and to give help if necessary. In the first two weeks, students did some exercises in WebKF and received a few lectures on land evaluation tools and models. Subsequently, students worked collaboratively in multidisciplinary teams to solve two open-ended problem cases. Students had to reformulate the problem first and then they had to solve the problem by using the models studied in the first two weeks. The problem-solving process was subsequently supported by subtasks, exercises and a planning schedule. First, students had to do subtasks and exercises individually; next, they had to respond to each other's contributions. Finally, they had to evaluate different problem solutions and make a shared decision about the best solution. The assessment was based on two tests that were held during the course. The tests consisted of a case, comparable to the open-ended cases solved in the CSCL-system. Participation and involvement in the course were also considered (33% of the assessment).

A total of nine undergraduate students were involved in the study. The course was meant for students from various disciplines. Three courses were recommended as prior knowledge. Seven students (78%) followed the three recommenced courses; two (foreign) students followed none of the recommended courses (22%). These students were divided into two groups (N=4; N=5). To create groups, students were selected at random, but in each group one foreign student participated. The teacher moderated the group of four students by critical interventions; the group of five students was self-regulated. In each group, one student had participated in a discussion group before; but in both cases, it was not in an educational course. Seven students had never participated in a discussion group before. Nevertheless, students had no difficulty in using the CSCL-system and no technical troubles occurred. All students were used to working at problem cases, face to face or on paper.

6.6.2 Results

Section 6.6.2.1 will give a global view of students' participation and learning activities used in the whole group to give an idea about the progress of the course. Section 6.6.2.2 will first summarise students' participation and learning activities used in more detail, and next, this section will compare the results of the moderated and self-regulated group to answer the second research question. Section 6.6.2.3 will describe the results of analysing moderator's activities sequenced by the seven sub-questions.

6.6.2.1 Global overview of participation and learning activities

All four views, two cases in the moderated and two in the self-regulated group, were analysed. Table 6.12 shows means and standard deviations split up into new, build-on notes and read notes. The views were organised in clusters of different sizes. A total of 417 notes was written by students; the moderator wrote 40 notes (see Table 6.14). As in study 5, clusters contained both students' and moderator's notes. It is striking that only 15% of the clusters consisted of one isolated note (=3% of all written notes); 56% of all clusters contained between 2 and 6 notes; 21% of all clusters contained between 7 and 14 notes. Furthermore, 8% of all clusters contained 15 notes or more.

Table 6.12. Global overview of the four analysed discussions (Land Evaluation II study)

	Mean	SD	Cluster size					
			1	2 ≤ 3	4 ≤ 6	7 ≤ 9	10 ≤ 14	≥ 15
(N=9)			12	26	21	14	4	7
New	12.88	10.04						
Build-on	33.44	23.33						
Read	192.67	89.69						

6.6.2.2 Analysing students' learning processes

Figure 6.9 shows students' participation per group (mean per student) expressed as the number of written notes (new and build-on) and read notes. It is true that the moderated group participated more than the self-regulated group with regard to every indicator of participation used, but only the difference in the number of written build-on notes was significant (difference = 29.35; p<.05).

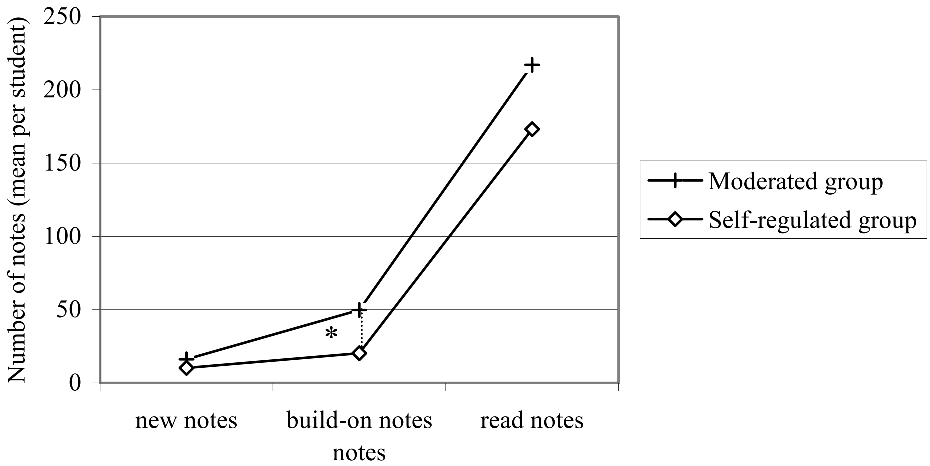


Figure 6.9. Mean participation per student (written, build-on and read notes) in the two different groups in the Land Evaluation II course (* p<.05).

Figure 6.10 illustrates the proportion of cognitive, affective and metacognitive learning activities in the moderated and self-regulated group. Students in the moderated group produced nearly four times as many cognitive units as students in the self-regulated group (difference = 58.3). Moderated students produced about twice as many affective units as self-regulated students (difference = 21.55). Finally, students in the moderated group used on average more metacognitive units than student in the self-regulated group (difference = 12.05).

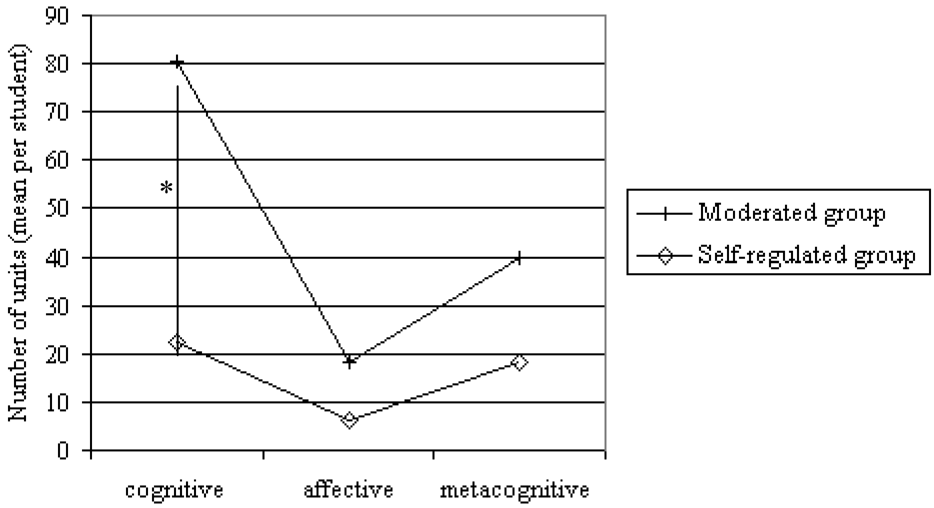


Figure 6.10. Mean of used learning activities per student (cognitive, affective and metacognitive) in the two different groups in the Land Evaluation II course (*p<.05).

The second research question of this chapter was formulated as: What are the effects of critically moderating a CSCL-discussion on students' learning? Therefore, the results are analysed in more detail per group (moderated and self-regulated) and next the means are compared. Table 6.13 summarises students' participation, learning activities used and quality of constructed knowledge in more detail.

Table 6.13. Overview of students' participation, the decoded learning activities and assigned levels, split up into the moderated and self-regulated groups (Land Evaluation II study)

	Critically moderated (N=4)		Self-regulated (N=5)		T (df=7)	p-value
	Mean	SD	Mean	SD		
Participation						
# Written notes	66.00	34.19	30.6	23.14	-1.86	.11
# New notes	16.25	12.01	10.2	8.56	-0.89	.41
# Build-on notes	49.75	22.63	20.4	15.01	-2.34	.05*
# Read notes	217.00	140.06	173.2	17.66	-0.71	.50
Learning activities						
Cognitive activities	80.50	17.90	22.20	11.69	-5.92	.00**
Debating	45.50	11.90	15.40	10.31	-4.07	.01**
External information	11.00	4.083	4.80	2.68	-2.76	.03*
Internal information	24.00	11.60	2.00	1.22	-4.29	.00**
Metacognitive activities	39.75	21.98	18.20	12.26	-1.88	.10*
Planning	16.75	7.37	7.00	6.00	-2.20	.06
Keeping clarity	10.25	6.95	5.40	4.83	-1.24	.26
Monitoring	12.75	8.34	5.80	2.49	-1.79	.12
Affective activities	18.25	15.97	6.20	4.15	-1.65	.14

Table 6.13 continued

Knowledge construction	41.5	15.6	14.00	11.53	3.05	.02*
Levels						
Level A	6.25	5.1235	0.60	0.89	-2.46	.04*
Level B	13.00	4.3205	4.00	2.00	-4.18	.00**
Level C	17.75	11.3248	9.00	9.03	-1.29	.24
Level D	4.50	2.6458	0.40	0.55	-3.43	.01**

Interesting results are the effects on cognitive learning activities (p< .01) and all subcategories within cognitive learning activities: debating (p< .01), external information (p< .05) and internal information (p< .01). Focusing on metacognitive learning activities, we see that the two groups differed marginally in number of planning activities used (p <.10). Moderated students planned on average more than self-regulated students (respectively 16.75 and 7.00 units), but this effect was only marginally significant (p<.10). Another effect was found for the amount of knowledge construction. Students guided by a moderator constructed more units decoded as knowledge than student who were not guided by a moderator (respectively 41.5 and 14 units; p< .05). Focusing on the four levels, an effect was found on levels A, B and D (p< .05, p< .01 and p< .01, consecutively). Besides expected differences, the two groups differed in the number of build-on notes used (p< .05). Students in the moderated group wrote 49.75 build-on notes on average against 20.4 by the students in the self-regulated group (difference = 29.35).

6.6.2.3 Analysing moderator's activities

Table 6.14 summarises the moderator's contributions in the experimental group, working at the two cases.

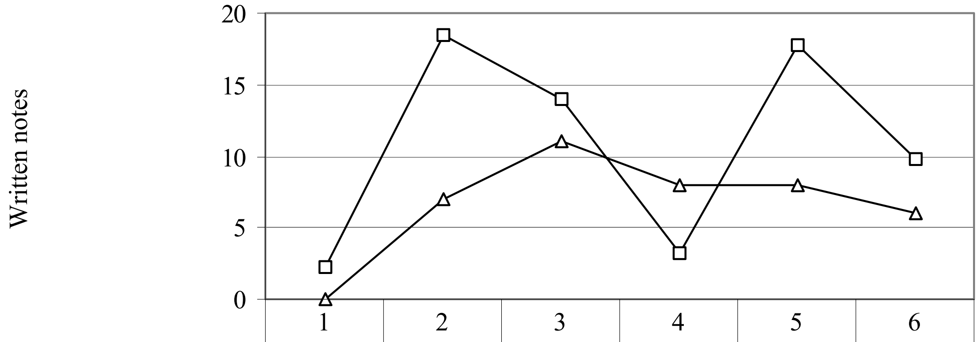
Table 6.14. Overview of the moderator's contributions in the two analysed views (Land Evaluation II study)

Quantitative activities moderator	
Read notes (%)	89
Written notes (#)	40
Build-on notes (#)	33
Students reacted to (%)	100
S1	33
S2	42
S3	12
S4	12
Reaction time in days (#)	
≤ 1	16
2	8
3	0
4	4
≥ 5	5
Notes following a moderator's note (#)	
0	16
1	11
2 ≤ 3	6
4 ≤ 6	4
≥ 7	3

Table 6.14 continued

Types of interventions moderator	
Content of notes – Number of critical interventions (100%)	
Check answers	6 (6%)
Ask to select the most suitable option/possibility	0 (0%)
Ask to comment/Continue to ask	8 (8%)
Give suggestions how to execute the task	13 (13%)
Support use of learning materials/Give additional information	17 (17%)
Put a statement on the forum	0 (0%)
Summarise contributions	9 (9%)
Give a counter-argument or counter-evidence/Ask provoking questions/Ask to elaborate or explain	9 (9%)
Ask for explanations or illustration	1 (1%)
Content of notes - Number of other interventions (100%)	
Give feedback (social)	24 (25%)
Call for personal participation (social)	3 (3%)
Emphasise the need for contributions (social)	5 (5%)
Social talk	4 (4%)

Focusing on the types of actions (sub-question a), the moderator used all critical interventions, except 'asking students to select the most suitable option' and 'putting a statement on the forum'. Mostly, the moderator supported the use of learning materials or gave additional information (17%). The action 'give suggestions how to execute the task' was also used relatively often (13%). Besides the instructed critical interventions, the moderator also used social interventions. The moderator gave feedback (25%) and emphasised the (personal) need for contributions (8%). The moderator read 89% of all students' notes (sub-question b). Over a period of six weeks he wrote 40 notes (99 units), of which 33 were build-on notes (sub-question c). There were at least five notes directed at each student (range = 12) (sub-question d). 40% of the moderator's notes were isolated, 60% of the moderator's notes were followed by one or more notes (sub-question e). 73% of the moderator's notes were sent quickly, measured by our standard (sub-question f). Figure 6.11 shows the mean number of students' notes and the absolute number of moderator's notes contributed in the progress of the course. No correlation was found between these two series of numbers (r=.63; p=.18) (sub-question g). In the fourth week, students wrote only a little (5% of all their notes). In this fourth week, the second case was started and to start a case it was necessary to read literature first.



	1	2	3	4	5	6
Students (M)	2,3	18,5	14	3,2	17,8	9,8
Moderator	0	7	11	8	8	6

Weeks

Figure 6.11. Pattern of students' and moderator's contributions in the six-week discussion (mean per student, absolute for the moderator) in the Land Evaluation II course.

6.6.3 Conclusions and discussion

The research question was formulated as: What are the effects of critically moderating a CSCL-discussion on students' learning? We expected moderated discussions to be more productive in terms of using more cognitive learning activities and constructing more knowledge than the unmoderated discussions. The quality of the knowledge was expected to be better, too. Considering affective and metacognitive learning activities, we did not expect to find effects. Finally, we expected to find relatively more build-on notes in the moderated group than in the self-regulated group because of an increase in debating activities.

The results confirmed our expectations. The moderated students produced on average significantly more cognitive learning activities than the self-regulated students. Focusing on the subcategories within the category cognitive learning activities, it becomes clear that the groups differed significantly in all three subcategories. Moderated students used more debating than self-regulated students. Students in the moderated group used more external information than students in the self-regulated group and besides, they linked more facts, ideas or remarks presented in the discussion. Students in the moderated group also constructed significantly more knowledge than students in the self-regulated group. This knowledge was assessed to be qualitatively better by assigning more levels A and B. As expected, no significant effects were found with regard to metacognitive and affective learning activities. Finally, students in the moderated group used more build-on notes than students in the self-regulated group.

Using the guidelines for moderating critically, the teacher directly asked students to carry out activities corresponding to the cognitive learning activities described in the first coding scheme (see chapter 4). For example: the action 'ask to elaborate' or 'check answers' refers to the cognitive learning activity 'A student does or does not agree with the opinion or idea contributed by another student or author. This viewpoint is followed by a backing, refutation or restriction (CDAF)'; and the action 'Give additional information' stimulates students to use information found in external information sources. In this study, we can conclude that critical moderating - operationalised as in section 6.2.2 - stimulated students to share information and to negotiate about knowledge, to sharpen their ideas, to provoke them to elaborate their ideas more thoroughly, and led to more knowledge construction of high quality. Chapter 5 describes, among other studies, the Land Evaluation I study. The design of the courses Land Evaluation I and II was comparable in the main features. In chapter 5, we concluded that CSCL was implemented successfully in the Land Evaluation I course. Therefore, it is not surprising that in the Land Evaluation II course CSCL was implemented successfully as well and affected students' learning processes positively. Moderating the discussions was of additional value and increased the number of cognitive learning activities used and the amount and the quality of knowledge constructed by students.

We checked whether the teacher moderated the discussion as instructed beforehand; 63% of all actions were assessed to be critical and 37% social (see Table 6.14). Therefore, the effects found mainly are a result of critically moderating, but socially moderating did play a part. We will return to the factor tone, discussed in the section conclusions and discussion of the study ICT in education (section 6.5.4). In the evaluation, the teacher explained that it was very difficult for him to strictly separate critical and social moderation. Therefore, he had chosen to give feedback the way he wanted to and sometimes he wanted to talk socially or found it necessary to emphasise the need for contributions. Before the course, different strategies of moderating discussions were discussed in detail. We searched for a way of moderating that felt natural to the teacher: intervening to provoke and challenge students to deepen their understanding, the essence of critical moderating. Looking at the response time (73% notes were sent quickly) and the percentage of read notes (89%) makes clear that the teacher was involved in the course. The contact among students and between the student and the teacher was constructive and pleasant. In our opinion, the success of the moderation was also due to the teacher's involvement and his natural way of responding. In other words, we believe that critical moderating will stimulate students to think more critically and to deepen their answers, but the success will stand or fall with the involvement of the teacher and his expertise to moderate in this way.

6.7 Overall conclusions and discussion

This chapter presented two studies in which CSCL was implemented. In each study, half of the students were moderated and the other half were self-regulated. In the first study, ICT in education, the teacher moderated on social aspects aiming at increasing students' participation in terms of written and read notes and affective and metacognitive learning activities. In the second study, Land Evaluation II, the focus of the moderating was on critical aspects in order to help students focus on the content of the task and deepen their cognitive learning activities in terms of amount of constructed knowledge and assigned level of understanding.

In the first study of this chapter, our expectations were not confirmed. With regard to participation, in each task the two groups differed (marginally) significantly in number of read notes. However, the effects found of the two tasks were contradictory. In task 1 (thematic discussion) students in the self-regulated group read on average more notes than students in the moderated group. In task 2 (deepening discussion), students in the moderated group read on average more notes than students in the self-regulated group. In both tasks, no differences were found with regard to the number of written notes. Besides, no effects were found on the number of affective and metacognitive learning activities used.

In the second study of this chapter, the results confirmed our expectations. The moderated_students produced on average significantly more cognitive learning activities than the self-regulated students. Focusing on the category cognitive learning activities showed that the groups differed in the use of all three subcategories. First, moderated students used more debating than self-regulated students. Next, students in the moderated group used more external information than students in the self-regulated group, and finally, students in the moderated group linked more facts, ideas or remarks presented in the discussion than students in the self-regulated group. Therefore, students in the moderated group also constructed significantly more knowledge than students in the self-regulated group. This knowledge was assessed to be qualitatively better by assigning more levels A and B. As we expected, no significant effects were found with regard to metacognitive and affective learning activities. Finally, students in the moderated group used more build-on notes than students in the self-regulated group. Table 6.15 gives an overview of quantitative aspects of the moderation in the two studies.

Table 6.15. Overview of quantitative aspects of the moderation in the two studies

	ICT in education (study 5)		Land Evaluation II (study 6)
	Task 1	Task 2	
Read notes (%)	100	100	89
Written notes (# per week)	1.38	7.25	6.67
Build-on notes (% of all written notes)	82	79	83
Students reacted to (%)	71	100	100
Response time (quick: < 2 days; slow: > 2 days	quick	quick	quick

Although the number of moderator's written notes in task 1 of the ICT in education course was remarkably low, in general we can conclude that the moderators in both studies were active and involved in the discourses. In both studies, teachers acted in accordance with the guidelines for moderation used in the studies; they moderated socially or critically. When checking the moderational actions, it appeared to be necessary to add a category, namely social talks. However, the teacher in study 6 found it difficult to strictly moderate critically and decided to use social types of interventions as well. Section 6.2.1 already mentioned that a distinction between the didactical and social role could be made in theory, but that it would sometimes be difficult to distinguish these two roles in practice. On the contrary, the teacher in study 5, who was asked to moderate socially, did not use critical moderation activities. We would suggest combining both moderational strategies in future research. Supporting critical moderation by social actions is expected to be more natural, which will increase the positive atmosphere in a group.

The findings indicate that successful moderation depends very much on the quality of the teacher. In other words, the results of these studies give reason to assume that teachers can be instructed, but that teachers' expertise, quality and motivation are essential to make courses a success. In study 5, the moderator was not able to stimulate students to work on the task collaboratively in spite of moderating according to the instructional guidelines and being involved in the course. We assumed that other factors played a role; factors we did not explicitly pay attention to during the instruction. Examples of factors we mentioned were time needed to read all notes and to contribute to the discussion, lack of information about the students (interests, studying motives, experiences with collaborative learning), and finding the right tone. In agreement with Collison *et al.*, (2000) tone was considered as a very important factor. Students do not like to be treated childish or to be humiliated; they want to be treated respectfully. Furthermore, it is true that a moderator should show involvement, but the proportion between number of students' and moderator's contributions must be well balanced. Too many notes can work counterproductive, students will think "Oh, the moderator again, yes, we know what you want". To illustrate this: in study 5, - task 1 -, the teacher wrote 11 notes against 9.8 on average per student. The moderator tried to activate students by writing motivational notes, but there was no effect on the students, they did not become motivated at all. The moderator must use the right tone and the right moment to react to students' contributions (Collison *et al.*, 2000).

