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Collaboration in Computer Conferencing

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Introduction

We have been experimenting with web based electronic conferencing (CMC) at the Educational Science Department of Utrecht University for a period of nearly 10 years now. Obstacles such as insufficient participation, the low quality of messages and the integration of CMC in a course have been overcome and nowadays many of our students appear actively engaged with knowledge construction activities (Veerman, 2000). While we may have succeeded in organizing interesting computer conferences, things are missing that relate to the affordances of computer conferencing for collaborative learning. It seems that at the level of individual courses we have reached limits we cannot move beyond. In order to understand this problem and its possible solutions, this paper discusses some of our data concerning the role of computer conferencing in higher education.

The main conclusion of this chapter is that productive use of computer conferencing for learning purposes in the context of current higher education requires participants (students and teachers) to have more knowledge of collaboration. We are currently witnessing (at least in the Netherlands) a gradual shift in thinking about learning and education, which is traditionally taken as a process of an individual knowledge acquisition by transmission from expert knowledge, towards more collaborative and project-based forms of learning. It is a slow change with many

dangers of failure, and we do not know much about the success factors. One main assumption, as a result of our research, is that the main obstacle for the success of any collaborative learning task is in the design of the curriculum, that is, if collaboration is not implemented as a necessary and important learning activity, it will not survive in the classroom. This integration of new learning is reflected in the conceptions about learning objectives of the participants in the educational activity system, and in the roles and responsibilities of participants, including the place of technology. A corollary of this idea is that causes of problems of using collaborative technology are not only in characteristics of the new technology, but also, and more importantly, in the new forms of collaboration it permits.

This chapter is organized as follows. First, we present a review of research on computer conferencing. We then provide an overview of our use of computer conferencing in regular courses that we have been engaged in during the past years. In the *second* part, we describe our research findings. We investigated the role of argumentation in computer conferencing and the relationship between task focus, argumentation and constructive discussion. We also examined how messages in a computer conference are thematically linked to each other, and if instruction can affect this linking. The nature of explicit personal reference between messages in an electronic forum is also examined from a social perspective. Finally, we examine participation profiles of participants in a six-month course in which all decisions had to be made by the participants themselves.

The *third* part of this chapter presents an explanatory framework for these results, both from a theoretical and didactical perspective. This framework supposes that the educational paradigms in which collaborative learning is used in practice evolve from use in knowledge transmission to use in knowledge negotiation, presumably though a number of intermediate

stages. Different scenarios in which specific learning goals, theoretical viewpoints on learning, characterize these different stages and the didactical methods that are applied. It is argued that an advanced use of CMC requires more advanced educational paradigms. The evolution through the stages can be characterized as increasing awareness of the goals of a learning situation and of the means to meet these goals. This evolution has to be supported by appropriate educational design. Computer conferencing as in constructive discussions, knowledge building or community building can only be fruitfully used in contexts where users are in advanced stages and contexts of awareness of learning.

Research with Computer Conferencing

In Computer Conferencing (CC) two or more persons participate in an electronic conference about a certain topic, called a forum. The conference is asynchronous, that is, participants do generally not contribute at the same time. They communicate by sending electronic messages that typically are displayed in a list (called a thread) visible to all participants. The topic could be a question or a controversial statement devised by a teacher, containing some crucial issues pertaining to a course or a text to study. Students can react to the initial statement and then to each other and, under ideal circumstances, an interesting discussion may develop. The role of the instructor in discussions may vary: observer, social worker, group therapist, expert on demand, organizer, and many other roles (Mason, 1991). Discussions can be constrained or not with respect to duration, timing, types of answers and conclusions.

CC may be envisaged as a slow discussion, offering participants much time for reflection and pondering, during which they may take appropriate notice of everything that has been said before. CC offers an educator a potentially interesting means to make students broaden and deepen their insights about important issues and to monitor progress at a relatively slow pace.

For a researcher involved in actual educational practice, it is relatively easy to arrange discussions as to obtain large databases with examples of constructive and less constructive communication, on the basis of different initial statements, moderator roles and collaborative arrangements.

The use of electronic discussions in educational settings seems a promising way of promoting reflection and learning by communication and argumentation. To date, mainly single case exemplars of such discussions have been published, often with an important role for the instructor. At the current stage, analyses of such discussions still have to establish accepted frameworks that specify the complex interactions between domain knowledge type, student knowledge (about the domain and about discussion and collaboration), student attitudes and characteristics of the resulting discourse.

From a rhetorical perspective on academic learning, academic education can be framed as an ongoing argumentative process (Petraglia, 1997). It is the process of discovering and generating acceptable arguments and lines of reasoning underlying scientific assumptions and bodies of knowledge. The purpose of collaborative discussion tasks is to have students externalize, articulate and negotiate alternative perspectives, inducing reflection on the meaning of arguments put forward by peers as well as experts.

It is believed that collaborative learning is particularly achieved when students are presented with conflicts, engage in argumentative processes and manage to produce a shared interpretation of information or arrive at a shared problem solution (e.g. Piaget, 1977; Doise & Mugny, 1984; Baker, 1996; Erkens, 1997; Savery & Duffy, 1996; Petraglia, 1997). In argumentation, students can gives prominence to conflict and negotiation processes, critically discuss information, elaborate on arguments and explore multiple perspectives. Knowledge and

opinions can be (re) constructed and co-constructed and expand students' understanding of specific concepts or problems. Thus, argumentation can be seen as an important mechanism for fruitful discussions and the production of constructive activities.