In the Land Evaluation II study, the teacher was familiar with the use of CSCL in this specific course. The teachers in the course ICT in education were also familiar with CSCL, but the course was more experimental and it was not always clear how to integrate CSCL in the course. The teacher of Land Evaluation II had already used CSCL in his course for two years and had a positive attitude towards CSCL. Furthermore, critical moderation felt natural to him; in other courses he also provoked students to be critical. The contact among students and between the students and the teacher was constructive and pleasant. Many notes were humorous and we think that humour and social talks can be helpful to create a positive and constructive atmosphere in which moderation will have effect. To conclude: we believe that success of moderating will stand or fall with the involvement of the teacher, his skill to create an atmosphere of critical thinking.

In our opinion it is very difficult, if not impossible, to instruct teachers to moderate asynchronous discussions in the short term. Although guidelines can be given and practised, teachers must become familiar with CSCL and moderating discussions. Logging daily must become a habit. However, moderating on-line discussions takes much time and teachers do not always have enough time. Additionally, although responding quickly did not guarantee success in our studies, we still think it is preferable to respond regularly and to all students. Students must not feel isolated and frustrated because of having to wait a long time for a response. Furthermore, guidelines for moderation must fit the personal way of teaching. If it does not feel natural, intervening in the discussions would not work and could even work counterproductively. Therefore, teachers must become aware of their personal style and have to exchange thoughts about different moderational strategies. Besides, teachers need time to become familiar with moderating CSCL-discussions.

Another factor of importance in successful moderating is the student's attitude. In the Land Evaluation II course, the teacher never answered directly to students in terms of giving a 'right' answer. However, students never asked for a 'right' answer. In the ICT in education course, students were more uncertain and wanted to know if they were working well. The task in the Land Evaluation II course was prestructured and in contrast to the ICT in education course, students exactly knew what they had to do. Besides, they had experiences with solving open-ended problem tasks. We assume that using an adequate task (see also chapter 5) and organising the course very well will help students feel more certain and will stimulate them to participate in the discussion. However, it should be noticed that students need time to learn by means of CSCL within the reasonable amount of time they can spend on their study.

To summarise, moderating asynchronous discussions is very complex and many factors are involved. We found that moderating an asynchronous discussion in a critical way can increase the number of cognitive learning activities used and the amount and quality of constructed knowledge. It is obvious that a course must be organised very well and that the task must be adequate to implement CSCL successfully. This appears to be self-evident, but our experiences point out it is not. Despite the importance of the task and organisation, we argued that the effect of moderating discussions depends especially on the quality of the teacher. Before starting a course, it is important to consider how to moderate discussions: what is the aim of moderating a discussion? Is the moderation directed at stimulating students to participate or is the aim to increase students' critical thinking and knowledge construction? It is worthwhile that the teacher feels comfortable with given guidelines, gets enough time to gain experience beforehand and has enough time to moderate during the progress of the course. Moderating discussion is time-intensive and asks a lot from the teacher.

Returning to the Five Step Model of Salmon (2001a) we notice the following. In our studies, we aimed at stages four and five, knowledge construction and development. However, in the first study of this chapter (ICT in education) the first two stages of the model, 'access and motivation' and 'on-line socialisation', consecutively, were not fulfilled. Students were not intrinsically motivated and the group atmosphere was not constructive and positive. The teachers tried to moderate the students, but apparently not in a right way; the moderators' contributions did not stimulate students to work harder, let alone to deepen their thinking. The cumulative character of the Five Step Model is confirmed in our study. Only the moderator in the Land Evaluation II study was successful in letting students reach the stages of knowledge construction and development.

Although the results of this study do not show a clear picture of effects of moderating and although the results are not simple to interpret, moderation of asynchronous discussions can be very useful in our opinion. We hope this study will motivate others to continue this line of research.

Chapter 7 – Conclusions and discussion

7.1 Introduction

This final chapter will first give the main conclusions in section 7.2. Section 7.3 will put all the findings and experiences of the research together in relation to the basic assumptions and by drawing parallels between other CSCL-studies. Section 7.4 will be about moderation discussions to improve the use of CSCL-opportunities. Section 7.5 will consider methodological issues. Next, section 7.6 will formulate conditions for introducing CSCL in higher education to increase the effective use of CSCL. The chapter will end with giving suggestions for future research (section 7.7).

7.2 Conclusions

The following main research questions are addressed in this PHdissertation:

1) *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?*
2) *How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?*
3) *Do students construct knowledge and what is the quality of that knowledge constructed by students in an asynchronous CSCL-system?*
4) *What are the effects of moderating a CSCL-discussion on students' learning?*

In the studies 1 to 4 of this PHdissertation (chapter 5) the focus was on questions 1 to 3. In the studies 5 and 6 of this PHdissertation (chapter 6) the final research question was at the centre of attention.

With regard to the first main research question we can conclude that in general students were willing to participate in the courses. To most of the students, CSCL was new and because of this, they were motivated to learn by means of CSCL. Furthermore, students considered it to be valuable to read other students' ideas. In courses without CSCL, students do not know very well what their fellow-students think. However, in all the courses studied the passive participation (reading notes) was larger than the active participation (writing notes). As a consequence, density based on read notes was larger than density based on linked notes. In most of the studies, students were involved in the discourses and the calculated density referred to a rather high extent of interaction between students.

Concerning the second main research question, students in the four studies differed substantially. In the studies 2, 3 and 4 students used more cognitive than metacognitive learning activities. In the first study it was just the other way around. In none of the studies, students used many affective learning activities. Because of the large differences found in the studies, it is not possible to give one characterisation of the way in which students use cognitive, metacognitive and affective learning activities in CSCL. Many factors seemed to play a part in the way in which students use a CSCL-system to conduct a task.

Referring to the third main research question, the conclusion is that in none of the studies students constructed much knowledge measured by our standard. In four of the six studies, students constructed little knowledge; in the other two studies, the amount of constructed knowledge was assessed to be reasonable. The quality of the knowledge varied between very low and high, but was assessed to be reasonable in most of the studies.

The fourth main research question concerned effects of moderating discussions. Moderation strategies were divided into social and critical moderation. We expected that social moderation would motivate students to participate and to collaborate to enhance communal effort. Besides, we expected that critical moderation would help students to focus on the content of the task and to deepen their cognitive learning activities. The results give reason to assume that moderating an asynchronous discussion critically can increase the number of cognitive learning activities used and the amount and quality of constructed knowledge.

7.3 Overall reflection

This section is meant to put the findings with regard to the main research questions as formulated above together. First, section 7.3.1 will return to the basic assumptions of the research and reflect on the question whether CSCL lived up to the expectations. Section 7.3.2 will compare some findings of the separate studies and interpret these results related to each other. Finally, section 7.3.3 will present a number of parallel CSCL-studies focusing on the results concerning knowledge construction.

7.3.1 Reconsidering constructivism and CSCL: Theory and practice

The study described in this PHdissertation is based on a constructivist view of learning outlined in chapter 2. Learning was seen as an active process in which learners construct new ideas or concepts based upon their current or past knowledge. In a constructivist view of learning, learners select and transform information, construct hypotheses, and make decisions, relying on a cognitive structure to do so. Besides, learning was called constructive because students should elaborate new information and relate this knowledge to other information to retain simple information and to understand complex material. It was assumed that learning results in knowledge construction and that knowledge is negotiated through interactions with others. A final characteristic of constructivism mentioned in chapter 2 is the idea of distributed knowledge. By distributed knowledge we meant that knowledge is divided among people. Everybody creates his own specific knowledge, but it is considered to be meaningful to share that knowledge and the attendant growth of individual knowledge.

A basic assumption of this study was that CSCL could be a useful tool to put constructivist principles into practice. Additionally, research indicated that improvement in student learning was found particularly in higher-order cognitive processes. In other words, CSCL would be most promising in higher education, because universities aim at a deep level of learning (Biggs, 1999; Gokhale, 1998). Deep learning (as opposed to surface learning) was characterised by having the intention to fully understand the learning material, interacting critically with the learning content, relating ideas to prior knowledge/experience, using organising principles to integrate ideas and examining the logic of the arguments used (MacFarlane Report, 1992). Within the framework of implementing credential in higher education, Franssen (2001) describes the academic core as the competencies to argue, to form an opinion and to communicate. It was found that goals of higher education could not be reached with (only) traditional ways of teaching. Research showed that skills that are required to achieve deep learning were more likely to be developed by students in constructivist settings than in traditional settings (Lethinen *et al.*, 2001; Paolucci, Suthers & Weiner, 1995; Reeves, 1998; Tynjäla, 1999). In university education, students have to deal with abstract, ill-defined and not easily accessible knowledge as well as with open-ended problems. Exactly these open-ended problems were considered to be useful to be solved in a CSCL-system. In this view relevant competencies students have to acquire are creative thinking, logical thinking, creating ideas, debating and arguing subjects, using knowledge in new situations, solving problems, formulating questions, linking different insights, summarising information concisely, sharing knowledge and elaborating on each others' ideas and results (De Klerk, 1992; Franssen, 2001; Van Ginkel, 1991; see also chapter 2). A CSCL-system offers opportunities to support the exchange of ideas, experiences and information among students, to negotiate about knowledge in order to construct personal knowledge serving as a basis for common understanding and a collective solution to a problem. Students can criticise their own and other students' contributions, can ask fellow-students for explanations, or can give counter-arguments.

Besides, it was assumed that CSCL should make it easier to reach agreement about the task approach and to carry out the plans made, compared to a situation of face-to-face collaboration. In accordance with a constructivist point of view, in this PHdissertation learning was seen as a dynamic process of knowledge construction. Knowledge construction was operationalised as adding, elaborating and evaluating ideas, summarising or evaluating external information, and linking different facts and ideas.

Based on the theoretical framework, all six studies were conducted at universities. The conclusions summarised in section 7.2 indicate that the use of CSCL in higher education certainly offers opportunities to realise constructivist principles. Thus, we can conclude that CSCL can indeed lead to learning. However, we cannot expect miracles from CSCL. It is true that students constructed knowledge, but the amount of knowledge often was not large and the quality of the constructed knowledge left to be desired. As with other educational appliances, the use of CSCL must be considered very thoroughly with an aim at effective use of CSCL. Although this remark seems to be obvious, it is an important finding. Nowadays, people too easily think that the use of ICT stimulates students to learn and that this learning automatically results in positive results. "Oh, they use ICT, that is okay. ICT works". Our research shows that this assumption is far from the reality. CSCL, as a specific ICT-application, must not be used as a goal in itself, but as a medium to reach learning goals with.

When considering using CSCL in education, examples of important questions are: What is the aim of the educational course? Which task is needed to reach the aim and is that task appropriate to work on in a CSCL-system? Is it desirable that students learn collaboratively in this course? Do students have to brainstorm individually first, or can they react to each other immediately? To what extent does the task have to be prestructured? Are the subject matter and the task useful to negotiate about knowledge? Have students experiences with CSCL and if not, can we train them in a short term? Is a user-friendly CSCL-system available? Are enough computers available? Do we prefer students working from a distance or in one room? How much time do we expect students to work on the task? Do we assess students' participation in the CSCL-system and/or the content of their contributions? Do we charge students with rules? Finally, it is important to consider whether moderation is desirable and if so, how to moderate discussions; what is your aim with moderating a discussion? Do you want to stimulate students to participate or do you want to increase their critical thinking and knowledge construction?

The previous section gave the overall conclusions. However, the results indicated that it is difficult to generalise the findings. Because of the differences between the educational settings, the next section will compare some main findings of the separate studies and interpret these results in relation to each other.

7.3.2 Differences and similarities between the six studies

The first main research question concerned students' participation and interaction and it was answered in chapter 5. Chapter 5 described four studies, namely: study 1- Agrification, study 2- Land Evaluation I, study 3- Psychology and study 4- Canadian study. The results showed that, first, the proportion between reading and writing notes was comparable in these four studies. Besides, in each study, students read much more notes than that they wrote. This is not surprising, because writing notes takes much more time than reading notes. The proportion between build-on and new notes varied between 0.60 and 7.39. On this point students in the different studies differed enormously. In the Agrification as well as in the Psychology course, students used on average more new notes than build-on notes. In both the Land Evaluation I course and the Canadian course, students used on average more build-on notes than new notes. However, students in the Canadian study used proportionally much more build-on notes than students in the Land Evaluation I course. To measure the extent of interaction among students, density was calculated. Density based on read notes varied between 0.61 (Psychology) and 1.0 (Agrification and Land Evaluation I). In the Canadian study, density based on read notes was 0.95. The range in density based on written notes was larger, namely 0.54. Students in the Psychology study were linked least, students in the Canadian study were linked most. In chapter 5 the results are given in detail, often divided because of different groups, phases or tasks. In this final chapter the results of each study will be given globally for the sake of easy reading. However, it is difficult to interpret these global results. In our view the most important meaning of the results concerning interaction is that students interact more if the tasks force students to share information and to debate about ideas. In the Agrification course, students had to evaluate several options in a production process, resulting in one written collective note. In the Land Evaluation I course, students had to brainstorm first and to comment on each other's ideas next. Both tasks triggered students to interact. On the contrary, the task Canadian students worked on did not explicitly ask for reflection and nevertheless density was high.

Students read articles concerning recent educational theories in order to formulate their own theories. Students could react to each other, but the task did not force students to interact. In our opinion it is better to guide students in approaching the task then to leave students regulating the task by themselves at all costs. When students are more familiar with CSCL we can pay out the rope. The Canadian students were used to being educated by CSCL and they applied CSCL in their own education. Apparently, the content and the structure of the task were of less importance because of seeing the added value of CSCL. Students always want to know the added value of CSCL. Why should they use the discussion forum if they could debate face to face likewise?

Comparing the learning activities used (main research question 2), we again see a large difference between the four studies. Canadian students were most cognitively oriented; 86% of the learning activities used concerned cognitive activities. Students in the Land Evaluation I and Psychology courses produced many cognitive units as well (79% and 70%, consecutively). However, the Agrification course showed a totally different picture; only 30% of the decoded units concerned cognitive codes. Comparing the metacognitive activities used, it was found that students in the Agrification course contributed relatively most units; 43% of all units were decoded as metacognitive against 14% in the Land Evaluation I course, 23% in the Psychology course, and 10% in the Canadian course. With regard to the use of the number of affective learning activities, we can conclude that students express few affective feelings in the CSCL-systems used. Again the Agrification course deviates most. In this course, 27% of all units were decoded as affective against 7% in the Land Evaluation I course, 7% in the Psychology course, and 4% in the Canadian course.

By using CSCL, we aimed at a high proportion of cognitive learning activities. The used definition of knowledge construction (adding, elaborating and evaluating ideas, summarising or evaluating external information and linking different facts and ideas) referred to the use of cognitive learning activities. The use of metacognitive learning activities was considered to be supportive in the learning process. In the Canadian study and in the studies Land Evaluation I and Psychology, students used relatively many cognitive learning activities in contrast to the students in the Agrification study. Relating the findings concerning learning activities to the results concerning knowledge construction, it becomes obvious that by far not all cognitive activities were assessed as knowledge construction. For example, when students put references in the discussion forum, contributed ideas to the forum without elaborating on these ideas or repeated information without drawing a conclusion or interpreting that information, it is true that these activities were seen as cognitive, but not as knowledge construction. In the Agrification and Psychology study students carried out these kinds of activities more than students in the Land Evaluation I and the Canadian study. Concerning the third main research question, we have to conclude that in none of the studies students constructed much knowledge, using our standard. In the Agrification and Psychology studies, students constructed little knowledge, in the Land Evaluation I and in the Canadian studies, students constructed a reasonable amount of knowledge. In Agrification as well as in the Psychology course, students were not used to learning by means of CSCL, and moreover, they were not used to work on complex, open-ended tasks. In the Land Evaluation I course, students did not use CSCL before, but they were used to solve open-ended problems. Besides, the task was prestructured, a schedule was given and the course was organised very well. The Canadian students were both used to learn by CSCL and to work on open tasks. We think students in the Agrification and Psychology courses were somewhat in at the deep end. In chapter 2, we warned of the danger of overloading students. We mentioned the great effort for students to construct knowledge actively and to monitor their learning processes at the same time. We emphasised the necessity of searching for a good balance between required effort on the one hand and expected learning results on the other. However, we think that students in the Agrification and Psychology courses had to deal with cognitive overload and did not get round to constructing knowledge. Students in these courses were also less motivated to follow the course than the Land Evaluation I and the Canadian students. It is difficult to retrieve the reasons they were so little motivated. We suspect that the complexity of the task and the unfamiliarity with CSCL played an important part, but also more trivial factors such as the weather, being busy, bad communication with the teacher, and length of the course could also have played a part. In chapter 3, we cited Webb and Sullivan Palinscar (1996) and Dillenbourg (1999) who argued that because of the multiple interactions between factors such as group size and task characteristics, it is very difficult to set up initial conditions that guarantee the effectiveness of collaborative leaning. This research also confirmed the complexity of factors in setting up a successful course.

The fourth main research question focused on effects of moderating CSCL-discussions. Two types of moderation were applied: social and critical moderation. Concerning moderating discussions socially (study 5 - ICT in education) we expected to find an effect on students' participation and interaction in terms of used build-on notes. However, no effects were found. In study 6 (Land Evaluation II) half the students were moderated critically. The results give reason to assume that moderating an asynchronous discussion critically can increase the number of cognitive learning activities used and the amount and quality of constructed knowledge. The two studies described in chapter 6 did not show an unambiguous picture concerning effects of CSCL-discussions. We checked whether teachers acted in accordance with the guidelines for moderation used in the studies, thus socially or critically. However, the types of actions used could not explain the differences we found. In our opinion the effect of moderating discussions depends especially on the quality of the teacher. Teachers can be trained beforehand, but apparently purely applying the guidelines is not sufficient. The results indicate that real involvement, using the right tone and a well-balanced proportion between the number of students' and moderator's contributions are of importance in successful moderation.

Although using CSCL is rather complex, based on our research and experiences, a number of implications can be formulated to increase the positive use of CSCL in a university course. Section 7.6 will describe these educational implications. First, the next section will compare our findings to some other studies on CSCL to put our research in a wider scope.

7.3.3 CSCL: Opportunities underused

In our opinion, the methods developed were useful to understand the way in which students learn in a CSCL-system. In other words, the analyses conducted gave insight into students' learning processes in a CSCL-system. Starting from the view of learning as a dynamic process of knowledge construction, we have to conclude that students in the courses studied in this PHdissertation made little use of the opportunities CSCL offers. It is true that students constructed knowledge, but the amount of constructed knowledge was never high and the quality of the constructed knowledge did not indicate deep learning. However, the results also showed that students differed in the amount and quality of knowledge construction and the way of using CSCL.

In chapter 3, a number of studies was discussed in the context of the methods used to analyse CSCL-data. In this section we will return to a number of those reviewed studies. However, in this section the focus is on the results instead of the methods used. We realise that by the use of different methods, definitions, and standards it is difficult to compare our findings with results of other studies on CSCL. In spite of these differences, we can say something. Veerman (2000) defined knowledge construction in terms of constructive activities, namely: (1) Additions, (2) explanations, (3) evaluations, (4) summaries, and (5) transformations (see also section 3.3.2). She compared synchronous to asynchronous discussions (in university courses) and found hardly any summaries or transformations in either of them. Transformations were based on evaluations and led to new insights or directions for further discussion. In summaries, information already stated was (re)organised in such a way that selected points of the discussions were put in relation to each other and reflected the main content of the discussion (Veerman, 2000). Apparently, Veerman expected to find knowledge construction of higher quality. She concluded that students have to prepare a task well and need a substantial knowledge base to come to transformations. Additionally, Veerman (2000) emphasised the complexity of factors playing a part in education organised by CSCL, too.

Other research cited in chapter 3 was Salovaara's study (1999). She grouped expressions in inquiry notes into seven subcategories representing different phases of students' knowledge construction processes: (1) Research questions, (2) working theories, (3) knowledge processing, (4) source-based knowledge, (5) experience-based knowledge, (6) explanations, and (7) meta-expressions. One of Salovaara's conclusions was that in most discussions she analysed, the strategies consisted of surface-level activity, in which students only went through the phases of inquiry process, without thoroughly reflecting on the questions and trying to increase their understanding related to the topic. Only 10% of the expressions were decoded as knowledge processing and 5% as explanations. Furthermore, all knowledge processing expressions were written by half of the participating students. To conclude: Salovaara (1999) expected students to construct a larger amount of knowledge. On the contrary, she was satisfied with the quality of students' expressions scored within the comment notes; 90% of the comments were scored as knowledge building (including notes in which students provided new information, follow-up questions or direct suggestions related to the investigation process to their peers).

Gunawardena, Lowe and Anderson (1997) classified the process of social construction of knowledge into phases. They distinguished five phases: (1) Sharing/comparing information, (2) the discovery and exploration of dissonance or inconsistency among ideas, concepts or statements, (3) negotiation of meaning/co-construction of knowledge, (4) testing and modification of proposed synthesis or co-construction, and (5) agreement statement(s)/applications of newly constructed meaning. Gunawardena *et al.* (1997) analysed data collected in a one-week asynchronous, on-line debate. A total of 554 people subscribed to participate in the debate. The topic chosen for the debate focused on a controversial issue in current research in distance education: the role and importance of interaction in effective distance education. Of all the written messages, 93% were decoded as phase 1, 3% as phase 2, 2% as phase 3, 0% as phase 4, and 2% as phase 5.

De Laat (2002) also applied the model of Gunawardena *et al.* (1997). He followed an existing community of practice within the Dutch police organisation to analyse their activities. This community of practice consisted of 46 members. The data that was analysed during this study was from the period of January until June 2001. De Laat (2002) did not code any messages according to phase 4 or 5. Comparable to the results of Gunawardena *et al.* just given, most messages were decoded as phase 1 (73%). Additionally, 20% of the messages were decoded as phase 2, and 7% messages as phase 3. The studies of Gunawardena *et al.* (1997) and De Laat (2002) show that students shared and compared information, but hardly reached the other phases of social construction of knowledge. Students hardly debated ideas, concepts or statements, negotiated about meaning, not to speak about constructing new ideas.

Our findings concerning knowledge construction are in line with the results given above. We think it is getting time to consider how to increase the amount and quality of knowledge construction by students in a CSCL-system. We still belief that CSCL offers opportunities to support the process of knowledge construction, but apparently, students do not make optimal use of these opportunities. We are interested in retrieving the reasons for missing opportunities. After conducting this project, we have ideas about reasons for missing opportunities across all studies: In most courses, students were unfamiliar with CSCL and in some courses, they were unfamiliar with solving open-ended tasks, too. This was a result of asking for the project in an early stage of applying CSCL in the Dutch courses. Besides, not all courses were organised very well. Although the teachers attempted to, a well-organised course was not always realised in practice. In addition, the task was not adequate in every study. Not every task provoked students to negotiate about knowledge intensively. With regard to the chosen CSCL-system, we are sure that KF was no reason for little knowledge construction. In all studies, students found it easy to use this system. With regard to the students we can notice the following. In the optional courses students seemed to be much more motivated than students in the regular courses. However, students often have a small job and cannot spend the expected time on the courses. Besides, in most courses, the activities in the CSCL-system were not assessed and therefore students focused on the learning product. These are ideas, but more research is needed on factors that can improve the quantity as well as the quality of knowledge construction. Our research was mainly explorative and aimed at forming a notion about how students learn in a CSCL-system. We developed and applied methods to analyse students' learning descriptively, a next step is systematic research to gain insight into factors that influence students' learning processes in CSCL.

7.4 Moderating CSCL

In our research, we deepened one factor, namely moderating discussions. Chapter 6 describes two studies in which learning situations were manipulated. Below, the results of those studies are discussed. Section 7.4.1 will reflect on the possibilities of moderating discussions to improve the use of CSCL-opportunities. In section 7.4.2, the importance of the quality of moderation will be emphasised.

7.4.1 Moderation to improve the use of CSCL-opportunities

We expected teacher interventions to be a useful tool to increase the quantity as well as the quality of students' contributions. Based on a theoretical framework and experiences with CSCL, moderational strategies were divided into social and critical moderation. It was expected that social moderation would motivate students to participate and to collaborate to enhance communal effort. Besides, it was expected that critical moderation would help students to focus on the content of the task and to deepen their cognitive learning activities.

Concerning moderation, our expectations were partly confirmed. The results of the study ICT in education described in chapter 6 gave no reason to assume that moderating a discussion socially increases students' participation and the collaboration between students. On the contrary, the results of the study Land Evaluation II confirmed our expectations. Students that were moderated critically produced on average more cognitive learning activities than the self-regulated students. This effect was found for all subcategories: debating, use of external information, and linking facts, ideas or remarks presented in the discussion. Consequently, students in the moderated group also constructed more knowledge than students in the self-regulated group. Besides, this knowledge was assessed to be qualitatively better by assigning more levels A and B. Finally, students in the moderated group used more build-on notes than students in the self-regulated group.

7.4.2 Quality of moderation

In both studies, teachers acted in accordance with the guidelines for moderation used in the studies, thus socially or critically. Besides checking the types of actions, moderators' actions were analysed for the percentage of read notes, the number of written notes, the percentage of students to whom the moderator directed notes, reactions of students in terms of build-on notes, and finally for reaction time. With regard to quantity of moderational contributions, it was concluded that the moderators in both studies were active and involved in the discourses. They read a high percentage of students' notes, regularly wrote some notes, used relatively many build-on notes, reacted to a large part of all students and reacted quickly to students' notes. By analysing moderators' activities on both types of actions and quantitative aspects, we could not explain the contradictory effects. Therefore, we assumed other factors had played a part in successful or failing moderation. The results and the experiences of the two studies gave reason to assume that successful moderation depends very much on the quality of the teacher. We can instruct teachers, but teachers' expertise, quality and motivation seems to be essential to let a course succeed. In this matter, one important factor is tone. The moderator must feel the right emotion and the right moment to react to students' contributions. The use of emoticons might have been useful to help students interpret the moderators' meaning. Emoticons are symbols depicting facial expressions (Collison *et al.,* 2000).

From these studies, we know it is very difficult to instruct teachers to moderate asynchronous discussions in the short term. Although guidelines can be given and trained, teachers must become familiar with CSCL and moderating discussions. Teachers must learn to log in frequently and to reserve time to respond; moderating on-line discussions takes much time. Additionally, although responding quickly did not guarantee success in our studies, we still think it is preferable to respond regularly and to all students. Students must not feel isolated and frustrated because of having to wait a long time for a response. Furthermore, guidelines for moderation must fit the personal way of teaching; it is important the teacher feels comfortable with the guidelines. To conclude: although the results of this study do not show a clear picture of effects of moderating and although the results are not simple to interpret, in our opinion moderating asynchronous discussions can be very useful as long as teachers have enough time to become familiar with the moderational strategies, can reserve enough time to moderate discussions during the course, can moderate discussions according to their personal way of teaching, react to students' contributions quickly, use the right tone, and are convinced of the benefit of moderating discussions.

7.5 Methodological considerations

Although the methods developed were found useful to analyse students' learning processes, of course we can comment on the method. Therefore, this section will consider the following methodological issues: the concept of knowledge construction (section 7.5.1), understanding students' learning processes (section 7.5.2), assessing students' learning (section 7.5.3), used standards (section 7.5.4), formulated sub-questions (section 7.5.5), and the subjects (section 7.6.5).

7.5.1 Concept of knowledge construction

In the very beginning of this project, the problem of the research was formulated as "gaining insight into students' knowledge construction processes in CSCL". One question that immediately occurred was how to operationalise the concept 'knowledge construction'. Much literature was studied, models were created and discussed, different definitions were compared and tested according to standards found in literature. Finally, we had to choose one definition and to operationalise this definition (adding, elaborating and evaluating ideas, summarising or evaluating external information and linking different facts and ideas). We are aware of the fact that the operationalisation used determines the way results are analysed and interpreted. In our opinion, the influence of the operationalisation used on the findings emphasises the usefulness of a strong relation between the theoretical framework and the analysing method. A next step was to assess the quality of knowledge. Again, much literature was studied in search of ideas; classifications were formulated and a few models were elaborated. However, applying the models on data often did not work. Finally, the SOLO-taxonomy of Biggs and Collis (1982) offered good possibilities to assess the quality of knowledge constructed by students in our courses (see also 7.5.3).

7.5.2 Understanding students' learning processes

In this PHdissertation, we aimed at understanding students' learning processes in a CSCL-system. The focus was on analysing the type of learning activities used; therefore, a coding scheme was developed based on both literature and experiences with CSCL. In section 3.4 a number of requirements were formulated for the method to develop. We aimed at a method that could be used to decode the complete text of students' written notes, was based on a classification of learning activities, emphasised cognitive processing as well as regulation strategies, paid attention to affective issues, made possible a detailed analyses of the process of knowledge construction, could be used to assess the quality of the constructed knowledge, could be helpful to gain insight into the process of interaction between students, could be applied to analyse students' individual performance, related to the whole context, was clear in the distinction between the scales and codes used, was applicable without the help of a domain expert, could be used in a simple way, and was not strongly based on a specific task students work at in a CSCL-system. In our opinion, the methods developed satisfy these wishes and were useful to gain insight into students' learning processes in a CSCL-system. However, we have the following suggestions to improve the first coding scheme. The code CSEI refers to summarising or evaluating the information found in other information sources. We would prefer to split summarising and evaluating (CSEI= summarising; CEEI= evaluating). Another suggestion is to add 'summarising' to the code MSD, thus structuring or summarising the contributions in the database, because summarising contributions also helps to keep the discourse clear. Notice that although the methods were useful, decoding all data appeared to be very time-consuming.

Besides analysing the use of different learning activities, we also analysed students' participation and interaction. Participation was measured by the number of written notes (new and build-on notes), and read notes. Concerning interaction, density was calculated. Notice that in all studies (chapter 5) density correlated positively with the code CIL (Linking facts, ideas or remarks presented in the discourse/Referring explicitly to a contribution in the discourse). Apparently, the extent of using the activity CIL means something to the extent of interaction in a discourse, too. In our research, the focus was on content analysis and besides, pragmatic reasons played a part in deciding to pay relatively little attention to students' participation and interaction. In further research, it would be interesting to also analyse participation in progress of the course. Besides, Social Networks Analysis might offer opportunities to improve quality of interaction analysis.

7.5.3 Assessing students' learning

At first, we asked teachers to assist in assessing the quality of students' contributions and we still assume that teachers' help could have been very valuable. However, assessing the notes on quality takes a lot of time and teachers did not have enough time do to that. Therefore, we needed a method we could apply without the help of a domain expert. The SOLO-taxonomy was assessed to be a useful basis to develop this method. In our opinion, the second coding scheme was useful indeed, but it is not easy to apply. Contributions must be read very precisely on the level of sentence analysis. Besides, it appeared to be important to involve the whole discourse in the assessment. In our opinion, contributions must be assessed in relation to earlier contributions of the author and to contributions of fellow-students. To illustrate: a student formulates an idea. Another student wrote about a similar idea. One has to check who contributed the idea first and next, one must compare the ideas. Did the student who contributed his idea last copy the idea of the other student or did the student revise the idea? Only copying becomes level D, but if the idea is elaborated and arguments are explained, the note is rated as level B. We decided to assess a note instead of a unit as part of a note. To illustrate: a note started with a long description on level D, but ended in a reflection on that description resulting in a conclusion on level A. In such a case, the note is assessed on quality based on a small part of the note. This idea fits the theory of Biggs (see also chapter 4, section 4.4.2). Biggs (1999) argued that developing understanding means that it becomes more structured and articulated. "In learning a new topic, understanding moves through a quantitative phase, from uni- to multistructural, which involves finding out more and more facts. These are the 'bricks' of understanding, which form more or less elaborate and original working structures at the relational and extended abstract levels" (Biggs, 1999, p. 51). In spite of this theory, one can debate the question whether assessing smaller parts of a note would have been better. Following this line of reasoning it becomes clear that in a discourse notes on all four levels are needed. However, while analysing and assessing notes we hoped to find many notes of the levels B and A and sometimes we were inclined to see notes on level C and D as less valuable. Applying the second coding scheme, it is good to be aware of this and to realise that notes assessed as level C or D sometimes can be very useful to breathe new life into the discourse (see also Veldhuis-Diermanse & Verburgh, 2001).

7.5.4 Standards

In our research, we decoded all units of meaning within notes by using the first coding scheme. Next, we summed up the number of units assessed to be knowledge construction per student and measured the amount of knowledge constructed per group by using a standard. Additionally, we assigned a level of understanding to each note in which students had constructed knowledge and measured the quality of knowledge construction per group by using a standard. However, the results raise doubts about the defined standards. Did we expect too much of students? Are the chosen standards not realistic? Defining standards is subjective and it could be useful to discuss our standards. Another issue is using the same standards for all studies. In order to compare results between studies, one standard is necessary. However, Henri (1992) offered an interesting point. Henri (1992) noticed that the results of content analysis must be interpreted in relation to the cognitive task assigned to the learners. If knowledge acquisition was the aim, we can expect to find high levels of clarification and inference activities; if problem solution was the aim, we can expect the whole range of skills to surface. If only a superficial processing of information was occurring, it might be due to the task at hand, or to a lack of relevant knowledge or even to the inability of learners to carry out in-depth processing of information. In accordance with this point, we had already decided in the beginning to use complex, open-ended tasks in our studies. Therefore, the problem of interpretation results of content analysis in relation to the task did not play an important part in the studies within our research.

7.5.5 Sub-questions

In this PHdissertation, the focus was on understanding students' learning in CSCL. The accent was on developing a analysing method to characterise learning activities and to assess the amount and the quality of knowledge construction. Some studies offered possibilities, and in study 1 the design of the course even forced us to do additional analyses. Three sub-questions were formulated with regard to group size, multidisciplinary teams, and learning styles. We are conscious of the fact that the design was not very powerful at these points and strong conclusions could not be drawn. Therefore, these sub-questions are taken to be explorative in nature and must be worked out more thoroughly and in larger groups to make generalisations possible.

7.5.6 Subjects

A practical problem in our research was the impossibility to implement CSCL in regular courses at Wageningen University. For that several reasons can be given: at the beginning of this Ph.D.-project, Wageningen University had to reorganise. As a consequence, it took a lot of energy for teachers to keep their head above water, they had to survive in the organisation. Moreover, as a result of the reorganisation plans, teachers had to deal with new educational programmes and simultaneously economy measures were taken; fewer people had to do more work. It is understandable that teachers were not very enthusiastic to participate in the research. Another reason was that ICT was planned to be implemented according to a specific plan. The accent was on delivering information on-line, in other words, to make current teaching material digital. CSCL did not fit the ICT implementation plans and as a consequence teachers did not warm to the use of other ICT-applications. The last reason concerns the tendency of teaching more traditionally. The greater part of the teachers was used to focusing on reproduction of facts in their lessons and they simply were not ready to teach with the concept of computer-supported collaborative learning.

No matter how, we were dependent on optional courses and therefore, few students participated in the courses. To organise the courses, small groups were not a problem; students experienced their group size as positive, came in for their turn sufficiently and discussion threads kept structured. However, statistical analyses prefer larger groups. For that reason we also searched for additional possibilities to collect data. It was possible to participate in two regular courses at the University of Nijmegen. However, in regular courses we also did not have the disposal of very large groups. Another problem we had to deal with was the inexperience of students. In all courses, except the Canadian course, education organised by CSCL was new to students. The research showed that it is necessary for students to learn how to use a CSCL-system, not in the sense of practically using technical possibilities, but in the sense of sharing their knowledge, thinking critically, not accepting information as automatically true and giving and receiving feedback. Students have to acquire another attitude towards learning and education compared to courses in which they usually participate. The research indicates that students with experience with CSCL and/or solving complex tasks profit by using CSCL compared to students who are not used to solving a complex task, let alone using CSCL. We were lucky to have permission to analyse Canadian data, but the problem of dealing with inexperienced students still remained in most of the studies. The problem of inexperience was less applicable to the teachers. The same teacher organised the two projects conducted at the University of Nijmegen, the course Land evaluation was organised three times by the same teacher, the course Agrification was organised for two successive years by the same teacher and the teacher of the Canadian course had much experience with teaching by CSCL.

7.6 Conditions for introducing CSCL in higher education

We have already mentioned above that CSCL certainly offers opportunities, but that the use of CSCL in (higher) education must be considered very thoroughly. Mulder (2000) warned us not to get stuck in formulating great educational views and learning goals and emphasised the importance of translating the view of education and learning goals into wanted learning activities, an adequate organisation of education and adequate assessment of learning. Based on the results and our experiences we can formulate a number of conditions to increase the effective use of CSCL in university courses. We suggest that the following measures have to be taken:

1. Before the course (preparation)

- Determine the function of CSCL in the course clearly, in other words, what is the added value of CSCL? It is thought too often that the use of CSCL will automatically lead to better learning results. The studies described in this PHdissertation indicate the importance of having to know what you are letting yourself in for.
- Integrate CSCL into other activities in the course; students must see the relevance of using CSCL. CSCL must be part of a course and it must be clear to which purpose CSCL is needed. The use of the CSCL-system has to become habit.

- Formulate unambiguous learning goals; students want to know where they stand. This will help to plan and organise activities better.
- Organise the course well and give students a schedule; a well-organised course seems to be obvious, but from experience we know it is not, and if students do not know what to do, they will not profit from the possibilities of CSCL. Giving a time schedule conflicts with ideas of independent learning, but certainly when CSCL is new, a schedule will support students.
- Take care of the basics students need in order to follow the course (such as time, computers, and technical help); lack of preconditions will reduce students' motivation and motivation is important because CSCL asks a lot from students.
- Consider the period of using the CSCL-system; search for a balance between enough time to learn using the system and flagging interest. Results indicate a period between 4 and 6 weeks.
- Choose for a transparent and user-friendly CSCL-system. Provide students and moderators with sufficient time and exercises to get used to the system.
- Create a complex, open-ended task in which information can be discussed from multiple perspectives and problems can be solved in many different ways; although theory emphasises the necessity of a complex, open-ended task, from experience we know it is not easy to design a useful task. However, this aspect seemed to be very crucial in the success of a CSCL-course or not.
- Use task structures that regulate organisational and planning issues, particularly when such issues are not related to task goals and learning goals; students can better focus on the core of the task.
- Consider moderating discussions. Is moderation assumed to be useful? And what is the aim of moderation? How can moderation be concretised? Notice, however, that moderation is not exactly easy and has to be trained beforehand.

2. During the course (facilitating and monitoring)

- Introduce the basics of the opportunities given by the system; students will waste little time if they do not have to figure out practical issues by themselves. Therefore, more time is left to spend on the content of the task. Another reason to introduce the basics is to prevent students from already dropping out in the beginning of the course.
- Arrange heterogeneous group compositions (prior knowledge; discipline, sex, age) and provide students with different discussion roles (multidisciplinary teams); students have to defend their interests and that gives ground for a critical exchange of ideas and arguments.
- Let students work in small groups (about six students); in large groups students take less responsibility to participate than in small groups and not all students will be involved in the discussion. Besides, in a large group it is more difficult to keep the discussion well organised.
- Give students time to learn to use the CSCL-system and to understand the task. This is especially important when CSCL is new to students. Besides, ensure they have enough time to read notes and react to notes.
- Organise regularly (once a week) a face-to-face meeting; experience shows that communication in a CSCL-system is more natural and easy when students meet each other regularly. Besides, students feel more compelled to participate in the system when they sometimes see fellow-students in real life.

- Do not use e-mail, but communicate on-line by means of the CSCL-system only; e-mail is not accessible to all students and using two systems causes gaps in information and causes confusion.
- Organise clear discussion threads; a well-organised discussion is necessary to prevent students from losing the focus. Students have to find easy different types of contributions. Separate discussion themes, technical issues, planning aspects and social issues.
- Support the use of clear titles when sending contributions and suggest a list with keywords typifying the sort of note (such as comment, question, answer, example, and new theory). Formulating clear titles and using keywords helps to keep the discussion clear and besides, it forces writers to characterise their contributions.
- If possible, do not present the task at once but present parts of the task distributed over the period; in this way you can breathe new life into the discussion. Students participated very regularly when this strategy was used.
- Let students brainstorm about the task individually first and compare their ideas and debate differences in understanding next; students sometimes are reserved in a group and research indicated that brainstorming first led to more ideas compared to students who debated about ideas immediately. Next, ideas can be compared.
- Let students summarise contributions between times in order to stimulate them to participate regularly and to keep the database well organised.
- Evaluate the progress of the course between times; evaluating between times will help students to keep focused on the task and to remain motivated.
- Show involvement by reading notes regularly, reserve enough time to log in daily. From experience we know that it is rather time-consuming to read the notes. Logging in has to become a daily habit. However, it is important; showing involvement motivates students.
- If you have decided to moderate discussions, maintain the moderation.
- Report between times on the progress of the course. We think this is always important, but especially when the task is complex and students are not used to learn by CSCL.