In effective collaborative argumentation students share a focus on the same issues and negotiate about the meaning of each other's information. Incomplete, conflicting, doubted or disbelieved information is critically checked, challenged or countered on its strength (is the information true?) and its relevance (is the information appropriate?), until finally a shared answer, solution or concept arises. However, generating effective argumentation in educational situations requires participants to deal with many constraints. First of all, adequate focusing is important for grounding and understanding messages. Students have to initiate and maintain a shared focus of the task. They have to agree on the overall goal, descriptions of the current problem-state, and available problem-solving actions (Roschelle & Teasley, 1995). Failure to maintain a shared focus on themes and problems in the discussion results in a decrease of mutual problem solving (Baker & Bielaczyc, 1995; Erkens, 1997). Second, assessing information critically on its meaning, strength or relevance depends on many factors, such as the (peer) student, the role of the tutor, the type of task, the type of instruction and the selected medium (Veerman, Andriessen & Kanselaar, 2000). Key problems that can inhibit students to engage in critical argumentation are that students tend to believe in one overall correct solution or show difficulties with generating, identifying and comparing counter-arguments and with using strong, relevant and impersonalized justifications (Kuhn, 1991). In addition, students' exposure of a critical attitude can be inhibited because of socially biased behavior. For example, students may fear to loose face (e.g. in front of the classmates), to go against dominant persons in status or behavior (e.g. a tutor), or for what other people think (e.g. that you are not a nice person).

To support and optimize students' engagement in argumentative dialogues for collaborative learning purposes, computer-mediated communication (CMC) systems provide new educational opportunities. Text-based and time-delayed communication can be beneficial to keep track and keep an overview of complex questions or problems under discussion. Text-based discussion is by necessity explicit and articulated. A history of the discussion can be used to reflect over time on earlier stated information. Moreover, in CMC systems students lack physical and psychological cues such as physical appearance, intonation, eye-contact, group identity etc. sometimes leads to democratizing effects (Short, Willams & Christie, 1976; Kiesler 1986; Rutter, 1987; Spears & Lea, 1992; Smith, 1994; Steeples, Unsworth, Bryson, Goodyear, Riding, Fowell, Levy & Duffy, 1996). Critical behavior, therefore, may be less biased towards a tutor or a dominant peer-student than in face-to-face discussion. However, it is unclear how the use of a CMC system, and which characteristics of such a system, relates to effective argumentation for collaborative learning purposes. The research that is reported in this chapter attempts to identify some of the necessary characteristics.

Computer Conferencing at Utrecht University

At our department we have been experimenting with electronic discussions for the past six years. Our initial purpose as teachers was to look for added value to our course by using CC, in terms of deeper insights, motivation and course efficiency. From a theoretical viewpoint, our interest was in knowledge co construction, that is, participants' attempts to arrive at shared understanding of concepts, by explaining ideas, discussing alternatives and argumentation of viewpoints (Roschelle & Teasley 1995; Scardamalia & Bereiter, 1994). In addition, we wanted to analyze the content of the discussions to find out in what way constructive discussions and learning could emerge form certain arrangements, and in what ways such discussions could be

supported. All data reported were obtained in actual courses with regular students. In the next sections we discuss some examples of what we tried to do, followed by a discussion of some relevant experiences and lessons learned.

As we work with regular students that are in general not used to seriously employing computer conferencing for learning purposes, one of the major obstacles was getting students to effectively use the medium. When we started it was not even very clear what effective use would mean. It was obvious that we needed our students to experience added value and to have as little technical problems as possible. Therefore we decided to build a website, and to integrate use of the web with the rest of the course. One problem appeared to be that while we gradually succeeded in adding meaningful learning experiences for the students, this also required students to spend more time on a course. Not many students are prepared for this, for various reasons. One effect is that we tend to lose about 20% of our students during the first weeks of a course.

The context in which our experiences with CC were taking place was a series of courses for advanced students at the department of Educational Sciences, aiming at the study of learning with new media. The topic of the courses, and the fact that they all were coordinated by the first author of this chapter, allowed to arrange them, relatively independently from the rest of the curriculum, to make use of the Internet as much as possible, according to the following main principles:

- Students are responsible for their own activities and participation and are expected to support each other. Teacher time is limited and we do not want to set a standard of high teacher involvement in terms of hours spent on a course. Teachers intervene as infrequently as possible, only to provide structure and guidance, not answers or

evaluations. Students are encouraged to say what they think, and not to feel ashamed about things they do not know or do not express clearly.

- The courses are on new media, but the actual topic is education and learning. Integrated use of new media is attempted: educational use of new media needs to be experienced as much as possible rather than read about.
- The use of specific applications of new media is carefully tuned to task purpose. We prefer open tasks, in which there are many correct solutions, and many ways to arrive at a result. We foster collaboration, argumentation and use of discursive media.

These principles were applied in three different courses. Table 1 gives a comprehensive list of the discussions and the frequency of participation in one of the courses in 1998. The discussion forums were part of a web site in which other types of activities and information (software, instructions, background texts, etc.) were provided. In our opinion, the table presents satisfactory results in terms of student participation and their evaluation of the activities. Of course, improvements on details and functionality are possible.