3. After the course (assessment)

- Assess the learning process in terms of participation, the amount and quality of students' contributions; in our view this is obvious, but from experience we know it is not. Assessing in this way is time-intensive and teachers are not used to it. However, many students in the courses studied asked for an assessment of their actions in the CSCL-system.
- If an additional test is needed, use a test that fits the learning goals best; teachers often fall back on traditional tests. In our opinion it is unfair to test factual knowledge since in CSCL importance is attached to thinking critically and creating one's own ideas.
- If students must write a collaborative report, prevent that students divide the report into paragraphs, work individually on a part, copy and paste the parts and finally contribute a report on the forum without working on the report collaboratively in the CSCL-system.

Table 7.1 summarises the conditions for introducing CSCL in higher education.

Table 7.1 Conditions suggested to increase the effective use of CSCL in university courses

Before the course (preparation)
• Determine the function of CSCL in the course clearly. What is the added value of CSCL?;
• Integrate CSCL into other activities in the course; students must see the relevance of using CSCL;
• Formulate unambiguous learning goals; students want to know where they stand;
• Organise the course well and give students a schedule;
• Take care of the basics the students need to follow the course;
• Choose for a transparent and user-friendly CSCL-system;
• Create a complex, open-ended task in which information can be discussed from multiple perspectives and problems can be solved in many different ways;
• Consider the period of using the CSCL-system; search for a balance between enough time to learn to use the system and flagging interest;
• Use task structures that regulate organisational and planning issues;
• Consider moderating discussions: why, how, when?
During the course (facilitating and monitoring)
• Introduce to students the basics of the opportunities given by the system;
• Arrange heterogeneous group compositions;
• Provide students with different discussion roles;
• Let students work in small groups;
• Give students time to learn to use the CSCL-system and to understand the task;
• Organise regularly (once a week) a face-to-face meeting;
• Do not use e-mail, but communicate on-line by using the CSCL-system only;
• Organise clear discussion threads;
• Support the use of clear titles when sending contributions and suggest a list with keywords typifying the sort of note;
• Do not present the task at once but present parts of the task distributed over the period;
• Let students brainstorm about the task individually first and compare their ideas and debate differences in understanding next;
• Let students summarise contributions between times;
• Evaluate the progress of the course between times;
• Show involvement by reading notes regularly, reserve enough time to log in daily;
• If you have decided to moderate discussions, maintain the moderation;
• Report between times on the progress of the course.
After the course (assessment)
• Assess the participation, learning activities used and knowledge construction in the CSCL-system;
• If an additional test is needed, use a test that fits the learning goals best;
• Prevent that students distribute tasks.

7.7 Suggestions for future research

In our opinion, the core of further research must concern the question of how to increase knowledge construction in CSCL. The present PHdissertation focuses on characterising students' learning processes in a CSCL-system and offers an instrument to analyse students' learning in terms of participation, interaction, use of (cognitive, affective and metacognitive) learning activities and knowledge construction. This instrument can be used in further research again, elaborated or not. It is to be hoped that students and teachers of next populations will have gathered more experiences with CSCL and that a new project does not have teething troubles. It would be interesting to analyse participation, interaction, use of learning activities and knowledge construction during the course as well. Social Networks Analysis might offer opportunities to improve quality of interaction analysis.

Additionally, our suggestion would be to focus on students' experiences. It would be interesting to know how students assess the use of CSCL, whether they see CSCL as an added value to their education and whether they are motivated to learn by CSCL. The relation between students' characteristics and the way they learn in a CSCL-system, which was briefly analysed in this PHdissertation, could also be deepened.

Another line of research we would suggest is systematically analysing the relation between the conditions of using a CSCL-system and the depth of learning. Which conditions promote the use of a CSCL-system as intended? By conditions one can think about additional or integral use of the CSCL-system, different types of CSCL-systems, and different types of tasks. Besides, it would be interesting to analyse the extent of transfer of acquired knowledge and skills compared to similar task situations.
In this PHdissertation, one condition of the educational context was picked out to look for effects on students' learning, namely the role of a moderator. Although the results of this study do not show a clear picture of effects of moderating and although the results are not simple to interpret, in our opinion moderating asynchronous discussions can be very useful. We hope this study will motivate others to go on in this line of research. This line of research is also relevant because of the current reorganisation of Dutch universities with regard to a Bachelor and Master phase. In the bachelor as well as in the master phase much importance is attached to academic competencies like for example logical reasoning, forming an opinion, critical reflection and analysing arguments (see Franssen, 2001). It would be interesting to think about the question of how to implement CSCL in order to support learning processes in new educational programs.

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Samenvatting

Aanleiding tot het onderzoek

Recente ontwikkelingen op het gebied van Informatie- en Communicatie Technologie (ICT) bieden volop mogelijkheden om onderwijs op een andere manier te organiseren. In deze context wordt anders opgevat als: op een nieuwe manier in vergelijking met traditioneel onderwijs, waar lerenden voornamelijk passief luisteren naar een docent en moeten proberen zoveel mogelijk informatie in zich op te nemen. Na afloop van de lessen wordt doorgaans getoetst of en hoeveel informatie een student heeft opgenomen ofwel kan reproduceren. Het onderwijs wordt steeds vaker ingericht volgens principes van constructivistische leertheorieën. Het constructivisme stelt niet de docent, maar de student centraal in het onderwijsleerproces. Van studenten wordt verwacht dat zij een actieve houding aannemen, dat ze zelf op zoek gaan naar informatie en deze informatie kritisch verwerken. Bij het toetsen van hetgeen geleerd is ligt het accent niet op reproductie van feiten, maar op het ontwikkelen van eigen standpunten en theorieën door studenten. In *hoofdstuk 2* van deze dissertatie wordt het theoretisch kader uitgewerkt, dat gebaseerd is op het constructivisme en dat bepalend is geweest voor wijze waarop het onderzoek is opzet en uitgevoerd.

ICT kan een ondersteunende rol spelen bij het verzorgen van onderwijs volgens constructivistische principes en kan daardoor de kwaliteit van het onderwijs verbeteren. In dit proefschrift wordt één specifieke ICT- toepassing onderzocht, namelijk een computerondersteund samenwerkende leeromgeving (CSCL omgeving). Een CSCL omgeving is op te vatten als een discussieforum, waarin studenten berichten kunnen typen en bewaren. Studenten zijn via een computernetwerk met elkaar verbonden, waardoor zij alle berichten die op het discussieforum zijn geplaatst kunnen lezen en tevens op deze berichten kunnen reageren. Er zijn zogenaamde synchrone en asynchrone systemen ontwikkeld. In een synchroon systeem werken studenten op een zelfde moment in het forum, in een asynchroon systeem is dat niet noodzakelijk. Studenten kunnen ook later, op een moment dat hen goed uitkomt, de berichten lezen en zelf berichten schrijven. In dit onderzoek is uitsluitend gebruik gemaakt van asynchrone CSCL systemen.

Een belangrijk uitgangspunt van computerondersteund samenwerkend leren (CSCL) is dat deze vorm van leren het gezamenlijk opbouwen van kennis door lerenden ondersteunt (Scardamalia & Bereiter, 1994). Leren wordt hierbij opgevat als een dynamisch proces van kennisconstructie. Een CSCL omgeving biedt de mogelijkheid om te onderhandelen over kennis. In CSCL staat de interactie tussen lerenden centraal (Erkens, 1997; Gokhale, 1998; Kanselaar & Van der Linden, 1984; Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001; Newman, Johnson, Webb & Cochrane, 1999; Van der Linden, Erkens, Schmidt & Renshaw, 2000). In interactie met medestudenten is het noodzakelijk dat studenten hun gedachten helder formuleren en hun ideeën expliciteren. Alleen al daarom wordt discussiëren zinvol gevonden (Johnston, 1997; Lethinen *et al.*, 2001; Slavin, 1997; Veerman, 2000). Dit effect, het gedwongen worden om duidelijk te formuleren, wordt verder versterkt in een situatie met CSCL. Studenten moeten immers hun ideeën intypen waarbij zij geen beroep kunnen doen op non-verbale communicatie als mimiek en gebaren (Rijlaarsdam & Couzijn, 2000; Tynjälä, 1999). Wanneer je schrijft, schrijf je niet puur op wat je weet, maar tijdens het schrijven worden gedachten opnieuw gestructureerd en gevormd (Bereiter & Scardamalia, 1987).

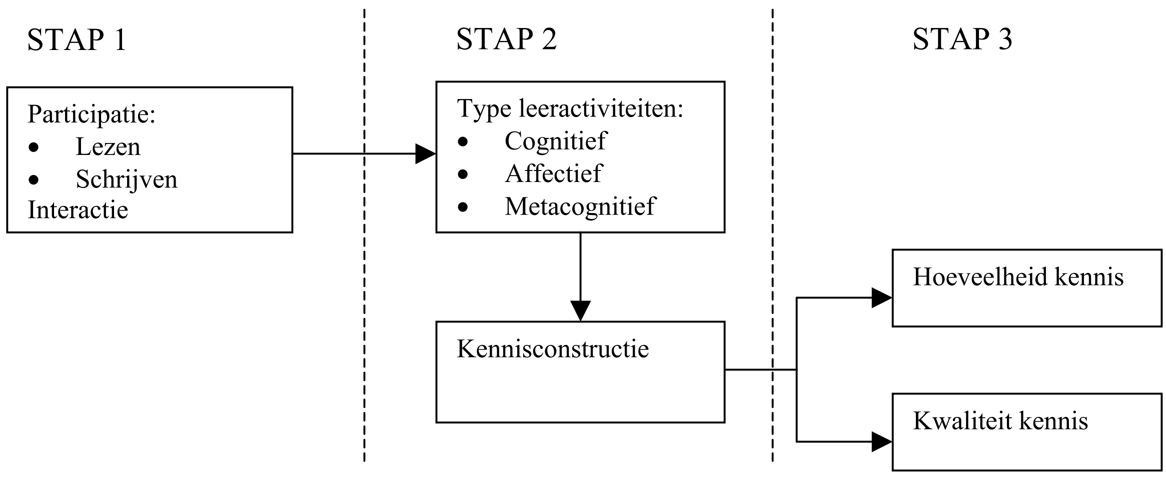
Onderzoeksvragen

De afgelopen jaren zijn er verschillende onderzoeken uitgevoerd waarvan de resultaten aanleiding geven te veronderstellen dat CSCL inderdaad een positief effect heeft op het proces van gezamenlijke kennisconstructie (De Laat & De Jong, 2001; Koschmann, Feltovich, Myers & Barrows, 1997; Lethinen *et al.*, 2001; Lipponen, 1999; Salovaara, 1999; Tynjäla, 1999). Desondanks is er nog veel onduidelijk over het leerproces van studenten tijdens CSCL. We weten niet goed hoe studenten een CSCL omgeving gebruiken, welke leeractiviteiten zij uitvoeren en hoe CSCL het leerproces van studenten ondersteunt. Dit onderzoek heeft dan ook als doel inzicht te krijgen in het leerproces van studenten in CSCL. We willen weten hoe studenten in een CSCL omgeving leren en tevens wat de kwaliteit van het geleerde is. We veronderstellen dat dit inzicht kan helpen om CSCL effectiever in het onderwijs te kunnen inzetten. Tegen deze achtergrond zijn daarom voor deze dissertatie de volgende onderzoeksvragen geformuleerd (*hoofdstuk 1*):

1) Hoe kan het leerproces van studenten die met behulp van een asynchrone CSCL omgeving leren gekarakteriseerd worden in termen van participatie en interactie?
2) Hoe kan het leerproces van studenten die met behulp van een asynchrone CSCL omgeving leren gekarakteriseerd worden in termen van cognitieve, affectieve en metacognitieve leeractiviteiten?
3) Construeren studenten kennis wanneer zij leren met behulp van een asynchrone CSCL omgeving en zo ja, wat is de kwaliteit van die geconstrueerde kennis?
4) Wat zijn de effecten van het modereren van een CSCL discussie op het leren van studenten?

Aanpak van het onderzoek

Om antwoord te vinden op deze onderzoeksvragen is allereerst een literatuurstudie uitgevoerd. Verschillende studies zijn bestudeerd om na te gaan of er reeds een methode beschikbaar was om de activiteiten van studenten in een CSCL omgeving te analyseren op mate van participatie en interactie, type leeractiviteiten en hoeveelheid en kwaliteit van kennisconstructie. Deze literatuurstudie wordt beschreven in *hoofdstuk 3*. Alhoewel de bestudeerde methodieken ideeën opleverden over hoe de bijdragen van studenten geanalyseerd kunnen worden, werd geen kant-en-klaar te gebruiken methode gevonden. Daarom is een nieuwe analyse methode ontwikkeld, welke wordt beschreven in *hoofdstuk 4*. Deze methode bestaat uit drie stappen (zie figuur I):



Figuur I: De drie stappen van de methode om bijdragen van studenten in een CSCL omgeving te analyseren.

Stap 1 van de analysemethode is gekoppeld aan de eerste onderzoeksvraag. Dit onderdeel van de analyse vormt de basisanalyse en is bedoeld om een globaal beeld te krijgen van de betrokkenheid van studenten en de mate van activiteit in de discussieomgeving. Om de participatie te meten is het aantal geschreven bijdragen (nieuwe en reactie) en het aantal gelezen bijdragen per student geteld. Daarnaast is in stap 1 de dichtheid van interactie berekend, zowel voor het lezen van berichten ('wie heeft wiens bijdragen gelezen?') als voor het op elkaar reageren ('wie op wie heeft gereageerd?').

Stap 2 bestaat uit het toepassen van een codeerschema. Dit codeerschema is gebaseerd op het algemeen theoretisch kader beschreven in hoofdstuk 2, op de bestudeerde methodieken beschreven in hoofdstuk 3, maar daarnaast ook op onze ervaringen met CSCL opgedaan in uitgevoerde voorstudies. De classificatie van leeractiviteiten van Vermunt (1992) is gebruikt om het type leeractiviteiten in te delen naar cognitief, affectief en metacognitief. Binnen de hoofdcategorie 'cognitief' zijn de volgende subcategorieën onderscheiden: (1) debatteren, (2) gebruik van informatie en (3) het leggen van relaties. *Debatteren* verwijst naar het inbrengen en uitwerken van ideeën, maar ook naar het stellen van inhoudelijke vragen. *Gebruik van informatie* betreft informatie gevonden in bronnen anders dan de discussieomgeving waarin gewerkt aan de taak en daarnaast naar ervaringen elders opgedaan. Deze informatie en ervaringen worden gebruikt om ideeën ingebracht in de discussie te onderbouwen. Het *leggen van relaties* verwijst naar relaties gelegd tussen berichten in de discussieomgeving of naar het herhalen van informatie gevonden in de discussieomgeving. De hoofdcategorie 'metacognitief' is onderverdeeld in: (1) plannen, (2) overzicht houden en (3) monitoren. *Plannen* heeft betrekking op de praktische uitvoering van de taak en op het maken van afspraken daarbij. Met de categorie *overzicht houden* wordt bedoeld zowel het begrijpelijk houden van de inhoud van de bijdragen als het behouden van overzicht op het verloop van de discussie. *Monitoren* tenslotte heeft betrekking op het bewaken van de doelen en planning en op het reflecteren op bijdragen in de discussie. De categorie 'affectief' is niet onderverdeeld in subcategorieën. Wel zijn een aantal codes onderscheiden binnen deze hoofdcategorie, wat overigens ook geldt voor de verschillende subcategorieën binnen de hoofdcategorieën cognitief en metacognitief.

De derde onderzoeksvraag kon niet beantwoord worden door toepassing van het ontwikkelde codeerschema. Daarom was het nodig een derde stap aan de analyse toe te voegen. Daartoe is allereerst het concept kennisconstructie geoperationaliseerd als: het toevoegen, uitwerken en evalueren van ideeën, het samenvatten van gevonden informatie, het kritisch reflecteren op deze informatie en het leggen van relaties tussen verschillende feiten en ideeën. Een selectie van codes uit het eerste codeerschema vormt een indicatie voor de hoeveelheid kennis die geconstrueerd is door de studenten. Om de kwaliteit van deze geconstrueerde kennis te beoordelen is een tweede codeerschema ontwikkeld dat gebaseerd is op de Structure of the Observed Learning Outcome (SOLO)-taxonomy van Biggs en Collis (1982). In dit schema worden vier niveaus van begrip onderscheiden, oplopend van niveau D tot niveau A. Deze niveaus van begrip zijn vertaald in werkwoorden als bijvoorbeeld: definiëren, beschrijven, classificeren, relateren, reflecteren of concluderen.

Van beide codeerschema's is de interbeoordelaars-betrouwbaarheid berekend om tot een betrouwbaar meetinstrument te komen. Het eerste codeerschema (stap 2) werd toegepast op zinvolle eenheden, er konden dus meerdere type leeractiviteiten binnen een bijdrage gecodeerd worden. Het tweede codeerschema (stap 3) werd toegepast op complete bijdragen. Met andere woorden: een bijdrage werd dus in zijn totaliteit beoordeeld op de kwaliteit. Vervolgens is een standaard opgesteld om een oordeel te kunnen geven over de hoeveelheid en kwaliteit van kennisconstructie en om de resultaten van verschillende studies te kunnen vergelijken.

Zes studies

In de periode van 1998 tot 2001 is CSCL geïmplementeerd in zes universitaire cursussen. In totaal zijn drie studies uitgevoerd aan de Wageningen Universiteit, twee studies aan de Katholieke Universiteit van Nijmegen en voor één studie kon gebruik worden gemaakt van data verzameld tijdens een cursus gegeven aan de Universiteit van Toronto. Alle data zijn geanalyseerd aan de hand van de ontwikkelde methode. Naast het feit dat alle studies zijn uitgevoerd binnen een universitaire setting, vertonen de studies nog enkele overeenkomsten. Alle studies waren gekoppeld aan een authentieke cursus, waarin studenten samenwerkten aan een complexe taak ondersteund door dezelfde CSCL omgeving (Knowledge Forum). Verder zaten alle studenten die participeerden in de cursus in de laatste fase van hun studie. Hiervoor was gekozen, omdat juist in een eindfase meer complexe leerstof wordt behandeld en open taken meer gebruikelijk zijn. In geen van de studies werden aan de studenten restricties opgelegd aangaande het lezen of schrijven van berichten. Zo moesten studenten bijvoorbeeld zelf weten hoe lang een bericht werd en of ze eerst bijdragen gingen lezen of dat ze meteen een nieuw bericht gingen schrijven. Van de studenten werd wel een actieve en betrokken houding verwacht.

Daarnaast zijn er ook verschillen tussen de studies. In sommige studies was de cursus een verplicht studieonderdeel, in andere studies was de cursus een keuzevak en hadden studenten bewust gekozen om aan de cursus deel te nemen. De cursussen varieerden aanzienlijk wat betreft omvang (2 weken tot 17 weken) evenals het aantal uur dat studenten per week in de CSCL omgeving aan de taak dienden te werken (2 tot 20 uur). Bovendien verschilde de toetsvorm van de cursussen. Zo werd de participatie in Knowledge Forum beoordeeld of bepaalde alleen een eindtoets het cijfer voor de cursus. Een belangrijk onderscheid tussen respectievelijk de studies 1, 2, 3, 4 (*hoofdstuk 5*) en de studies 5 en 6 (*hoofdstuk 6*) was het al dan niet modereren van discussies door een docent. In de studies 1-4 reguleerden de studenten zelf het proces. In de studies 5 en 6 was de docent actief in het schrijven van berichten gericht op de samenwerking tussen studenten of het stimuleren van kritisch denken. Docenten waren vooraf geïnstrueerd over de wijze waarop ze de helft van de studenten in hun cursus dienden te modereren. Hiertoe waren richtlijnen besproken en was er gelegenheid om met deze richtlijnen te oefenen.

In het vijfde hoofdstuk worden de eerste drie onderzoeksvragen beantwoord in elke studie. Daarnaast zijn drie sub-vragen geformuleerd gerelateerd aan de specifieke kenmerken van de verschillende onderwijssettings in studie 1, 2 en 3. De sub-vraag in studie 1 betreft de groepsgrootte, de sub-vraag in studie 2 betreft het hebben van een specifieke rol en de sub-vraag in studie 3 heeft betrekking op de leerstijl van studenten. In hoofdstuk 6 wordt antwoord gegeven op de vierde onderzoeksvraag. Net als in de studies beschreven in hoofdstuk 5 wordt eerst het leerproces van studenten geanalyseerd. Vervolgens worden de acties van de moderators geanalyseerd op onder andere het soort bericht (aan de hand van de instructierichtlijnen), het aantal geschreven berichten, het percentage gelezen bijdragen, de reactietijd (hoe lang duurde het voor een docent reageerde op een bijdrage van een student?) en het aantal studenten dat een bericht kreeg van de docent uitgedrukt als percentage van de hele groep.