Table 1: Available forums in the 1999 course and their participation per week by 30 students[1]

Name	**Description**	**N**[2]	**Rating**[3]
Theoretical forums (compulsory)	A discussion about theoretical issues (formulated as questions or discussible statements) derived by the tutor from course texts. Sometimes moderated. The purpose of these discussions is to deepen understanding of theoretical matters. These discussions last two weeks and are then closed. In 1999 there were 3 discussions of this type every two weeks, a total of 14 for the full course. Students could choose one and were to contribute at least two substantial messages each week. In addition, a long list of expert consultants (mostly scientists from all kinds of disciplines) is available, who can be mailed with specific questions. It is possible for students to propose new discussion themes, but this hardly ever happens. A discussion is closed and then commented by one of the instructors on a different web location. Example: *For the study of learning processes, phenomenography offers a more promising research approach than instructional design, intelligent tutoring systems or instructional psychology.*	48[4]	8.0
Table 1 (continued)			
Applied forums (compulsory)	A discussion on practical issues (picked by the tutor) on the basis the literature and the student's own intuitions and experiences. Sometimes an instructor who attempts to provide structure and motivation moderates a discussion. There are three such forums, and students have to actively participate in one forum of their own choice. The purpose of these discussions is to promote reflection on the relations between theory and practice. These discussions last two weeks and are then closed. It is possible for students to propose new discussion themes, but this hardly ever happens. A discussion is closed and then commented by one of the instructors on a different location. Example: *Human tutors are better adapters to student learning styles than intelligent tutoring systems*	47[4]	7.8
Red threads	On the basis of questions or statements formulated by the instructional team, students are requested to post at least two serious contributions during the full course to a discussion on general issues related to the use of media in education. In 1999 there were two such forums, and students were free to propose additional ones, however, this has not happened. Examples: (1) *Interactive learning should be a crucial aspect of educational design of courses in social sciences; (2) Learning with new media equals adaptive instruction*	5.1	6.2
Course organization	These serve all kinds of purposes. The most important one is the forum in which the instructors post announcements on new assignments, changing course plan, and the consequences of failing technology. Students are expected to consult this forum on a daily basis.	2.7	6.8

[1] The number of students in the course decreased by about 20% during the first weeks

[2] Mean number of contributions each week

[3] Student evaluation of a discussion type on a 10 point scale

[4] An average of 9 students participate in each discussion of this type, the number sums up three discussions

Comprehension forum	Serves for students to discuss their problems with understanding the literature with each other and with the instructors.	1.9	6.0
Practice forum	A number of teachers from secondary schools participated in the 1999 course and were invited to propose some issues and ask questions to the students about their own practice with the implementation and use of new media.	3.1	6.0
News forums	Relevant conferences, web sites and texts. Also, there is the evaluation forum, for students to post their experiences with the course, to propose alternatives and solutions for all kinds of problems experienced.	17	7.7
Helpdesk	For all kinds of problems involving technical matters	2.7	5,6
Stock Exchange	Requests for new topics and themes and meetings with or without tutors. Tutors are to oblige a student request, for example, to give a lecture about Intelligent Tutoring Systems, if at least 5 students support the request.	0.2	5.6
Visual Basic	Programming helpdesk	2.8	6.2
Bar and café	There is a bar (asynchronous) and a coffee shop (synchronous), where students and staff can meet for informal chat.	7.4[5]	5.3
Total (week)		171	

Student Reactions to Computer Conferencing

Our evaluations of students' reactions have been informal. Most students indicated they found it useful and instructive to participate in theoretical discussions and that this increased their understanding. Some indicated it even stimulated them to look for additional information. Most students acknowledge that participation was most useful if it was prepared by reading the relevant texts. Some individual students thought the discussions were not always very deep. One student viewed discussions mainly as a means to keep students busy.

Some students judged the discussions as too theoretical, others say that the discussions are too much about students' own experiences. Many students claim that too many questions remain and not enough conclusions are reached. Only a few students think these discussions help to develop a personal viewpoint. Half of the respondents indicate a preference for face-to-face

[5] Only for asynchronous contributions

discussions in addition to electronic ones. Many also indicate a need for more information by a tutor.

All students indicate to have learnt more form the collaborative discussions than from learning by themselves. The discussions require attention and clarity, and to see other viewpoints and insights helps understanding. Others help to keep learning going. It matters a lot who is participating in a particular discussion. One student preferred independent study because relying on others' responses takes too much time.

Asynchronous discussions were preferred over synchronous discussions. Students like the possibility to reflect longer, some indicate the relative anonymity induces them to really say what they think. One student suggests starting theoretical discussions asynchronously, but to have a synchronous conclusion session.

Students' opinions of the role of the moderator were mixed. This clearly is a controversial issue. Some think that the presence of the moderator should be more prominent and that he or she should intervene more often. The moderator should summarize, conclude and ask questions to deepen discussion, and has to provide content related feedback during the discussions. Some students indicate they want to know if their ideas are correct or not. Only a few students mention the danger of a moderator bringing a discussion to a standstill.

All students indicate they like to receive information from experts. This helps them to understand the concepts involved. It can also be interesting to compare reactions to the same questions from different experts. However, most students did not consult any expert even once. They indicate hesitations to write and a lack of time as the main reasons for this. Furthermore, experts did not always react promptly. When experts reacted, their messages were not interpreted, but simply pasted into the discussion.

When reported in research studies (e.g. Goodfellow & Manning, 1999; Tolmie & Boyle, 2000), student evaluations of electronic learning groups give a consistent picture. One part of the students is very happy with these new developments, but another part, just as big, prefers traditional education. Most students want more tutor feedback, for structure as well as for content evaluation. Although, in our case at least, students have many opportunities to take initiative, and tutors are mainly reactive here, hardly any initiative is found. For example, students barely pose any questions about the source texts to the tutors. We do not think this is a feature of electronic discourse or even of collaborative learning. It is a feature of traditional, tutor-based educational contexts. Students participate in compulsory parts of a course, and although they tend to dislike most things that are compulsory, they tend to acknowledge their usefulness afterwards, even when inappropriate. The responses of our students indicate involvement and understanding, but lack of shared purpose (Tolmie & Boyle, 2000).

Research Questions

How can the discussions in the electronic forums be characterized? To what extent do we have constructive, interesting, argumentative or simply good discussions? Many questions can be asked, and our approach is to ask seemingly simple questions, from different theoretical viewpoints. Discussions can be explained from quite different angles (see, e.g. Baker, 1999, for constructive argumentation), and we feel that theoretical insights are not as complete as to be able to present and explain a clear picture on what is happening. In the next sections we present five analyses that attempt to clarify some main characteristics of these electronic discussions:

Study 1

1. To what extent are these discussion content-related? In what way can they be called constructive? Does this relate to argumentation?

2. To what extent are discussions focused? On what does this depend?
3. To what extent are messages connected in terms of personal reference? Does this depend on the content of a message, or the individual posting the message, and are there developments over time in this respect?

Study 2

4. To what extent are messages connected in terms of content? Can the type of discussion or the rules of discussion affect connectedness?

Study 3

5. To what extent do individuals differ in terms of their responsibility for a discussion?

The first three analyses involve the same 28 theoretical and applied forums of the electronic conferences that were discussed above. The second study (analyses 4) concerned the same course one year later. The third study involves an analysis of a different course (analyses 5).

Study 1

The purpose of this study is to characterize students' discussions with respect to the relations between focusing, argumentation and collaborative learning-in-progress. Two content-related *focus* categories reflect students' focus on the task and learning goals: (a) a focus on the meaning of concepts, (b) a focus on the application of concepts. In addition, students' focus could be on task strategy issues (planning how to start the task, time management, how to carry out the task), social issues, etc. Furthermore, six types of dialogue moves are included into the analyzing system: statements, acceptances, conclusions and checks, challenges and counter-arguments. Although all these categories may embody elements of argument, only (a) check questions (e.g. "What do you mean by…."), (b) challenges (e.g. "How can you justify that….") and (c) counter-arguments (e.g. "I don't agree on the issue of…") are considered as

argumentative dialogue moves.

Students' discussions can be viewed as collective information networks in which content can change dynamically and grow by the production of *constructive activities*: messages in which content-related information is added, explained, evaluated, summarized or transformed. Adding information means that an input of new information is linked to the discussion. Explaining information means that earlier stated information is for example differentiated, specified, categorized, or made clear by examples. Evaluations are (personally) justified considerations of the strength or relevance of already added or explained information. In transforming knowledge, already stated information is evaluated and integrated into the collective knowledge base in such a way that a new insight or a new direction transpires that can be used to answer questions or to solve problems. Summarizing means that already given information is reorganized or restated in such a way to reflect the main points of the discussion. The production of constructive activities is regarded as to signal collaborative learning-in-process and is related to the concept of knowledge-building discourse (Scardamalia & Bereiter, 1994). In this research, all content-related messages are analyzed on types of constructive activities. Each message was coded once, as one (or none) of the following constructive activities: (a) addition, (b) explanation, (c) evaluation, (d) transformation, (e) summary.

Content of Forums

Table 2 presents a summary of the results of this analysis. These results are presented in more detail elsewhere (Veerman 2000). Veerman (in press) compares these data, using the same classification system, with synchronous chat discussions and discussions using Belvedere (Suthers, 2001), and this allowed considering the number of content related messages and the number of constructive activities (explanations) in CMC as relatively high. However,

argumentation is low, especially challenges and counters. Moreover, we do not find transformations or summaries. Remember the student evaluations above indicated that students expected the tutor to be responsible for this.

Table 2: Number and Kinds of Messages Generated in Forums from Veerman (2000) study.

Total number of discussion forums analyzed	28
Average number of messages per discussion (2 weeks)	34
Average number of words per message	120
Total number of messages analyzed	952
Number and percentage of content-related messages	30 (88%)
Number of non content-related messages (focused on task strategy, social issues etc.)	4 (12%)
Focus of content-related messages per discussion forum	
- meaning of concepts	14 (47%)
- application of concepts	16 (53%)
Argumentativeness of content-related messages per discussion forum	
- Not argumentative (statements, acceptances etc.)	21 (71%)
- Checking information	7 (23%)
- Challenging information	1 (3%)
- Countering information	1 (3%)
Constructiveness of content-related messages per discussion forum	
- Not constructive	8 (27%)
- Constructive	22 (73%)
Types of constructive messages per discussion forum	
- Additions	7 (30%)
- Explanations	11 (50%)
- Evaluations	2 (10%)
- Summaries	1 (5%)
- Transformations	1 (5%)

The results of this study induced us to be quite positive about the usefulness of electronic conferences. While the conferences are mainly used to explain rather than to argue, they are very much content-focused. At this point, also taking up the results from student evaluations, our conclusion is that this type of discussion characterizes students seriously trying discussing things they are not very familiar with. The next analysis concerns the focus of these discussions.

Focus of Discussions

While the discussions were characterized to be much on-topic, topics can be defined at various levels of generality. For example, one discussion was about the statement made by Laurillard (1993): "Teaching is a rhetorical activity". General topics are 'teaching', 'rhetorical' and 'activity'. More specific topics include teaching experience, types of activities, motivation, involvement, teaching materials, mediation, argumentation, etc. In this study, a more specific topic definition was applied, which allowed examining (1) the breadth (nr. of topics and arguments) and depth (nr. of contributions for a topic or about an argument) of discussion threads, (2) references to other topics and arguments in the discussion threads.

All discussions were about a general topic mentioned in the problem statement. However, analysis of more specific topics (van der Pol, 1998) revealed the opposite: the number of specific topics increased with time, and students did not return or refer to specific topics discussed earlier. In addition, discussions seldom arrived at a conclusion. Recall some students in the evaluation in section 2.2 also remarked this. This aspect of discussions is characterized in Figure 1. The picture on the left matches the results of the topic analysis.