Resultaten

In tabel A staan de hoofdresultaten van de zes studies beschreven: de gemiddelde participatie per student, de dichtheid van interactie, het gemiddeld aantal leeractiviteiten per student en de gemiddelde kennisconstructie per student.

Tabel A: De gemiddelde participatie per student, de dichtheid van interactie, het gemiddeld aantal leeractiviteiten per student en de gemiddelde kennisconstructie per student voor de zes studies

	Hoofdstuk 5				Hoofdstuk 6	
	Studie 1 (n=15)	Studie 2 (n=13)	Studie 3 (n=24)	Studie 4 (n=7)	Studie 5 (n=28)	Studie 6 (n=9)
Participatie (gemiddeld per student)						
# Geschreven bijdragen	19.13	11.38	10.31	24	16.76	46.32
# Gelezen bijdragen	76.13	51.30	58.53	148.14	65.44	192.67
Interactie (dichtheid) gebaseerd op:						
Gelezen bijdragen	1.0	1.0	.61	.95	*	*
Geschreven bijdragen	.60	.48	.13	.67	*	*
Leeractiviteiten (gemiddeld per student)						
Cognitief	9.07	22.89	20.50	62.86	7.33	48.11
Affectief	7.73	1.70	2.33	3.43	6.75	27.78
Metacognitief	13.47	3.78	7.38	7.14	10.29	11.56
Kennisconstructie (gemiddeld per groep)						
Hoeveelheid	weinig	redelijk	weinig	weinig	weinig	redelijk
Kwaliteit	laag	hoog	hoog	redelijk	redelijk	redelijk

* In deze studie is interactie niet berekend omdat de docent in de helft van de groepen intervenieerde en interactie geen onderdeel was van de onderzoeksvraag behorend bij de studie.

Opvallend is dat de resultaten per studie enorm verschillen. De enige overeenkomst tussen de studies is dat in alle studies de gemiddelde passieve participatie per student (het lezen van berichten) groter was dan de gemiddelde actieve participatie per student (het schrijven van berichten). Wat betreft de verhouding tussen het gebruik van cognitieve, affectieve en metacognitieve leeractiviteiten zien we grote verschillen. Het gebruik van affectieve leeractiviteiten is in elke studie, uitgezonderd studie 6, het laagst. Verder zien we dat studenten in de studies 2, 3, 4 en 6 meer cognitieve leeractiviteiten gebruikten dan metacognitieve leeractiviteiten en dat in de studies 1 en 5 juist het omgekeerde het geval was. In vier van de zes studies construeerden de studenten weinig kennis, in de overige twee studies werd de hoeveelheid kennisconstructie als redelijk beoordeeld. De kwaliteit van de geconstrueerde kennis varieerde van laag tot hoog, maar is in de meeste studies beoordeeld als redelijk.

Op grond van de resultaten van dit onderzoek blijkt het niet mogelijk om een standaard profiel te schetsen van de wijze waarop studenten in een asynchrone CSCL omgeving leren. Studenten leren op hun eigen wijze, dat geldt voor meer traditionele onderwijsmethoden, maar dus ook voor een CSCL leersituatie. In studie 3 hebben studenten een deel van de Inventaris Leerstijlen ingevuld om na te gaan of er samenhang bestaat tussen het hanteren van een bepaalde leerstijl en het leren in een CSCL omgeving. Er werd geen verband gevonden tussen de mate waarin studenten participeerden in de discussie en hun leerstijl. Tussen leerstijl en het gebruik van leeractiviteiten werden wel een paar verbanden gevonden. Zo lijkt het voor het overzichtelijk houden van de discussie en het monitoren van de taak een voordeel om een toepassingsgerichte of betekenisgerichte leerstijl te hebben (Vermunt, 1992). Er is geen verband gevonden tussen het hebben van een bepaalde leerstijl en kennisconstructie. Na het berekenen van correlaties op het niveau van leerstijl, zijn correlaties berekend op het niveau van de schalen die de vier leerstijlen bepalen. Daaruit blijkt onder andere dat studenten die hoog scoren op de schaal diepteverwerking meer kennis construeren dan studenten die laag op deze schaal scoren. Verder blijkt het gunstig wanneer studenten een positieve houding hebben ten opzichte van samenwerkend leren. Studenten die hoog scoren op de schaal samenwerkend leren gebruiken meer cognitieve en planningsactiviteiten dan studenten die laag scoren op deze schaal. Studenten die een gebrek hebben aan regulatiestrategieën hebben net als in andere onderwijsvormen problemen met het plannen en uitvoeren van een taak.

Onder andere Webb en Sullivan Palinscar (1996) en Dillenbourg (1999) schrijven over de complexiteit die een onderwijsleersituatie kenmerkt. Verschillende factoren zoals bijvoorbeeld taakkenmerken, tijdsinvestering of studentkenmerken hangen met elkaar samen. Alhoewel deze studie een exploratief karakter had, is het idee van een complexe samenhang tussen verschillende factoren in de onderwijssetting met deze studie bevestigd. Zoals hierboven reeds beschreven, is met de factor docent interventie gemanipuleerd in de studies 5 en 6. De resultaten geven aanleiding te veronderstellen dan studenten meer kennis construeren en dat de kwaliteit van die kennis hoger is wanneer de docent studenten uitlokt tot kritisch denken dan wanneer de docent dat niet doet. Deze vorm van uitlokken wordt in dit onderzoek kritisch modereren genoemd en wordt geconcretiseerd door onder meer: het stellen vragen, het checken van antwoorden en het plaatsen van stellingen. Kritisch modereren zet studenten aan tot diep leren wat betekent dat studenten kritisch interacteren met de leeromgeving, relaties leggen tussen bijdragen in de discussie of met informatie gevonden in andere bronnen, ideeën met elkaar integreren en de logica van argumenten toetsen (MacFarlane Report, 1992). Alhoewel een effect werd gevonden op het gebruik van cognitieve leeractiviteiten en kennisconstructie, geven de resultaten aanleiding te veronderstellen dat de kwaliteit van de docentinterventies bepalend is voor het al dan niet effect hebben op het leerproces. Het is moeilijk docenten op korte termijn te instrueren. Ook al modereren docenten volgens vooraf gegeven richtlijnen, factoren als de juiste toon aanslaan, goed contact met de studenten en werkelijke betrokkenheid zijn moeilijk te oefenen, maar lijken van wezenlijk belang.

Een andere factor waarmee gemanipuleerd is, is de benadering van een probleem vanuit een bepaald perspectief. In studie 2, voerden studenten twee taken uit. In de eerste taak was studenten geen rol opgelegd. In de tweede taak werd wel een specifieke rol opgelegd en werkten studenten in multidisciplinaire teams. Met andere woorden, iedere student kreeg andere informatie behorend bij een bepaalde rol (bijvoorbeeld econoom, toerist of boer). Het beschikken over andere informatie en het vertegenwoordigen van tegengestelde belangen zette aan tot participatie. In de multidisciplinaire teams werden door studenten meer berichten geschreven en meer bijdragen gelezen, wat resulteerde in meer kennisconstructie.

Conclusies

In *hoofdstuk 7* worden de belangrijkste conclusies op een rij gezet en bediscussieerd vanuit zowel theoretisch als methodologisch perspectief. Zo wordt er onder meer gereflecteerd op de gehanteerde definitie van kennisconstructie, de gebruikte standaarden om de hoeveelheid en kwaliteit van kennisconstructie te beoordelen en het aantal studenten dat participeerde in de bestudeerde cursussen.

Naar onze mening was de ontwikkelde methodiek geschikt om leerprocessen van studenten tijdens CSCL te analyseren. Met andere woorden, door de uitgevoerde analyses hebben we inzicht gekregen in het leerproces, konden we in kaart brengen welke activiteiten studenten ondernemen wanneer ze onderwijs volgen via CSCL. Vooraf veronderstelden we dat CSCL zinvol kan zijn om het leerproces van studenten te ondersteunen, met name in het hoger onderwijs. Na het uitvoeren van dit onderzoek zijn we nog steeds overtuigd van de mogelijkheden die CSCL biedt. Na het onderzoek zijn we van mening dat het tijd is om goed na te denken over de vraag hoe we het proces van kennisconstructie kunnen bevorderen. Studenten blijken kennis te construeren, maar gemeten naar onze standaard was de hoeveelheid geconstrueerde kennis in geen van de studies hoog te noemen. Ook de kwaliteit van de kennis liet vaak te wensen over.

Concluderend kan dus gesteld worden dat CSCL mogelijkheden biedt, maar dat we er geen wonderen van moeten verwachten. Naast docentinterventie en het werken in multidisciplinaire teams lijken onder meer de volgende aspecten van belang voor het succesvol gebruiken van CSCL in het onderwijs:

- ervaring en motivatie van studenten;
- een goede organisatie van de cursus;
- het regelmatig organiseren van bijeenkomsten waarin docenten en studenten elkaar ontmoeten;
- een complexe taak die discussie uitlokt en onderhandelen over kennis noodzakelijk maakt;
- eenvoudig te gebruiken CSCL omgeving;
- voldoende tijd om aan het ICT programma te wennen;
- voldoende tijd om aan de taak te werken, om bijdragen van elkaar te lezen en om op bijdragen te reageren;
- het voorstructureren van de taak;
- een fase waarin studenten individueel brainstormen alvorens met elkaar in discussie te gaan;
- het beoordelen van de bijdragen van studenten geplaatst in de CSCL omgeving naast het eventueel beoordelen van een eindproduct.

Net als bij de inzet van andere leermiddelen moet ook het gebruik van CSCL grondig doordacht worden. Alhoewel deze opmerking een open deur lijkt, is dat toch niet zo. Te makkelijk wordt vaak nog gedacht dat gebruik van ICT studenten automatisch aanzet tot leren en dat dit leren leidt tot positieve resultaten: "Oh, ze gebruiken ICT, dat is goed, ICT werkt!". Als docent is het nodig om antwoord te geven op vragen als: Wat is het doel van de cursus en waarom wil ik CSCL gebruiken? Hoe kan ik CSCL integreren in de cursus? Hebben mijn studenten ervaring met samenwerkend leren? Is het wenselijk dat studenten samenwerken? Hoe kan ik de taak zo formuleren dat die geschikt is om in CSCL uit te voeren? En, in hoeverre moet ik de taak voorstructureren? Nodigt de taak uit tot discussie en tot het onderhandelen over kennis? Is er een gebruikersvriendelijk CSCL programma beschikbaar gedurende de periode van de cursus? Zijn er voldoende computers beschikbaar voor studenten om mee te werken? Wat doe ik met de bijdragen van studenten? Beoordeel ik studentbijdragen en zo ja, waarop en wanneer? Leg ik studenten regels op voor bijvoorbeeld het aantal te schrijven berichten per week? En wat doe ik als docent? Ga ik alleen berichten lezen of ga ik ook interveniëren door berichten op het forum plaatsen? Ga ik langs de zijlijn staan en aanwijzingen geven of ga ik me bemoeien met de inhoud van de discussies?

Vervolgonderzoek

Naast conclusies en praktische aanbevelingen om CSCL in te zetten in het onderwijs worden in hoofdstuk 7 suggesties gegeven voor vervolgonderzoek. Naast het meer systematisch onderzoeken van mogelijke effecten in verschillende condities, zoals bijvoorbeeld additioneel en integraal gebruik van een CSCL omgeving, verschillende varianten van een CSCL omgeving, cursusduur of toetsing, zou het interessant zijn om participatie, interactie, gebruik van leeractiviteiten en kennisconstructie te analyseren over tijd, dus in de verschillende fasen van een cursus. Voor de inhoudsanalyse zou opnieuw gebruik kunnen worden gemaakt van de methode ontwikkeld voor, en toegepast in, de studies beschreven in dit proefschrift. De methode is betrouwbaar en is zinvol gebleken bij het in kaart brengen van het leerproces van studenten. Bij herhaling van het onderzoek is het interessant om te kijken of ook in andere onderwijssettings relatief weinig kennis wordt geconstrueerd. Als dat zo is, zou het doel van vervolgonderzoek vooral moeten zijn het vinden van een oplossing voor het probleem dat studenten weinig kennis construeren in CSCL.

Summary

Background of the research

Recent developments in Information and Communication Technology (ICT) offer many opportunities to reorganise education according to constructivist principles. In contrast to more traditional education, education organised by constructivist principles is not teacher-centred, but student-centred. Students can influence their education and are not only consumers as in traditional education. Students work in collaboration to solve tasks and importance is attached to their own ideas; reproducing facts is becoming less important. Students are expected to be active and independent. They have to search for information by themselves and are expected to process this information critically. The accent is not on testing reproduction of facts but much importance is attached to creating own ideas and theories. *Chapter 2* of this PHdissertation outlines the theoretical framework which was based on constructivism and which determined the design and conduction of the research.

The assumption is that supporting education by ICT can increase the quality of learning. This PHdissertation studies one specific ICT-application, namely Computer-Supported Collaborative Learning (CSCL). In CSCL, students learn collaborative by using a CSCL-system. A CSCL-system can be considered to be a discussion forum in which students can contribute messages and can read each other's messages. A computer network connects students and therefore, students can read all messages and react to all the messages contributed to the discussion forum. Synchronous as well as asynchronous systems are available. In synchronous systems, students can work from different places in real time. In asynchronous systems, work is independent of time and place. In the research described in this PHdissertation, only asynchronous systems are used. Students could work in the system at any moment.

The central idea of CSCL is that it supports shared knowledge building by the learners (Scardamalia & Bereiter, 1994). The principles of shared knowledge building and CSCL are consistent with a constructivist view of learning. From a constructivist point of view, learning is a dynamic process of knowledge construction. In this PHdissertation, collaborative learning is described as a learning situation in which participating learners exchange ideas, experiences and information to negotiate about knowledge in order to construct personal knowledge that serves as a basis for common understanding and a collective solution to a problem. Research shows that collaborative learning can be useful to reach intellectual goals such as critical thinking or debating. People learn by interaction (Erkens, 1997; Gokhale, 1998; Kanselaar & Van der Linden, 1984; Lethinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 2001; Newman, Johnson, Webb & Cochrane, 1999). Characteristic to collaboration is the interaction between people and people learn through interaction with each other (Biggs & Collis, 1982). Discussion is important because we will only 'give words to our thoughts' when we use these words to communicate with others, and this in turn may be related to our ability to clarify and remember ideas (Johnston, 1997); understanding is achieved through interaction (Veerman, 2000). Besides, CSCL seems to be an effective tool because students have to write down their ideas. Writing can be seen as the most important tool of thinking, and it has a crucial significance in explication and articulation of one's conceptions (Bereiter & Scardamalia, 1987; Rijlaarsdam & Couzijn, 2000; Tynjälä, 1999).

Research questions

Literature shows that there is a reasonable amount of published experiments indicating positive learning effects when CSCL-systems have been used in education (De Laat & De Jong, 2001; Koschmann, Feltovich, Myers & Barrows, 1997; Lethinen *et al*., 2001; Lipponen, 1999; Salovaara, 1999; Tynjäla, 1999). Despite developments in research and educational practice, much is still unclear about students' learning processes in CSCL. It is unknown how students use a CSCL-system, which learning activities they use and how CSCL supports students' learning. The aim of this research is to gain insight into students' learning processes in CSCL, focused on both the amount and the quality of knowledge construction. The underlying assumption is that understanding students' learning processes will be helpful to use CSCL effectively in education. Inspired by this research problem the following main research questions were addressed (*chapter 1*):

1) How can students' learning processes in an asynchronous CSCL-system be characterised in terms of participation and interaction?
2) How can students' learning processes in an asynchronous CSCL-system be characterised in terms of cognitive, affective and metacognitive learning activities?
3) Do students construct knowledge and what is the quality of that knowledge constructed by students in an asynchronous CSCL-system?
4) What are the effects of moderating a CSCL-discussion on students' learning?

Method

To find an answer to our research questions, first a review study (*chapter 3*) was carried out to find out if a method was available to analyse students' activities in a CSCL-system on participation, interaction, types of learning activities and amount and quality of knowledge construction. The reviewed methods supplied many ideas we could use to develop a new method and helped us to clarify our view on analysing CSCL-data. However, studying a number of methods did not result in finding a workable, ready-made method to answer our research questions. Therefore, a new method was developed on the basis of the theoretical framework outlined in chapter 2, on the ideas supplied by the reviewed methods described in chapter 3, and on our experiences with CSCL in pilot projects. *Chapter 4* describes the developed method used to analyse students' learning processes in this PHdissertation. The method consist of three steps (see Figure I):

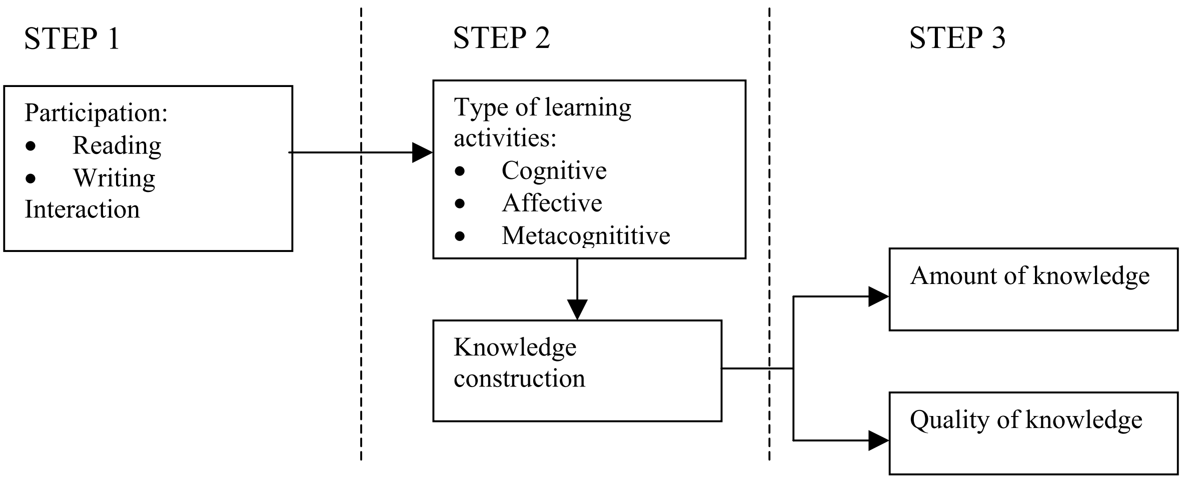


Figure I: Three steps of the method used to analyse students' contributions in a CSCL-system.

The method consists of three steps: (1) Analysing students' participation and interaction, (2) analysing cognitive, affective, and metacognitive learning activities, and (3) assessing the amount and quality of knowledge constructed by students and expressed in written contributions. Students' participation was operationalised as the number of written notes (new notes or build-on notes) and number of different read notes. To indicate interaction, density was calculated twice, based on read notes as well as on linked notes. Density describes the general level of linkage among the students in a discourse. In other words, density refers to the extent of interaction between students.

The second step of the method concerns the use of learning activities. The classification of learning activities of Vermunt (1992) was used as a frame to create a coding scheme divided into (1) Cognitive, (2) affective, and (3) metacognitive learning activities. Next, these main categories were divided into several subcategories. The main category 'cognitive learning activities' consists of three subcategories: (a) Debating, (b) using external information and experiences, and (c) linking or repeating internal information. *Debating* refers to the process of negotiation, critical thinking, asking questions and discussing subjects with other participants in the database. *Using external information and experiences* was inserted into the scheme because in an asynchronous CSCL-system students have time to search for information to support their ideas with explanations and to elaborate their questions. Information can be used to evaluate contributions thoroughly. Types of information contributed to the CSCL-system are for example articles found on the Internet, notes made in a lecture, a summary of a book chapter, results of running a specific tool, or a summary of another discussion. A third subcategory is *Linking or repeating internal information*. Internal information concerns information found in the discussion view students are working in. Referring to and linking notes were considered to be important because of increasing coherence in the database. It was assumed that more coherence between notes means more interactions between students. By 'affective learning activities', students' feelings expressed in their notes while working in the learning environment are meant. An affective category was included in the coding scheme to provide information about the kinds of feelings and was expected to be useful in interpreting the nature of the interactions between students. In this coding scheme affective learning activities are not related to content of subject matter, they are non-task-related. The category 'metacognitive learning activities' consists of three subcategories: (a) Planning, (b) keeping clarity, and (c) monitoring. *Planning* refers to practical issues such as making appointments, subdividing parts of the task, appointing a group member as chairperson or to theoretical issues such as choosing a definition after discussing a concept or deciding to run a specific tool. Characteristic of these content-related approaches is their effect on the process of the task performance. The subcategory *Keeping Clarity* refers to messages written in order to keep the structure and the content of the notes clear. The last subcategory of metacognitive learning activities is called *Monitoring*. While conducting the task, students will keep watching the learning process. Next, a number of codes are distinguished within all the subcategories.