Figure 1: The left picture characterizes a discussion in which topics disperse, the picture on the right shows topics that merge towards a conclusion

Further analysis showed that students did not very often react to each other, in terms of references to other topics. They merely appeared to explain their own contributions on the basis of a question (check) by someone else. Moreover, students seldom directly reacted to tutors. Suggestions by tutors about the plan to proceed and criteria to keep in mind were often completely ignored.

At this point, it seems that interpretations in the previous section were too optimistic with respect to the constructiveness of explanations and additions in the discussions. It seems that our discussions elaborate in terms of breadth, but do not go deeper and do not arrive at integration or a conclusion. This process seems to be characteristic of brainstorming and it may be that students need help, more time, different motivation, and/or more knowledge and skills, to engage into deeper discussions. In the next section, we look at the degree to which students referenced one another's comments. It may be that connectivity among students may promote greater depth in the discussions.

Personal Reference

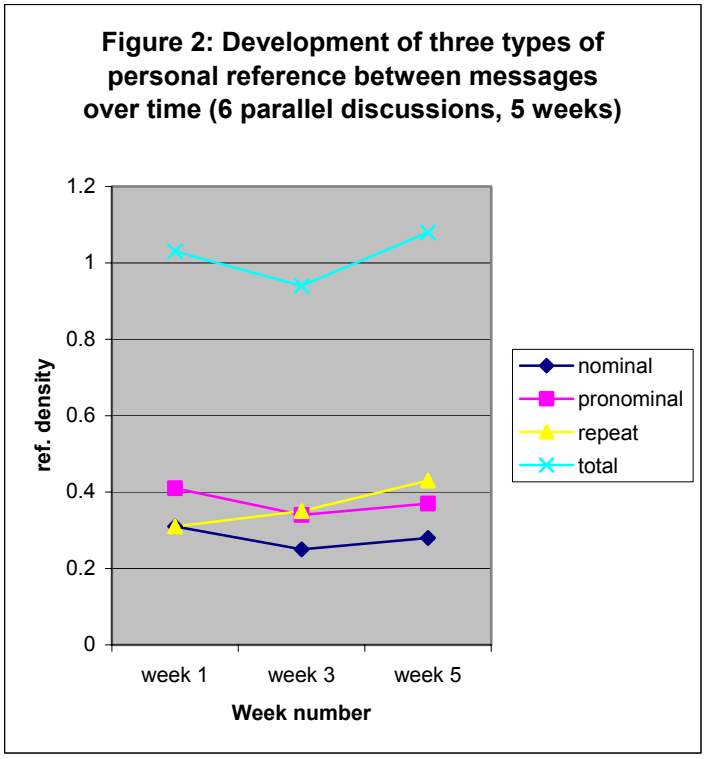
Effective collaboration requires awareness of the process of collaboration in which students are engaged. For example, it would be good for collaboration if students in their messages explicitly referred to other students, and not only to their messages. Brand (1999) examined students referring to each other's messages from a social viewpoint. The manner in which messages referred to each other, and whether explicit reference to a specific individual's messages increased or decreased during participation in several discussions over a 13-week period. The idea was that, as in every collaborative group process, over time some people would be better recognized as to the importance of their contributions to the discussion, reflected as more explicit references to their messages.

First, the *referential density* of a discussion was computed as the percentage of explicit *personal* references to messages in a discussion. This was computed for three types of reference: explicit naming of the author, repetition of (parts) of the message, and use of personal or referential pronouns. A referential density of 1 for a discussion means that on the average, a message by a participant is explicitly referenced to once during the 2-week period of a discussion.

Figure 2 displays the results. As can be seen, referential density was uniformly low, a message generating an average of about 1 personal reference in a discussion. In addition, the personal reference density for individual participants varied between 3.67 and 0.4, that is, for the most referenced participant, each message that this participant contributed elicited an average of 3.67 explicit reactions. In case of the least referenced participant, each message was referred to only .4 times.

Second it was attempted to identify characteristics of core messages in a discussion, that is, messages that are referred to with a frequency above the average (in this case: 4 references or more). To this end, the following variables were examined: (1) Contributor (regular student, part-time, working, tutor); (2) Gender and (3) type of discussion (theoretical vs. applied).

A total of 18 discussions was analyzed, each discussion lasting two weeks. In all of these discussions together 17 core messages could be identified, 14 of which were posted during the first week of a 2-week discussion. There were no differences between discussions that started during the first, third, or fifth week in the frequencies of core messages. Women produced twice as many core messages as men. There were no other significant differences.



While the previous analyses showed characteristics of content relations between messages, the current study examined these relationships from a different angle. It seems to show that there are no discernible changes of personal status over time. The number of core messages in the discussion, that is, messages that are referred to relatively very often, is very low, and this number does not change over time. In addition, it seems that messages in which the contribution of another student is personally acknowledged are quite rare as well, and we also see no developments over time. Discussion groups change every two weeks, which may be a possible explanation for this result. It may be interesting to examine what happens when collaboration is extended over a longer period.

Study 2: Intervening To Increase Connectivity

The connections between different messages seem to cause the topic structure of electronic discussions to expand, with the result that often newly added knowledge will just keep 'floating' on its own, without being further refined or elaborated. This results in different pieces of knowledge to coexist in the discussion without ever being confronted. The lack of specific comments on earlier messages could be a general problem in electronic discussions for educational purposes: Veerman (2000) found there were hardly any transformational activities in electronic discussions and Wan & Johnson (1994) found there were no integration messages, while both are essential to learning and to building a shared knowledge base.

The specific research question for this study (van der Pol, 2001) was: "Is it possible to create more and better connections between messages in electronic discussions by means of task-specific instruction?" The choice for task-specific instruction was a practical one, because changes in the interface (with the purpose of creating a more natural form of connecting and learning in electronic discussions) were not yet possible.

Twenty five third year educational science students have been discussing in one of three different conditions for contributing to discussions, designed to stimulate them to connect more and relate better to each other's messages: 1) to compulsory contribute in the form of explicit replies to a previous message, or 2) to contribute summaries of previous discussion and 3) to compose more and shorter messages. The messages in every condition were scored according to their level of connectivity, which could be any of the following (hierarchical) categories: no connection, association, checking, elaboration and convergence. The control group consisted of ten discussions on identical topics that were held the year before, with different students.

There were significant differences between the three conditions in terms of connectivity,

measured as the proportion of elaborations ($F(2,22)=6.247$, $p=.003$). Table 3 displays the differences between conditions. There were hardly any messages that were scored as converging different contributions in the discussion.

Table 3:Connectivity of Messages as a Function of Condition

	N forums	N messages	% Replies	% Connect[6]
1. Reply (weeks 1-4)	10	341	.77	.47
2. Summarize (weeks 5-8)	10	308	.69	.34
3. Short messages (weeks 9-10)	5	212	.80	.38
Mean	25	861	.65	.40
Mean previous year[7]	10	280	.65	.37

The variable with the most influence on the level of connectivity between messages appeared to be the topic of discussion. Two classes of topics were compared: 1) discussions about the book used in the course, and 2) broader discussions, which involved relating personal experience, the same book, articles and combinations between them. Discussions in the first group displayed a significantly higher level of connectivity ($F(2,22)=6.172$, $p < .007$). This effect can be interpreted as the influence of common ground. A discussion topic with a fixed reference point (the book) appears to help connecting to each other's messages. Making a good connection to a message demands a good understanding of the ideas involved, it and the effort of interpretation is reduced when some degree of common ground has been achieved. This supports the idea that grounding is a natural and gradual process in communication: with less common ground more information checks are found. The amount of checking in turn is moderately

[6] Corrected for replies to the moderator

[7] Only discussions with identical topics were taken into account

positively related to the level of connectivity (correlation = .439, α = .10). This is promoted in condition 3, where more and shorter contributions were requested, which in turn increases the amount of replies. With high common ground, condition 1 gives the best results for connectivity. These results can be interpreted as that connectivity can be stimulated, but the appropriate way to do this depends on the level of common ground.

We conclude here that this study helped to better understand what actually happens in a discussion. While the number of messages that summarize or converge a discussion is very low, indicating that the level of a discussion can still be substantially raised, the characteristic that has a significant effect on the elaboration of a discussion is the degree to which a discussion is grounded. Multiple discussions over time on topics from the same book, gradually achieve more connectivity, presumably because of increasing familiarity with the reasoning of the author, especially when participants are explicitly asked to reply to each other's contributions. It seems that students have to learn how to react coherently, and that grounding in these electronic discussions is a slow process, which has to be studied more deeply (Clark & Schaefer, 1989; Baker, Hansen, Joiner & Traum, 1999). Furthermore, checking and explicit replying may increase connectivity, checking being an indication of attempts to achieve common ground, while replying may serve elaboration.

Study 3: Knowledge Negotiation

Some conclusions from the previous analyses concern the importance of grounding and the apparent lack of development in the sense of personal reference. Can such developments can be observed in discussions over a longer period. A small group (N=10) of serious and experienced students volunteered to be part of a long-term experiment. The original plan was to

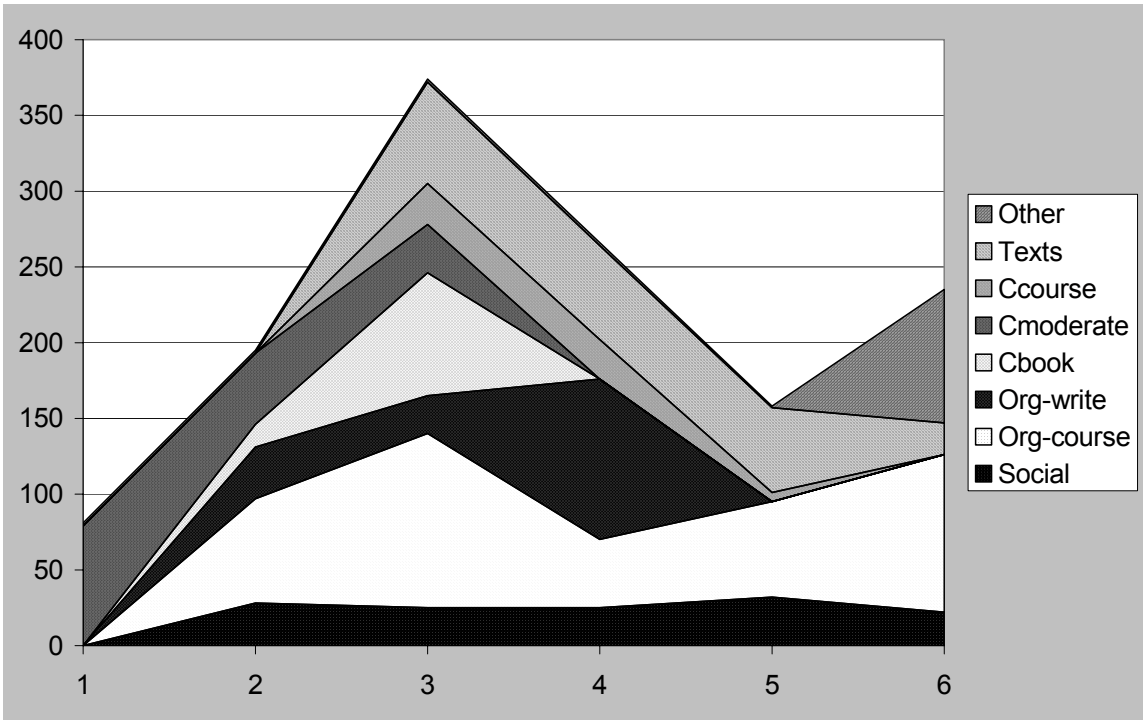
collaboratively produce a review of a theoretical textbook on constructivism (Petraglia, 1997). The assignment to produce a review (to be published!) was a pretext, based on the idea that this could be a way of advanced students joining the ranks of serious researchers, to study electronic communication. The group was aware of this, and the participants agreed with the general constraint that all communication was supposed to take place electronically and publicly on a discussion forum. The role of the tutor was not defined at the start, and there was no plan. The original intention was to carry on for three months, for a couple of hours each week, but the process took much more time, and currently, two years after the start of the course, 4 students are left working to produce a text, communicating both orally and electronically. The analyses that are presented here involve the first six months of this process.