Because the third main research question could not be answered by means of the first coding scheme, it was necessary to add a step to the process of analysis, step three. Therefore, knowledge construction was first operationalised as adding, elaborating and evaluating ideas, summarising or evaluating external information and linking different facts and ideas. In line with this definition, six codes from the first coding scheme were selected to indicate the amount of constructed knowledge. To measure the quality, a second coding scheme was developed on the basis of the Structure of the

Observed Learning Outcome (SOLO) taxonomy of Biggs and Collis (1982). This scheme consists of four levels of quality, increasing from level D to level A. Both coding schemes were validated by calculating Cohen's Kappa to determine the inter-rater reliability of the scheme. The first coding scheme (step 2) was applied to units of meaning. In other words, several types of learning activities could be decoded within one message. The second coding scheme (step 3) was applied to complete messages; a contribution was assessed in its entirety. The coding schemes were developed to understand students' learning processes. Standards were formulated to judge students' learning processes and to compare results of different studies.

Six studies

From 1998 until 2001, CSCL was implemented in six university courses. Three studies were conducted at the Wageningen University, two studies at the University of Nijmegen and in one study we made use of data collected in a course organised at the University of Toronto. All data were analysed by means of the method developed. Besides the similarity of a university context, the six studies were comparable in some other aspects. All studies took place as part of a real course in which students had to work collaboratively on complex tasks by the use of a CSCL-system. All studies were planned in the final phase of the educational programmes. Another similarity was the CSCL-system used, namely Knowledge Forum. In none of the studies, students were charged with rules concerning the use of Knowledge Forum. They were expected to log in regularly, but were not obliged to read all notes or to write a certain numbers of notes. However, there were differences between the studies as well.

Sometimes, the course was required; sometimes it concerned an optional course. The period of the use of CSCL varied substantially (2 to 17 weeks), just as the number of hours students were expected to spend in the CSCL-system weekly (2 to 20 hours). Besides, courses differed in their testing of learning. Sometimes, the participation in Knowledge Forum was assessed, but sometimes only a final test determined the course's grade. The discussions analysed in studies 1, 2, 3, and 4 (*chapter 5)* differ from the discussions analysed in studies 5 and 6 *(chapter 6*) in being not moderated; students in studies 1-4 were self-regulated. In studies 5 and 6, a teacher was active in writing contributions focused on stimulating collaboration between students or triggering critical thinking. Beforehand, teachers were instructed on how to moderate half of the students in their courses. Guidelines were discussed and notes were available to try out the guidelines.

Each study of chapter 5 first answers the main research questions. Besides these overall research questions, three more specific questions were formulated related to specific characteristics of the different educational tasks and settings in studies 1, 2 and 3. The sub-question in study 1 concerns group size, the sub-question in study 2 concerns having a specific discussion role and the sub-question in study 3 concerns students' learning style. Chapter 6 answers the fourth main research question. Comparable to the studies 1-4, first students' learning processes were analysed. Additionally, moderators' activities were analysed to survey how the moderation was carried out. Moderators' activities were analysed on types of actions, percentage of read notes, number of written notes, the percentage of students to whom the moderator directed notes, response time and relation between number of students' and moderator's notes contributed per week.

Results

Table A shows the main results of the six studies: mean participation per student, density of interaction, mean number of used learning activities per student and knowledge construction on average per group.

Table A: Mean participation per student, density of interaction, mean number of used learning activities per student and knowledge construction on average per group in the six studies

	Chapter 5 Study 1 (N=15)	Study 2 (N=13)	Study 3 (N=24)	Study 4 (N=7)	Chapter 6 Study 5 (N=28)	Study 6 (N=9)
Participation (mean per student)						
# Written contributions	19.13	11.38	10.31	24	16.76	46.32
# Read contributions	76.13	51.30	58.53	148.14	65.44	192.67
Interaction (density) based on:						
Read contributions	1.0	1.0	.61	.95	*	*
Written contributions	.60	.48	.13	.67	*	*
Learning activities (mean per student)						
Cognitive	9.07	22.89	20.50	62.86	7.33	48.11
Affective	7.73	1.70	2.33	3.43	6.75	27.78
Metacognitive	13.47	3.78	7.38	7.14	10.29	11.56
Knowledge construction (mean per group)						
Amount	Little	Reasonable	Little	Little	Little	Reasonable
Quality	Low	High	High	Reasonable	Reasonable	Reasonable

* In this study interaction was not calculated because a teacher intervened in one half of the group, and besides, interaction was not part of the research question in this study.

It is striking that the results of the different studies vary enormously. The only similarity between the studies is that in each study, students read many more notes (passive participation) than they wrote (active participation). Concerning the use of cognitive, affective and metacognitive learning activities we see large differences. Except for study 6, in each study students used affective learning activities least. Next, students in the studies 2, 3, 4 and 6 used more cognitive than metacognitive learning activities. In the studies 1 and 5, it was just the other way around. In four of the six studies, students constructed little knowledge, in the remainder of the studies, a reasonable amount of knowledge was constructed. The quality of the knowledge constructed varied between low and high, but in most of the studies, quality of knowledge was assessed to be reasonable.

Based on the results, it was not possible to create a pattern of the way in which students learn in a CSCL-system. Comparable to more traditional settings, students learned on their own way. In study 3, students were asked to fill in a part of the Inventory of Learning Styles (Vermunt, 1992) to search for a possible relationship between students' learning style on the one hand and students' learning processes in a CSCL-system on the other hand. No correlations were found between students' learning style and their participation. Between students' learning style and their learning activities a few significant correlations were found. To keep the discussion clear and to monitor the task, it seems to be good to have students with an application-directed learning style or meaning-directed learning style in the group. However, because of the lack of explicit learning styles of most students, a Pearson correlation test was also executed on the level of scales. There, some interesting correlations were found. It will bear fruit to stimulate a positive attitude towards collaborative learning. Another correlation consisted between the scores on the scale deep cognitive processing and amount of knowledge construction. Students who scored high on the scale deep cognitive processing constructed more knowledge than students who scored low on this scale. Additionally, students who lack regulating strategies will have some problems in working with CSCL.

Among others, Webb and Sullivan Palinscar (1996) and Dillenbourg (1999) wrote about the complexity of educational contexts. They argued that because of the multiple interactions between factors such as group size and task characteristics it is very difficult to set up initial conditions that guarantee the effectiveness of collaborative leaning. This research also confirmed the complexity of factors in setting up a successful course. As mentioned above, we deepened one factor in our research, namely moderating discussions. The results gave reason to assume that students that are moderated critically construct on average more and qualitative better knowledge than self-regulated students. Critical moderation was among other things concretised by asking questions, checking answers and contributing statements. Critical moderation triggered students to deep learning which means that students interact critically with the learning content, relate contributions within the discussion or to information found in other sources, use organising principles to integrate ideas and examine the logic of the arguments used (MacFarlane Report, 1992). Although an effect was found for the use of cognitive learning activities and knowledge construction, the results indicate that the quality of teacher interventions determines the success. It is difficult to instruct teachers to moderate asynchronous discussions in the short term. Although guidelines can be given and trained, teachers must become familiar with CSCL and moderating discussions. Factors such as using the right tone, moderating according to a personal way of teaching, real involvement in the course and pleasant contact with students are of importance to let moderation succeed.

Another factor that was manipulated is solving a problem from a certain perspective. In study 2, students conducted two tasks. In contrast to the first task, students working on the second task played a specific role (for example economist, tourist or farmer); students worked in a multidisciplinary team. Having other information and contradictory interests stimulated active as well as passive participation, which resulted in more knowledge construction.

Conclusions

Chapter 7 summarises our most important findings and discusses the results from both theoretical and methodological perspectives. Among other things, comments are given on the definition of knowledge construction used, the standards used to assess the amount and quality of knowledge construction and the number of students participating in the studied courses.

In our opinion, the developed method was useful to analyse students' learning processes in a CSCL-system. In other words, the executed analyses increased our insight into students' learning processes and helped us to survey the activities students use when taught by CSCL. Beforehand, we assumed that CSCL could be useful to support students' learning processes, especially in higher education. After carrying out the research, we still believe CSCL offers opportunities to support the process of knowledge construction. However, we think it is getting time to consider how to increase the amount and quality of knowledge construction by students in a CSCL-system. Students do not make optimal use of the opportunities. It is true that students constructed knowledge, but the amount of knowledge often was not large and the quality of the constructed knowledge left to be desired. Thus, we can conclude that CSCL can lead to learning indeed. However, we do not have to expect miracles from CSCL. Besides teacher interventions and working in multidisciplinary teams, the following aspects appear to be of importance for the use of CSCL in education successfully:

- experiences and motivation of students;
- a well-organised course;
- organising face-to-face meetings regularly;
- a complex task that provokes discussion and negotiation about knowledge;
- a transparent and user-friendly CSCL-system;
- enough time to become familiar with the ICT-program;
- enough time to work on the task, to read each others' contributions and to react to contributions;
- task structures that regulate organisational and planning issues;
- brainstorming about the task individually first and comparing ideas next;
- assessing the learning process.

As with other educational appliances, the use of CSCL must very thoroughly be considered. Although this remark seems to be obvious, it is an important finding. Nowadays, people often think too easily that the use of ICT stimulates students to learn and that this learning automatically results in positive results. Our research shows that this assumption is far from the reality. When considering the use of CSCL in education, examples of important questions are: What is the aim of the educational course? Which task is needed to reach the aim and is that task appropriate to work on in a CSCL-system? Is it desirable that students learn collaboratively in this course? To what extent does the task have to be prestructured? Are the subject matter and the task useful to negotiate about knowledge? Do students have experience with CSCL and if not, can we train them in a short term? Is a user-friendly CSCL-system available? Are enough computers available? Do we prefer students working from a distance or working in one room? How much time do we expect students to work on the task? Do we assess students' participation in the CSCL-system and/or the content of the contributions? Do we charge students with rules? Finally, it is important to consider whether moderation is desirable, and if so, how to moderate discussions; what is your aim with moderating a discussion? Do you want to stimulate students to participate or do you want to increase their critical thinking and knowledge construction?

Future research

Besides conclusions and practical implications to use CSCL effectively, chapter 7 gives suggestions for future research. A line of research suggested is systematically analysing the relation between the conditions of using a CSCL-system and the depth of learning. By conditions one can think for example of additional or integral use of the CSCL-system, different types of CSCL-systems, and different types of tasks. Besides, it would be interesting to analyse the extent of transfer of acquired knowledge and skills compared to similar task situations. Another interest is analysing participation, interaction, use of learning activities and knowledge construction during the course as well. Therefore, the instrument developed and used in this PHdissertation can be used in further research again, elaborated or not. When repeating the research, attention must be paid to the used standard to check whether students construct little knowledge in other settings, too. If so, the core of further research must concern the question of how to increase knowledge construction in CSCL. It would be wise to involve students' experiences more intensively.

Contents appendices

APPENDIX I

OVERVIEW OF ASSIGNED CODES PER STUDENT

(STUDY 1 - 4 CHAPTER 5, STUDY 5 - 6 CHAPTER 6)

Table I.1. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Agrification study (study 1, chapter 5)

	Agrification study														
	Group 1		Group 2			Group 3				Group 4					
	S1	S2	S3	S4	S5	S6	S7	S8	S9	10	S11	S12	S13	S14	S15
Cognitive															
Debating															
CDPF	2	4	4	0	1	0	2	2	2	0	3	0	0	0	0
CDPNF	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
CDAF	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0
CDANF	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0
CDAQ	3	2	0	1	2	4	0	0	0	0	1	0	0	0	1
External															
CCEI	5	1	2	1	1	0	0	0	1	0	0	0	0	2	0
CREI	1	1	1	0	4	1	3	4	0	0	3	1	1	1	4
CSEI	1	1	2	2	3	1	2	3	0	0	1	3	1	4	6
CREE	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0
Internal															
CIL	1	1	3	1	0	0	1	3	2	2	0	0	0	0	0
CIR	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Affective															
AM	1	1	1	0	3	3	2	1	2	0	2	2	1	0	1
AA	2	3	0	2	4	4	9	3	1	0	0	3	2	0	1
AC	11	5	1	1	2	3	6	2	7	0	6	5	9	2	2
Metacognitive															
Planning															
MPA	3	3	4	2	10	8	10	9	6	1	6	4	5	4	9
MAA	2	1	0	1	0	0	2	4	0	0	2	2	2	0	0
MEA	2	1	8	2	1	1	3	7	2	0	2	3	3	1	3
Clarity															
MSD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAC	0	1	1	0	0	1	2	0	2	2	1	1	0	0	0
MGE	0	1	0	1	1	1	0	0	0	0	1	0	1	0	1
Monitoring															
MKW	1	1	0	0	2	2	1	1	1	1	0	2	0	0	1
MRP	1	2	3	2	2	1	4	4	3	1	3	2	2	0	2
Rest															
RNE	1	1	3	0	7	5	3	3	1	2	3	1	1	4	1
Knowledge															
Level A	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Level B	1	1	2	2	0	0	2	4	0	0	1	0	0	0	0
Level C	2	3	2	1	1	0	1	4	2	3	2	3	1	2	4
Level D	2	2	1	1	1	2	1	1	2	0	2	1	0	3	0

Table I.2[A]. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Landevaluation I study – Wieringermeer case (study 2, chapter 5)

	Landevaluation I study (Wieringermeer)												
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Cognitive													
Debating													
CDPF	14	5	4	3	4	2	2	7	10	7	10	7	6
CDPNF	0	0	2	1	0	0	1	1	0	1	4	0	1
CDAF	2	4	6	6	1	3	0	0	3	0	1	0	2
CDANF	0	1	0	0	1	2	1	0	0	0	0	0	1
CDAQ	0	2	2	0	0	2	0	0	0	0	1	1	0
External													
CCEI	2	1	4	5	1	1	1	0	4	2	2	2	0
CREI	2	0	4	0	0	0	0	0	2	1	1	1	2
CSEI	3	0	3	0	0	2	2	4	9	3	5	2	0
CREE	0	1	1	2	1	1	0	3	2	1	2	1	1
Internal													
CIL	2	3	4	11	2	2	0	0	3	0	4	0	3
CIR	0	1	0	0	0	0	0	0	0	0	0	0	1
Affective													
AM	0	1	2	1	3	0	0	0	2	0	0	0	1
AA	0	0	0	0	1	0	0	0	0	0	0	3	0
AC	0	0	0	0	0	0	0	0	1	0	2	0	0
Metacognitive													
Planning													
MPA	3	2	3	3	0	2	0	0	0	0	1	0	0
MAA	0	0	0	0	0	0	0	0	0	0	0	0	0
MEA	0	0	0	1	1	0	1	0	0	0	1	0	1
Clarity													
MSD	0	0	0	0	0	0	0	0	0	0	0	0	0
MAC	2	4	1	1	0	0	1	1	0	2	1	1	1
MGE	0	1	5	2	1	0	0	0	0	0	1	0	0
Monitoring													
MKW	0	0	0	0	0	0	0	0	0	0	0	0	0
MRP	0	3	1	0	0	0	0	1	1	0	1	0	1
Rest													
RNE	0	0	0	2	0	1	0	1	1	2	3	1	0
Knowledge													
Level A	1	3	2	0	0	0	0	0	4	0	1	0	0
Level B	3	4	4	2	1	0	2	3	1	1	2	1	5
Level C	2	2	4	4	4	6	1	3	3	4	7	2	3
Level D	0	1	0	0	0	0	0	0	0	0	0	1	0

Table I.2[B]. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Landevaluation I study – Alora case (study 2, chapter 5)

	Landevaluation I study (Alora)												
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
Cognitive													
Debating													
CDPF	7	0	5	8	5	5	8	5	18	11	16	6	10
CDPNF	0	1	2	0	3	0	1	2	2	3	1	0	2
CDAF	6	1	6	2	4	4	1	1	7	2	5	2	4
CDANF	1	0	2	1	0	0	0	1	0	0	0	0	0
CDAQ	0	1	1	2	1	0	1	0	4	0	1	1	0
External													
CCEI	6	3	2	2	3	5	0	0	2	1	5	1	0
CREI	2	0	4	8	2	2	0	1	4	2	1	2	2
CSEI	1	5	1	1	0	1	4	5	5	1	7	4	4
CREE	0	0	2	0	1	0	1	0	1	1	3	3	0
Internal													
CIL	5	0	2	4	1	2	2	2	15	1	7	2	1
CIR	0	0	0	0	0	0	0	0	0	0	0	0	0
Affective													
AM	0	0	1	2	0	1	1	1	2	1	2	0	0
AA	0	0	0	0	0	0	0	0	3	1	2	0	0
AC	0	0	0	0	0	0	1	1	1	2	3	1	1
Metacognitive													
Planning													
MPA	1	0	0	2	0	0	4	2	2	2	1	0	2
MAA	0	0	0	0	0	0	0	0	1	1	1	0	2
MEA	0	0	0	0	0	0	0	0	0	0	0	0	0
Clarity													
MSD	1	0	0	0	1	0	0	0	0	0	0	0	0
MAC	0	0	0	1	0	1	0	3	4	0	1	0	0
MGE	1	0	1	0	0	1	1	0	1	0	1	1	2
Monitoring													
MKW	0	0	0	0	0	0	0	0	0	0	0	0	0
MRP	0	0	0	0	0	0	0	0	2	0	0	1	1
Rest													
RNE	1	0	0	2	0	0	1	3	1	0	0	0	2
Knowledge													
Level A	3	0	5	2	2	1	0	0	3	1	3	1	2
Level B	3	1	3	2	2	3	3	2	6	2	5	3	3
Level C	3	1	3	2	3	5	8	4	7	4	10	2	7
Level D	0	0	0	0	0	0	0	1	4	3	2	0	0

Table I.3[A]. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Psychology study – phase 1 (study 3, chapter 5)

	Psychology study (phase 1)																							
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24
Cognitive																								
Debating																								
CDPF	2	5	0	1	1	4	7	1	4	9	4	2	3	1	2	2	1	0	1	3	3	1	7	4
CDPNF	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
CDAF	3	1	1	1	0	0	4	2	2	1	0	0	1	0	1	0	0	0	4	0	3	3	1	1
CDANF	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
CDAQ	0	2	0	1	0	0	3	0	2	0	7	0	0	1	1	1	1	0	1	0	0	0	1	4
External																								
CCEI	0	1	0	0	1	0	1	0	0	5	7	0	0	0	0	0	0	0	0	1	0	0	2	0
CREI	1	5	0	0	3	0	4	0	8	8	11	0	1	0	0	0	0	0	0	0	0	0	2	1
CSEI	0	3	0	0	3	0	2	0	9	1	7	0	1	0	0	1	0	0	1	0	0	1	1	1
CREE	2	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
Internal																								
CIL	3	5	2	3	1	0	10	1	4	1	3	4	3	4	1	0	0	0	3	3	2	3	5	5
CIR	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	1
Affective																								
AM	3	1	0	3	0	0	1	0	2	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1
AA	0	1	0	1	0	0	0	0	2	1	0	0	0	1	1	1	1		0	0	0	0	1	0
AC	1	0	0	0	1	0	0	0	2	0	1	0	0	1	0	3	0	2	0	1	1	0	0	0
Metacognitive																								
Planning																								
MPA	1	4	0	1	0	0	4	0	7	0	6	1	2	1	0	5	0	0	0	1	1	0	2	2
MAA	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
MEA	1	1	0	0	1	0	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	0	1
Clarity																								
MSD	0	0	1	0	0	0	4	0	0	0	1	0	0	4	0	1	0	0	0	0	0	1	0	5
MAC	1	2	0	3	0	0	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	1	1	0
MGE	0	0	0	0	0	0	1	0	2	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0
Monitoring																								
MKW	2	1	0	1	0	0	1	0	2	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
MRP	1	1	0	1	1	0	4	0	1	1	3	0	1	3	1	0	0	0	0	0	0	0	0	2
Rest																								
RNE	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	6	1	0
Knowledge																								
Level A	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	0	2	0
Level B	0	5	0	2	0	2	5	1	5	2	3	1	1	0	2	0	1	0	2	4	4	1	1	1
Level C	3	0	0	0	4	2	8	0	10	5	0	1	2	2	2	2	0	0	0	1	1	4	4	1
Level D	2	2	1	1	0	0	1	1	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1

Table I.3[B]. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Psychology study – phase 2 (study 3, chapter 5)