The participants had to decide, organize and plan many things, and they did not succeed in all respects. Van de Groep (2000), who was one of the participants of the course, undertook a study in which he examined the extent to which individual participants contributed to various aspects of the group process. To this end, first, the 34 different discussion threads were categorised and the frequency of the individual contributions to each class of discussions were counted. Figure 2 shows the landscape of general discussion themes over the first six months. The sizes of the peaks indicate the number of contributions. The following classes of discussion forums were distinguished:

- Social: explicitly for chatting, not related to group tasks
- Texts: forums in which participants contributed texts for the final product
- Ccourse: theoretical discussions about the authenticity of the course
- Cmoderate: Theoretical discussions about moderating electronic discussions
- Cbook: Theoretical discussions about the book to review

- Orgwrite: negotiations about the organization of the writing task
- Orgcourse: negotiations about the organization of the course
- Other: other discussions

Figure 3: Landscape of themes of discussions over six months

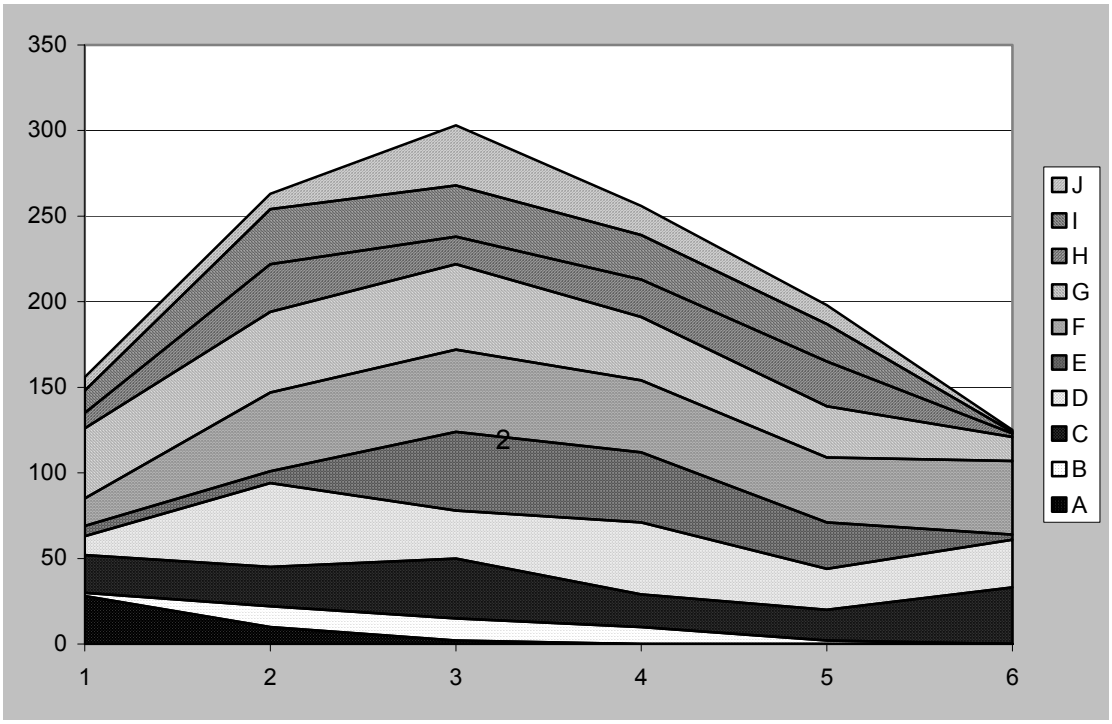


Concerning themes, Figure 3 shows that from the start of the group, participants were very concerned with the issue of the role of the moderator. They decided to alternate and evaluate the moderator role every two weeks. One important task of this role was to regulate the group process in terms of tasks, but also to support the social process, as encouragements as well as interventions when things went the wrong way. Immediately, it became clear that not every participant was equally involved in each part of the process, as can be easily seen from Figure 4 where the relative participation of individuals is displayed. Very soon organization problems emerged, and the nature of the course, both at the level of theory (is this negotiation?: Ccourse) as well as practice was extensively discussed (Org-course). The peak at the very end, after six

months, shows that the organization question remained and was not answered satisfactorily. Division of tasks, and taking up the responsibility of carrying out a task within reasonable time constraints, remained a problem for the group. Individual expectations differed and many of these differences only appeared during discussion, sometimes when explicitly addressed, but more often implicitly as silence and delays. At the end, four participants remained active (C, D, F & G). Participant A was only active at the beginning, but left the group after 2 months. Participant B lasted a bit longer, but was never very active. Participant E was very active during months 3-5, when most text production for the assignment took place. Participants H and J contributed selectively.