	Psychology study (phase 2)																							
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24
Cognitive																								
Debating																								
CDPF	0	7	0	7	0	0	0	3	2	0	0	0	4	0	0	0	4	0	2	0	0	0	0	10
CDPNF	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CDAF	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CDANF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CDAQ	0	2	0	7	0	0	0	0	11	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
External																								
CCEI	0	1	0	5	0	0	1	2	0	0	0	0	2	0	0	0	3	0	2	0	0	0	0	4
CREI	0	1	0	3	0	0	1	0	0	0	0	0	2	0	0	0	1	0	5	0	0	0	0	10
CSEI	0	5	0	8	0	0	3	3	12	0	0	0	1	0	0	0	3	0	7	0	0	0	0	4
CREE	0	1	0	2	0	0	1	1	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	2
Internal																								
CIL	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	3	0	0	0	0	0	0	4
CIR	0	0	0	3	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Affective																								
AM	0	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
AA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
AC	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
Metacognitive																								
Planning																								
MPA	1	4	0	4	1	0	1	0	2	0	0	0	2	0	0	0	3	0	0	0	0	0	0	3
MAA	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
MEA	1	1	0	3	1	0	1	2	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	6
Clarity																								
MSD	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
MAC	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MGE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monitoring																								
MKW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MRP	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Rest																								
RNE	8	1	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1
Knowledge																								
Level A	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Level B	0	1	0	4	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1
Level C	0	2	0	1	0	0	3	1	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Level D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table I.4. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Canadian study (study 4, chapter 5)

	Canadian study						
	S1	S2	S3	S4	S5	S6	S7
Cognitive							
Debating							
CDPF	15	14	10	14	12	0	6
CDPNF	0	0	0	2	2	0	0
CDAF	6	5	2	8	8	0	1
CDANF	1	0	0	1	1	0	0
CDAQ	5	2	7	8	8	0	9
External							
CCEI	12	4	5	10	10	1	5
CREI	7	5	4	9	8	1	8
CSEI	5	2	4	6	5	0	4
CREE	10	8	11	9	6	5	0
Internal							
CIL	8	23	8	18	9	0	6
CIR	1	1	2	1	1	0	0
Affective							
AM	4	5	1	1	2	0	1
AA	3	1	3	1	2	1	1
AC	0	0	1	1	0	0	0
Metacognitive							
Planning							
MPA	2	5	2	2	1	1	2
MAA	0	1	0	0	1	0	0
MEA	0	2	0	3	0	0	1
Clarity							
MSD	1	0	0	0	1	0	1
MAC	0	0	1	0	1	0	0
MGE	1	0	0	0	0	0	0
Monitoring							
MKW	0	0	0	0	0	0	0
MRP	6	6	0	2	2	2	3
Rest							
RNE	0	1	0	1	0	0	0
Knowledge							
Level A	2	3	1	3	5	0	1
Level B	5	7	8	8	7	0	4
Level C	14	10	7	11	6	1	4
Level D	6	3	0	6	0	0	1

Table I.5^{A}. Overview of the assigned codes concerning learning activities and knowledge construction per student in the ICT in education study – task 1 (study 5, chapter 6)

	ICT in education study (task 1)																	
	Moderated							Self-regulated										
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
Cognitive																		
Debating																		
CDPF	4	0	1	2	4	1	2	0	0	0	0	0	0	0	0	0	0	0
CDPNF	1	0	0	0	1	0	0	1	0	0	2	1	0	0	0	1	0	0
CDAF	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
CDANF	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
CDAQ	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
External																		
CCEI	1	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0
CREI	0	1	0	1	6	0	0	0	0	0	0	1	0	1	0	1	0	0
CSEI	1	1	0	1	1	0	0	0	2	0	0	1	0	1	0	2	0	0
CREE	3	1	0	0	0	1	2	0	0	1	0	4	0	1	0	2	0	1
Internal																		
CIL	2	1	0	0	1	0	1	0	0	0	3	1	0	0	0	0	0	0
CIR	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0
Affective																		
AM	3	0	0	4	1	0	2	1	4	0	4	7	1	0	3	4	4	1
AA	4	0	0	2	2	0	3	0	0	1	4	11	2	2	4	7	13	0
AC	1	0	0	4	8	1	6	0	0	1	4	11	2	2	4	7	13	0
Metacognitive																		
Planning																		
MPA	5	0	0	10	10	0	6	0	3	1	8	9	2	2	7	9	11	0
MAA	1	0	1	1	2	0	1	1	0	0	4	3	0	1	1	1	0	0
MEA	3	1	0	4	4	0	1	0	0	0	6	4	0	0	3	3	4	0
Clarity																		
MSD	0	0	0	2	1	0	0	0	0	0	1	4	0	0	1	0	1	0
MAC	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0
MGE	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Monitoring																		
MKW	3	0	1	3	4	1	2	1	3	0	3	4	0	1	2	1	8	1
MRP	5	0	0	1	3	0	1	0	2	0	3	4	1	1	2	1	3	1
Rest																		
RNE	0	0	0	0	1	0	1	0	0	2	2	4	0	1	2	2	6	1
Knowledge																		
Level A	0	1	0	0	2	0	0	1	0	1	0	2	1	1	1	0	0	1
Level B	3	0	0	1	2	0	0	0	0	0	1	1	0	0	0	2	0	0
Level C	2	0	1	2	1	1	2	0	0	0	0	1	1	2	0	0	0	0
Level D	1	0	0	0	1	0	0	0	0	0	0	1	1	2	0	0	0	0

Table I.5[B]. Overview of the assigned codes concerning learning activities and knowledge construction per student in the ICT in education study – task 2 (study 5, chapter 6)

	ICT in education study (task 2)									
	Moderated					Self-regulated				
	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28
Cognitive										
Debating										
CDPF	1	4	1	1	0	3	0	0	2	2
CDPNF	0	0	0	1	0	0	0	0	0	0
CDAF	1	2	1	2	0	1	3	1	0	1
CDANF	2	2	2	0	0	0	0	0	0	1
CDAQ	0	2	0	1	0	1	0	0	2	3
External										
CCEI	1	1	0	1	1	0	0	0	0	3
CREI	1	0	0	3	1	5	1	1	2	1
CSEI	4	3	0	2	0	5	1	1	1	3
CREE	1	1	1	2	0	2	0	2	1	0
Internal										
CIL	2	4	2	2	0	3	1	1	0	7
CIR	0	0	0	0	0	0	1	0	0	1
Affective										
AM	1	0	0	0	0	4	2	2	1	1
AA	3	5	2	1	2	3	1	1	2	3
AC	1	2	4	1	2	2	1	0	4	1
Metacognitive										
Planning										
MPA	5	5	9	2	3	5	1	5	2	4
MAA	0	0	1	0	0	1	0	2	1	2
MEA	1	0	1	2	2	3	1	2	1	1
Clarity										
MSD	0	0	0	1	0	1	0	0	0	2
MAC	0	0	0	1	0	0	0	1	0	2
MGE	0	0	1	0	0	2	0	0	0	0
Monitoring										
MKW	2	4	2	3	1	5	2	0	1	6
MRP	9	6	6	3	0	1	1	2	3	4
Rest										
RNE	1	1	0	1	0	1	0	0	0	0
Knowledge										
Level A	0	0	0	0	0	1	0	0	0	0
Level B	0	2	0	0	0	3	3	0	1	4
Level C	3	5	2	4	0	3	1	3	2	1
Level D	2	1	1	2	1	2	0	0	0	1

Table I.6. Overview of the assigned codes concerning learning activities and knowledge construction per student in the Landevaluation II study (study 6, chapter 6)

	Landevaluation II study								
	Moderated				Self-regulated				
	S1	S2	S3	S4	S5	S6	S7	S8	S9
Cognitive									
Debating									
CDPF	34	21	18	13	12	6	17	5	4
CDPNF	4	3	3	1	0	0	2	3	3
CDAF	11	22	6	21	6	1	6	0	0
CDANF	10	3	5	6	4	1	4	1	0
CDAQ	1	0	0	0	2	0	0	0	0
External									
CCEI	2	0	3	3	1	2	2	2	0
CREI	7	2	2	2	3	2	1	2	0
CSEI	0	0	0	1	0	0	0	0	0
CREE	8	8	3	3	3	2	0	3	1
Internal									
CIL	13	36	14	26	2	2	4	1	1
CIR	0	3	3	1	0	0	0	0	0
Affective									
AM	21	12	2	1	5	1	4	1	0
AA	13	18	3	3	5	7	5	3	0
AC	9	12	4	5	34	8	12	1	1
Metacognitive									
Planning									
MPA	14	14	6	6	10	5	6	1	0
MAA	1	0	1	0	0	1	1	0	0
MEA	7	10	5	3	5	3	2	0	1
Clarity									
MSD	0	0	0	0	0	0	0	0	0
MAC	8	4	2	4	7	2	3	3	0
MGE	10	10	1	2	3	1	8	0	0
Monitoring									
MKW	2	1	0	1	1	2	0	0	0
MRP	21	15	5	6	9	2	6	4	5
Rest									
RNE	0	1	0	1	4	0	2	0	0
Knowledge									
Level A	1	12	3	9	0	0	2	0	1
Level B	17	15	7	13	7	3	5	2	3
Level C	32	20	14	5	13	4	23	4	1
Level D	6	7	4	1	1	0	1	0	0

APPENDIX II

CASE-BY-CASE MATRICES CONCERNING LINKED AND READ NOTES

(STUDY 1 - 4 CHAPTER 5)

The relations in the matrix are directed from one student in the group to another student in the group, to indicate if a student read at least one note of the other student or reacted at least once to the other student. Concerning reading, the matrices show if the student at the left has read at least one note that was written by the student at the top. Concerning linking, the matrices show if the student at the left has linked at least to one note that was written by the student at the top ("1" representing an existing relation and "0" representing no existing relation).

Agrification, group **1**

	1	2
1	0	0
2	1	0

Linked notes

	1	2
1	0	1
2	1	0

Read notes

Agrification, group **2**

	1	2	3	4
1	0	1	1	1
2	0	0	1	1
3	0	1	0	1
4	0	1	1	0

Linked notes

	1	2	3	4
1	0	1	1	1
2	1	0	1	1
3	1	1	0	1
4	1	1	1	0

Read notes

Agrification, group **3**

	1	2	3	4
1	0	1	1	0
2	1	0	1	0
3	1	1	0	0
4	1	1	1	0

*Linke*d notes

	1	2	3	4
1	0	1	1	1
2	1	0	1	1
3	1	1	0	1
4	1	1	1	0

Read notes

Agrification, group **4**

	1	2	3	4	5
1	0	1	1	0	1
2	1	0	1	0	0
3	1	0	3	0	0
4	1	0	0	0	0
5	0	0	0	0	0

Linked notes

	1	2	3	4	5
1	0	1	1	1	1
2	1	0	1	1	1
3	1	1	0	1	1
4	1	1	1	0	1
5	1	1	1	1	0

Read notes

Figure II.1. Case-by-case matrices concerning linked and read notes in the Agrification study of chapter 5 (group 1, 2, 3, 4).

Landevaluation I, group 1 (**no roles**)

	1	2	3	4	5	6
1	0	0	1	0	0	1
2	0	0	0	0	0	0
3	0	0	0	1	1	0
4	0	0	0	0	1	0
5	0	0	1	0	0	0
6	0	1	0	1	1	0

Linked notes

	1	2	3	4	5	6
1	0	1	1	1	1	1
2	1	0	1	1	1	1
3	1	1	0	1	1	1
4	1	0	1	0	1	1
5	1	1	1	1	0	1
6	1	1	1	1	1	0

Read notes

Landevaluation I, group 2 (**no roles**)

	1	2	3	4	5	6	7
1	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0
3	0	0	0	0	1	0	0
4	0	1	0	0	1	0	0
5	0	0	1	1	0	0	0
6	0	0	0	0	0	0	1
7	0	0	0	0	0	1	0

Linked notes

	1	2	3	4	5	6	7
1	0	1	1	1	1	1	1
2	1	0	1	1	1	1	1
3	1	1	0	1	1	1	1
4	1	1	1	0	1	1	1
5	1	1	1	1	0	1	1
6	1	1	1	1	1	0	1
7	1	1	1	1	1	1	0

Read notes

Landevaluation I, group 1 (**roles**)

	1	2	3	4	5	6
1	0	0	1	0	0	1
2	0	0	0	0	0	0
3	0	0	0	1	1	0
4	0	0	0	0	1	0
5	0	0	1	0	0	0
6	0	1	0	1	1	0

Linked notes

	1	2	3	4	5	6
1	0	1	1	1	1	1
2	1	0	1	1	1	1
3	1	1	0	1	1	1
4	1	0	1	0	1	1
5	1	1	1	1	0	1
6	1	1	1	1	1	0

Read notes

Landevaluation I, group 2 (**roles**)

	1	2	3	4	5	6	7
1	0	1	0	1	0	1	1
2	1	0	1	0	1	0	1
3	0	1	0	1	1	1	1
4	0	0	1	0	0	1	1
5	0	1	1	0	0	0	1
6	0	0	1	0	0	0	1
7	1	1	1	0	1	0	0

Linked notes

	1	2	3	4	5	6
1	0	1	1	1	1	1
2	1	0	1	1	1	1
3	1	1	0	1	1	1
4	1	1	1	0	1	1
5	1	1	1	1	0	1
6	1	1	1	1	1	0
7	1	1	1	1	1	1

Read notes

Figure II.2. Case-by-case matrices concerning linked and read notes in the Landevaluation I study of chapter 5 (group 1 and 2; case with and without roles).

Psychology, phase **1**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	0	0	0	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
2	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4	1	0	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5	0	0	0	1	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	1	0	1	0	0
6	1	0	1	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
7	0	0	1	1	0	0	0	0	1	1	0	1	1	0	0	1	0	0	1	1	0	0	0	0
8	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0
9	1	0	0	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0	0	1	0	1	1	0
10	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1
12	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
13	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
15	1	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
17	1	0	1	1	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1
21	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1
22	1	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1
23	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1
24	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Linked notes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1
3	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
4	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
5	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0
6	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1
7	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
8	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	0	0	1	1	1	1	1	1	0
12	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1
13	1	1	0	1	1	0	1	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0
14	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1
16	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	0
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	0	0
18	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0	0	1	0	1	1	1	1	1	0
19	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	0	1	1	1	1	1
20	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	0
21	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1
22	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1
23	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	0
24	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0

Read notes

Figure II.3. Case-by-case matrices concerning linked and read notes in the Psychology study of chapter 5 (phase 1).

Psychology, phase **2**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Linked notes

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	0	0	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	1
2	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	0	1	1	0	0	0	0
3	0	0	0	1	1	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	0	0	0	0
4	0	0	0	0	1	1	0	0	0	1	0	1	1	1	1	1	1	0	0	1	0	0	0	1
5	0	0	0	0	0	1	0	1	1	0	0	1	1	1	1	1	1	0	1	1	0	0	0	0
6	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1
7	0	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	1	1	1	1	0	0	0	0
8	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0
9	0	0	0	1	1	0	0	0	0	1	0	0	1	0	1	1	0	1	1	1	0	0	0	0
10	0	0	0	1	1	1	0	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	1
11	1	0	0	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1	0	0	1	1	1	0	1	0	1	0	0	1	1	0	0	1	1	1	1	0	0	0	1
16	0	0	0	0	1	1	0	1	1	1	0	0	0	1	1	0	1	0	0	1	0	0	0	0
17	1	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
18	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
21	0	0	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0
22	0	0	0	0	1	1	0	0	1	0	0	0	1	1	1	1	1	0	0	1	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	1	0	0	1	0	1	0	1	0	1	1	0	1	0	0	1	0	0	0	0

Read notes

Figure II.4. Case-by-case matrices concerning linked and read notes in the Psychology study of chapter 5 (phase 2).

Canadian study

	1	2	3	4	5	6	7
1	0	1	1	1	1	0	1
2	1	0	1	1	1	0	1
3	1	1	0	1	1	0	1
4	1	1	1	0	1	0	1
5	1	1	1	1	0	1	1
6	1	0	0	0	1	0	0
7	0	0	0	0	0	0	0

Linked notes

	1	2	3	4	5	6	7
1	0	1	1	1	1	1	1
2	1	0	1	1	1	1	1
3	1	1	0	1	1	1	1
4	1	1	1	0	1	1	1
5	1	1	1	1	0	1	1
6	1	0	1	0	1	0	1
7	1	1	1	1	1	1	0

Read notes

Figure II.5. Case-by-case matrices concerning linked and read notes in the Canadian study of chapter 5.

APPENDIX III - V

QUESTIONNAIRES

- **III EXAMPLE OF AN EVALUATIVE QUESTIONNAIRE**
- **IV INVENTORY OF LEARNING STYLES (PART A AND B)**
- **V EXAMPLE OF A QUESTIONNAIRE CONCERNING PRIOR KNOWLEDGE AND USE OF THE COMPUTER**

Evaluation WEB Knowledge Forum in the course:
'Quasi Landevaluation and variability for explorative land use studies'

These evaluative questions are meant to visualise your experiences with working Web Knowledge Forum and your experiences with the whole course. Your experiences are very important for me in order to interpret my results correctly. So, please read each question carefully and then select the answer that corresponds to your experience by making it **bold**. If you prefer to write with a pencil, you can fill out a printed version. Sometimes I will ask you to explain your answer. In addition, if you have any remarks, you can type it in the third column.

Thanks for filling out!

1.	Was it difficult for you to learn using WebKF? (Here I mean the possibilities like writing a note, creating a link and so on)	1. Yes, it was 2. No, it was not Remark:
2.	Was the use of thinking types useful to you?	1. Yes, it was 2. No, it was not Remark:
3.	Did you find the exercises of Chapter 1 to 4 suitable to make in WebKF?	1. Yes, I did 2. No, I did not Remark:
3.	Was it useful to solve the two cases in WebKF? With other words: did WebKF have an added value to you?	1. Yes, it was 2. No, it was not Explain your answer:
4.	In contrast to the Wieringermeer case, in the Alora case each of you got a special role in the discussion. Can you explain how this difference effected the discussion? Think for example about the following aspects: was using WebKF more or less useful; took it more or less time to discuss; did you read the notes better or not?	Your answer:

5.	Would you advise students to follow the course?	1. Yes, I would 2. No, 3. I would not Explain your answer:
6.	How many hours a week did you spend on the course?	1. <8 hours 2. 8-<15 hours 3. 15-<20 hours 4. >20 hours Remark:
7.	How many hours a week did you spend on working in WebKF?	1. <5 hours 2. 5-<10 hours 3. 10-<15 hours 4. >15 hours Remark:
8.	Did you exchange information or ideas concerning the exercises with your group members face-to-face?	1. Yes, I did > go to question 9 2. No, I did not> go to question 10
9.	Can you estimate both the percentage of face-to-face discussion and the percentage of on-line discussion ?	... % face-to-face ... % in WebKF
10.	Did you have enough time to do all the exercises?	1. Yes, I did 2. No, I did not Remark:
11.	Did you find the course intensive or difficult?	1. Yes, I did 2. No, I did not Remark:
12.	Are you satisfied about the participation of your group members?	1. Yes, I am 2. No, I am not Remark:

13.	Are you satisfied with the collaboration within your group?	1. Yes, I am 2. No, I am not Remark:
14.	What was your group number?	1. Group 1-> go to question 15 2. Group 2-> go to question 20

Some questions specially for the members of group 1

15.	Did the teacher intervene a lot?	1. Yes, he did 2. No, he did not Remark:
16.	Can you characterise the kind of teacher's interventions? For example: did the teacher provoke you to be more critical or to elaborate your answers?, Did he stimulate the collaboration between the group members? Did he motivate you? And so on.	
17.	Do you think the teacher played an important part in the group processes?	1. Yes, he did 2. No, he did not Remark:
18.	Did the teacher's contributions help you to make progress?	1. Yes, they did 2. No, they did not Remark:
19.	Was the teacher intervening sufficiently in your opinion?	1. Yes, he was 2. No, he was not Explain your answer:

Some questions specially for the members of group 2

20.	Do you think a teacher could have been of importance?	1. Yes, I do 2. No, I do not Explain your answer:

21.	Was it a student with a central role in your group, a person who took the lead?	1. Yes, it was 2. No, it was not Remark:
22.	Did you stimulate your group members to be critical?	1. Yes, I did 2. No, I did not Remark:
23.	Did you stimulate your group members to be more active in the forum?	1. Yes, I did 2. No, I did not Remark:
24.	The discussion in your group was in English. Do you think you should have write more, or longer, notes if the discussion would have been in Dutch? In other words: was the language an additional complex factor to you?	1. Yes, it was 2. No, it was not Remark:

Last question to all of you

25.	Finally: is there anything I have to know that could be of importance to analyse the data? Please, write down everything you want to express concerning the course.	

Of course, I will analyse your answers anonymously. However, to illustrate, sometimes I will use a screendump of WebKF. If printing your name is a problem to you, please let me know.

Thanks for filling out! Please save the document as 'lastname.doc' and send it by email to:

Else Veldhuis-Diermanse@Alg@AO.WAU

Introduction questionnaire learning styles

ICT and Education

Developments in the area of Information- and Communication Technology (ICT) offer new opportunities to organise education. It is not always clear how these new applications like for example the Internet, videoconferencing or Groupware effect students' learning processes. In this course, we will use a Computer-Supported Collaborative Learning system. We want to get insight into students' learning processes using CSCL. We will ask you to fill in this questionnaire about learning styles; in order to have more profit of computer-supported collaborative learning at WU.

The Inventory of Learning Styles

The Inventory of Learning Styles (ILS) was developed to get insight into the way students are used to study and how they view their own learning. The ILS consists of a list of statements on studying strategies, motives and attitudes.

How to fill in the inventory

The ILS is comprised of two parts: A and B. Each part consists of a list of statements concerning studying. The statements are taken from interviews with students. You are requested to indicate to what extent each statement applies to you. You can express your view by making the number of your choice **bold**.

Bear in mind that this list had nothing to do with right or wrong answers. Every person has his own ideas, opinions and study habits. The aim is to gain insight into your study habits and your personal view of studying and education. This means that an honest answer is automatically a correct answer. The purpose of the ILS is to identify *individual* views, motivations and learning activities.

This instrument is meant to fill in on your computer. It is a Word 6.0/95 document. We advise you to view the document in the *Page Layout view* (menu View).

Important

Read each statement carefully and then indicate to what extent it applies to you by making **bold** the relevant number.

The meaning of the numbers

The numbers after statements have the following meaning:

In part A	In part B
1 = I do seldom or never	1 = disagree entirely
2 = I do this sometimes	2 = disagree for the most part
3 = I do this regularly	3 = undecided or do not know
4 = I do this often	4 = agree for the most part
5 = I do this almost always	5 = agree entirely

Good luck with filling out!

Continue on the next page

Part 1

General

Type the answers on question 1 until 6 behind the colon.

1. Name:
2. Discipline:
3. Specialty:
4. Started in academic year:
5. Sex:
6. Age:

Part A: Study activities

Knowledge and insight do not develop on their own: it takes effort to master a particular piece of subject matter. This part of inventory is concerned with the activities students undertake in the context o f their studies. Read each statement carefully and then indicate to what extent you yourself engage in the activity concerned while studying by making the number of your choice **bold**. Terms such as 'course' and 'subject matter' refer to the courses and subjects you are taking. The meaning of the numbers after each statement is:

1 I do this seldom or never	2 I do this sometimes	3 I do this regularly	4 I do this often	5 I do this almost always

1.	I work through a chapter in a textbook item by item and I study each part separately.	1	2	3	4	5
2.	I repeat the main parts of the subject matter until I know them by heart.	1	2	3	4	5
3.	I use what I learn from a course in my activities outside my studies.	1	2	3	4	5
4.	If a textbook contains questions or assignments, I work them out completely as soon as I come across them while studying.	1	2	3	4	5
5.	I study all the subject matter in the same way.	1	2	3	4	5
6.	I try to combine the subjects that are dealt with separately in a course into one whole.	1	2	3	4	5
7.	I memorise lists of characteristics of a certain phenomenon.	1	2	3	4	5
8.	I realise that is not clear to me what I have to remember and what I do not have to remember.	1	2	3	4	5
9.	I make of list of the most important facts and learn them by heart.	1	2	3	4	5
10.	I try to discover the similarities and differences between the theories that are dealt with in a course.	1	2	3	4	5

Continue on the next page

1 I do this seldom or never	2 I do this sometimes	3 I do this regularly	4 I do this often	5 I do this almost always

11.	I experience the introductions, objectives, instructions, assignments and test items given by the teacher as indispensable guidelines for my studies.	1	2	3	4	5
12.	I test my learning progress solely by completing the questions, tasks and exercises provided by the teacher or the textbook.	1	2	3	4	5
13.	I relate specific facts to the main issue in a chapter or article.	1	2	3	4	5
14.	I try to interpret events in everyday reality with the help of the knowledge I have acquired in a course.	1	2	3	4	5
15.	I notice that I have trouble processing in a large amount of subject matter.	1	2	3	4	5
16.	In addition to the syllabus, I study other literature related to the content of the course.	1	2	3	4	5
17.	I analyse the separate components of a theory step by step.	1	2	3	4	5
18.	I learn everything exactly as I find it in the textbooks.	1	2	3	4	5
19.	I try to relate new subject matter to knowledge I already have about the topic concerned.	1	2	3	4	5
20.	I notice that it is difficult for me to determine whether I have mastered the subject matter sufficiently.	1	2	3	4	5
21.	To test my learning progress when I have studied a textbook, I try to formulate the main points in my own words.	1	2	3	4	5
22.	I pay particular attention to those parts of a course that have practical utility.	1	2	3	4	5
23.	I do not proceed to a subsequent chapter until I have mastered the current paper in detail.	1	2	3	4	5
24.	When I start reading a new chapter or article, I first think about the best way to study it.	1	2	3	4	5
25.	I try to see the connection between the topics discussed in different chapters of a textbook.	1	2	3	4	5
26.	I memorise the definitions as literally as possible.	1	2	3	4	5
27.	I realise that the objectives of the course are too general for me to offer any support.	1	2	3	4	5
28.	I do more than I am expected to do in a course.	1	2	3	4	5
29.	I compare my view of a course topic with the views of the authors of the textbook used in that course.	1	2	3	4	5

Continue on the next page

1 I do this seldom or never	2 I do this sometimes	3 I do this regularly	4 I do this often	5 I do this almost always

30.	If I am able to give a good answer to the questions posed in the textbook or by the teacher, I decide that I have a good command of the subject matter.	1	2	3	4	5
31.	When I have difficulty grasping a particular piece of subject matter, I try to analyse why it is difficult for me.	1	2	3	4	5
32.	I study according to the instructions given in the study materials or provided by the teacher.	1	2	3	4	5
33.	I memorise the meaning of every concept that is unfamiliar to me.	1	2	3	4	5
34.	I try to construct an overall picture of a course for myself.	1	2	3	4	5
35.	I compare conclusions drawn in different chapters.	1	2	3	4	5
36.	To test my learning progress, I try to answer questions about the subject matter which I make up myself.	1	2	3	4	5
37.	I notice that the study instructions that are given are not very clear to me.	1	2	3	4	5
38.	I study the subject matter in the same sequence as it is dealt with in the course.	1	2	3	4	5
39.	I check whether the conclusions drawn by the authors of a textbook follow the facts on which they are based logically.	1	2	3	4	5
40.	I study details thoroughly.	1	2	3	4	5
41.	I realise that I miss someone to fall back on in case of difficulties.	1	2	3	4	5
42.	I add something to the subject matter from other sources.	1	2	3	4	5
43.	I draw my own conclusions on the basis of the data that are presented in a course.	1	2	3	4	5
44.	When doing assignments, I train myself thoroughly in applying the methods dealt with in a course.	1	2	3	4	5
45.	I analyse the successive steps in an argumentation one by one.	1	2	3	4	5
46.	To test whether I have mastered the subject matter, I try to think up other examples and problems besides the ones given in the study materials or by the teacher.	1	2	3	4	5
47.	I use the instructions and the course objectives given by the teacher to know exactly what to do.	1	2	3	4	5
48.	With the help of the theories presented in a course, I devise solutions to practical problems.	1	2	3	4	5
49.	I try to be critical of the interpretations of experts.	1	2	3	4	5

Continue on the next page

1 I do this seldom or never	2 I do this sometimes	3 I do this regularly	4 I do this often	5 I do this almost always

50.	To test my own progress, I try to describe the content of a paragraph in my own words.	1	2	3	4	5
51.	When I am studying, I also pursue learning goals that have not been set by the teacher but by myself.	1	2	3	4	5
52.	When I am studying a topic, I think of cases I know from my own experience that are connected to that topic.	1	2	3	4	5
53.	I pay particular attention to facts, concepts and problem solving methods in a course.	1	2	3	4	5
54.	If I do not understand a study text well, I try to find other literature about the subject concerned.	1	2	3	4	5
55.	If I am able to complete all the assignments given in the study materials or by the teacher, I decide that I have a good command of the subject matter.	1	2	3	4	5

Part B: Study motives and views on studying

B1. Study motives

There can be many reasons for someone to take up a course of study. This part of the ILS is concerned with the motives, objectives and attitudes students may have with regard to their studies. Indicate for each statement to what extent it applies to you. Bear in mind that you are *not* asked to indicate whether you think a motive or objective is good, less good or bad; you are only asked to indicate to what extent you think a statement applies to you personally. This is the meaning of the numbers:

1 Disagree entirely	2 Disagree for the most part	3 Undecided or do not know	4 Agree for the most part	5 Agree entirely

56.	When I have a choice, I opt for courses that seem useful to me for my present or future profession.	1	2	3	4	5
57.	I do these studies out of sheer interest in the topics that are dealt with.	1	2	3	4	5
58.	I want to prove to myself that I am capable of doing studies in higher education.	1	2	3	4	5
59.	I doubt whether this is the right subject area for me.	1	2	3	4	5
60.	I aim at attaining high levels of study achievements.	1	2	3	4	5
61.	I want to show others that I am capable of successfully doing a higher education program.	1	2	3	4	5
62.	I have chosen this subject are, because it prepares me for the type of work I am highly interested.	1	2	3	4	5

Continue on the next page

1 Disagree entirely	2 Disagree for the most part	3 Undecided or do not know	4 Agree for the most part	5 Agree entirely

63.	The main goal I pursue in my studies is to pass exams.	1	2	3	4	5
64.	I view the choice I have made to enrol in higher education as a challenge.	1	2	3	4	5
65.	The only aim of my studies is to enrich myself.	1	2	3	4	5
66	I have little confidence in my study capacities.	1	2	3	4	5
67.	For the kind of work I would like to do, I need to have studied in higher education.	1	2	3	4	5
68.	What I want in these studies is to earn credits for a diploma.	1	2	3	4	5
69.	I see these studies as sheer relation.	1	2	3	4	5
70.	I study above all to pass the exam.	1	2	3	4	5
71.	The main goal I pursue in my studies is to prepare myself for a profession.	1	2	3	4	5
72.	I want to discover my own qualities, the things I am capable and incapable of.	1	2	3	4	5
73.	What I want to acquire above all through my studies is professional skill.	1	2	3	4	5
74.	When I have a choice, I opt for courses that suit my personal interests.	1	2	3	4	5
75.	I wonder whether these studies are worth all the effort.	1	2	3	4	5
76.	I doubt whether this type of education is the right type of education for me.	1	2	3	4	5
77.	I want to test myself to see whether I am capable of doing studies in higher education.	1	2	3	4	5
78.	I do these studies because I Like to learn and to study.	1	2	3	4	5
79.	I am afraid these studies are too demanding for me.	1	2	3	4	5
80.	To me, written proof of having passed an exam represents something of value in itself.	1	2	3	4	5

B2. Study views

What do learning, good education and cooperation with others mean to you? What, according to you, are the tasks of your teachers? What do you regard as your own tasks, as a student? What could be the role of your fellow students in your studies? Questions such as these are addressed in this part of the questionnaire. The statements reflect students' views concerning matters related to learning, being educated, the division of tasks between the student and the educational institution, and the contact with other students. This part is not so much concerned with the activities you actually undertake in your studies, as with what you consider to be important in general with regard to studying and teaching. Indicate for each statement to what extent it corresponds to your own view by making the number of your choice **bold**. This is the meaning of the numbers:

Continue on the next page

1 Disagree entirely	2 Disagree for the most part	3 Undecided or not to know	4 Agree for the most part	5 Agree entirely

81.	The things I learn have to be useful for solving practical problems.	1	2	3	4	5
82.	I like to be given precise instructions as how to go about solving a task or doing an assignment.	1	2	3	4	5
83.	The teacher should motivate and encourage me.	1	2	3	4	5
84.	When I prepare myself for an exam, I prefer to do so together with other students.	1	2	3	4	5
85.	To me, learning means trying to approach a problem from many different angles, including aspects that were previously unknown to me.	1	2	3	4	5
86.	To me, learning is making sure that I can reproduce the facts presented in a course.	1	2	3	4	5
87.	The teacher should inspire me to work out how the course material relates to reality.	1	2	3	4	5
88.	I should look for relationships within the subject matter of my own accord.	1	2	3	4	5
89.	I like to be encouraged by other students to process the study materials at a particular pace.	1	2	3	4	5
90.	I should try myself to apply the theories dealt with in a course to practical situations.	1	2	3	4	5
91.	The teacher should encourage me to combine the separate components of a course into a whole.	1	2	3	4	5
92.	If I have difficulty understanding a particular topic, I should consult other books of my own accord.	1	2	3	4	5
93.	I prefer to do assignments together with other students.	1	2	3	4	5
94.	The teacher should explain clearly what is important and what is less important for me to know.	1	2	3	4	5
95.	I have a preference for courses in which a lot of practical applications of the theoretical parts are given.	1	2	3	4	5
96.	In order to learn, I have to summarize in my own words what the subject matter means.	1	2	3	4	5
97.	When I have difficulty understanding something, the teacher should encourage me to find a solution by myself.	1	2	3	4	5

Continue on the next page

1 Disagree entirely	2 Disagree for the most part	3 Undecided or not to know	4 Agree for the most part	5 Agree entirely

98.	I think I can not just rely on the books recommended by the syllabus, so I have to try to discover myself what else has been written about a particular topic.	1	2	3	4	5
99.	I think it is important to check with other students to see whether I have sufficiently understood the subject matter.	1	2	3	4	5
100.	I should memorise definitions and other facts on my own.	1	2	3	4	5
101.	When I have difficulties, the teacher should encourage me find out for myself what causes them.	1	2	3	4	5
102.	To me, learning means acquiring knowledge that I can use in everyday life.	1	2	3	4	5
103.	Good teaching includes giving a lot of questions and exercises to test whether I have mastered the subject matter.	1	2	3	4	5
104.	To test my own learning progress, I should try to answer questions about the subject matter which I make up myself.	1	2	3	4	5
105.	The teacher should encourage me to compare the various theories that are dealt with in a course.	1	2	3	4	5
106.	I should repeat the subject matter on my own until I know it sufficiently.	1	2	3	4	5
107.	I prefer a type of instruction in which I am told exactly what I need to know for an exam.	1	2	3	4	5
108.	To me, learning is providing myself with information that I can use immediately or in the longer term.	1	2	3	4	5
109.	I consider it important to be advised by other students as to how to approach my studies.	1	2	3	4	5
110.	The teacher should encourage me to check myself whether I have mastered the subject matter.	1	2	3	4	5
111.	When I have difficulty understanding particular topics, I prefer to ask other students for help.	1	2	3	4	5
112.	To me, learning means: trying to remember the subject matter I am given.	1	2	3	4	5
113.	The teacher should give trial tests to enable me to check whether I have mastered all of the subject matter.	1	2	3	4	5
114.	To me, learning means acquiring knowledge and skills that I can later apply in practice.	1	2	3	4	5
115.	I consider it important to discuss the subject matter with other students.	1	2	3	4	5

Continue on the next page

1 Disagree entirely	2 Disagree for the most part	3 Undecided or not to know	4 Agree for the most part	5 Agree entirely

116.	I think good teaching is teaching that includes some preparation on my own part.	1	2	3	4	5
117.	I should try to think up examples with the study materials of my own accord.	1	2	3	4	5
118.	The teacher should encourage me to reflect on the way I study and how to develop my way of studying.	1	2	3	4	5
119.	In order to check whether I have mastered the subject matter, I should try to describe the main points in my own words.	1	2	3	4	5
120.	I have a need to work together with other students in my studies.	1	2	3	4	5

Thanks for filling out! Please save the document as 'lastname.doc' and send it by email to:

Else Veldhuis-Diermanse@Alg@AO.WAU

EXAMPLE OF A QUESTIONNAIRE
CONCERNING PRIOR KNOWLEDGE AND USE OF THE COMPUTER

General questions

Type the answers to question 1 until 5 behind the colon.

1. Discipline:
2. Speciality:
3. Started in academic year:
4. Sex:
5. Age:
6. If you participated in some of the courses below, mark the first box by typing an X. If you received credits for that course too, mark also the second box by typing an X.

Course	Followed	Credits
Basic concepts Geographic Information Systems-gathering		
Basic concepts Geographic Information Systems-processing		
Soil and Landscape worldwide		

Questions concerning use of the computer

Select the answer that corresponds to your experiences the best by making the number of your choice **bold**.

7. Where do you work the most on a computer?
   At home
   At the university
   Others...

8. Do you have a computer at home?
   Yes, I have a computer of my own
   Yes, my parents/ housemates do have a computer
   No, I do not > go to question 10

9. Does this computer have an Internet-connection?
   Yes, is does.
   No, it does not.

10. For what purpose do you use a computer? (More answers are possible.)
   Word processor
   Playing games
   Searching the WWW
   E-mail
   Chatting
   Others...

When saying 'discussion group' we mean a group of people in an electronic platform debating with each other. The participants do have their own computers and are not necessary debating in the same room. It is like sending one e-mail to a number of peoples. However, a difference from sending e-mails is that everybody can read all the messages and has the possibility to react on those messages. When saying a 'face-to-face discussion' we mean a discussion in that people do not use a medium. They are in the same room and talk to each other.

11. Did you ever see a discussion group on a Website?
    Yes, I did > go to question 12
    No, I did not > go to part 2

12. Did you ever participate in a discussion group before?
    Yes, I did
    No, I did not

13. To what extent do you agree with the following statement? *'Discussing in a discussion group takes more time than discussing in a face-to-face discussion'.*
    Disagree entirely
    Disagree for the most part
    Undecided
    Agree for the most part
    Agree entirely

14. Do you prefer discussing in a discussion group or in a face-to-face discussion?
    I prefer discussing in a discussion group
    I prefer discussing in a face-to-face discussion
    No, I do not prefer one of both possibilities.

15. In how many courses did you use a discussion group before?
    I never used it
    1 – 2 courses
    3 – 4 courses
    > 4

Thanks for filling out! Please save the document as 'lastname.doc' and send it by email to:

Else Veldhuis-Diermanse@alg@ao.wau

Curriculum Vitae

Anna Elske (Else) Veldhuis-Diermanse werd op 17 oktober 1971 geboren te Harlingen. Zij volgde haar VWO-B opleiding aan het Christelijk Lyceum te Veenendaal en deed eindexamen in 1990. In de periode van 1990-1994 studeerde zij aan de Marnix Academie in Utrecht. In 1994 behaalde zij haar diploma en verliet zij deze Pedagogische Academie BasisOnderwijs. Ze bleef echter in Utrecht, maar ging naar de Universiteit Utrecht om Onderwijskunde te gaan studeren. Ze studeerde hier in de periode van 1994 tot 1997. In de doctoraalfase specialiseerde zij zich in onderwijsontwikkeling en het leren met behulp van nieuwe media. Tijdens haar studie keerde zij tijdelijk terug naar de Marnix Academie om onderzoek te doen naar studielast en om cursussen te evalueren. In het kader van haar afstuderen deed zij bij de vakgroep Onderwijskunde (Universiteit Utrecht) onderzoek naar computerondersteund samenwerkend schrijven en onderzoek naar de invloed van planning op het schrijven van argumentatieve teksten. Nadat ze in de zomer van 1997 haar studie Onderwijskunde had voltooid begon ze in september 1997 als assistent-in-opleiding bij de vakgroep Agrarische Onderwijskunde aan de Landbouwuniversiteit Wageningen (later: leerstoelgroep Onderwijskunde, Wageningen Universiteit). Het onderzoeksproject was getiteld: "Computerondersteund samenwerkend leren: kennisconstructie processen van studenten in het hoger onderwijs". Tijdens haar promotieonderzoek volgde zij de aio-opleiding bij het Interuniversitair Centrum voor Onderwijsonderzoek (ICO). Gedurende de eerste periode van haar aanstelling gaf ze voor de leerstoelgroep diverse trainingen in presentatie vaardigheden. In 2000 richtte zij een CSCL-analyse werkgroep op waarin onderzoekers van verschillende Nederlandse universiteiten participeren. Verder was ze lid van de ICO Onderwijscommissie en was ze als redactielid werkzaam voor de nieuwsbrief van deze onderzoekschool.

ico

The research reported in this thesis was conducted at the Interuniversity Center for Educational Research (ICO).

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