Although participants differed to some extent concerning the distribution of their individual activities across themes, every participant contributed most messages to organization discussions, and then to content-based discussions.

Figure 4: Individual participations over six months



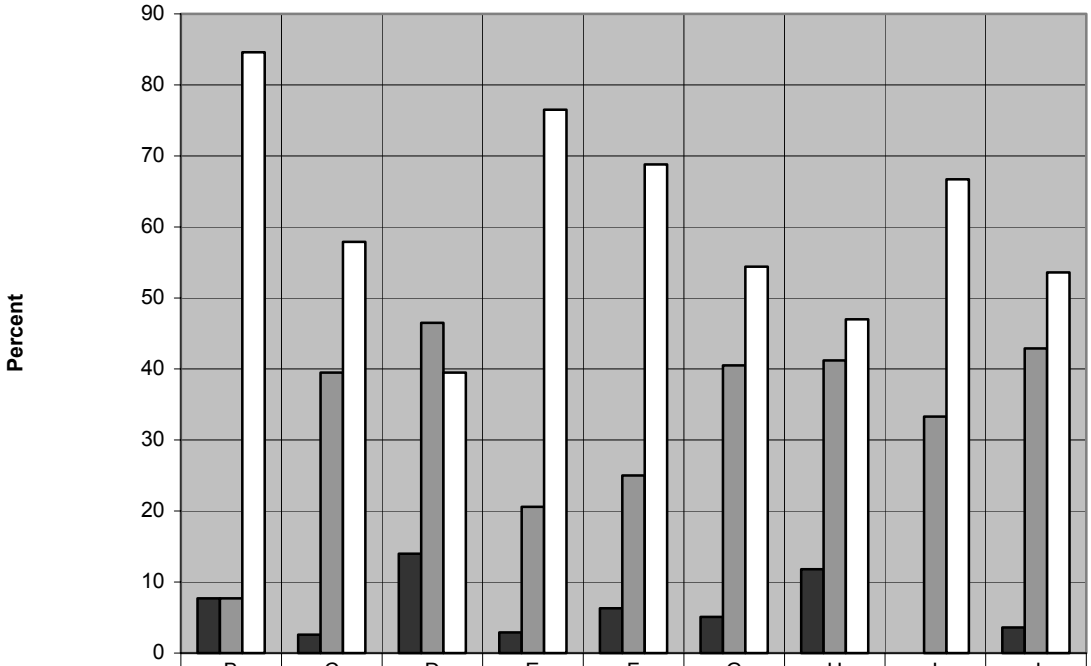
One of the core activities of the group was supposed to be engagement in content-based discussion. While organization of the group process and writing were obvious tasks to focus on, the main goal of the course, as was explained at the beginning, involved the construction of theoretical knowledge about conceptions of constructivism and learning, triggered by the text to read. This activity (Cbook) mainly took place during the third month, and was followed by a discussion about the authenticity of the current course (Ccourse) in months 3 and 4. After that, all content-based discussion faded out and discussion on organizational matters and text production took over.

The next step in the analysis was to arrive at a characterization of the group activities. To this end, the level of activity of each message was classified (Hansen et al, 1999, p. 193; Heeren & Lewis, 1997, p. 89). Based on ideas formulated by Leontiev (1978) it is supposed that these levels coexist at the same time but the focus of activity may be at different levels:

- Intentional: a participant focuses on *motives*, desires, needs, and values. It is the level of global orientation that gives meaning to human processes. Practically it means that a participant indicates and explains his intentions, for example in order to reach a shared understanding. This is supposed to be a major activity for grounding, especially during the initial stages
- Functional: activity is oriented to specific conscious *goals* in the context of motives. It is the level of organizational planning and problem solving to achieve (intermediate) goals.
- Operational: the level of *practical* conditions of actions. It is the level of practical routines required to carry out conscious, purposeful actions at the functional level.

Figure 5 clearly shows that the activity of the participants was mainly at the operational level, especially without enough expression of motives. In other words, discussion focused on the result, and not on the personal reasons to achieve this result. This result can be compared to that of study 1, in which it was shown that students tend to focus on practical application of knowledge as often as on meaning. The current study provides an enlarged picture of this: students are struggling with what to do and on how to achieve that goal, while the reasons for the activities (discussing personal views on concepts) are not negotiated enough.

Figure 5 : Individual differences in activities for all discussions



	B	C	D	E	F	G	H	I	J
Intentional	7.7	2.6	14	2.9	6.3	5.1	11.8	0	3.6
Functional	7.7	39.5	46.5	20.6	25	40.5	41.2	33.3	42.9
Operational	84.6	57.9	39.5	76.5	68.8	54.4	47	66.7	53.6

A more general conclusion is that the task seems too hard for our students. First, it maybe is too difficult for most students to produce a review of a theoretical text. Although it was made

clear from the start that theoretical discussions were more important than the actual product that was required, the group took their main task as producing a review. This product orientation was necessary in order to give ground to their efforts. Second, in order to facilitate the process at the level of course organization, it would have been possible for a tutor to provide more structure and task division. Participants have problems with focusing on both task organization and engaging in theoretical discussions at the same time. But it would be hard to organize the roles of individual participants during different phases of the process, as these roles are an outcome of the group process itself. Needs of learners change over time, and roles may develop as a function of that change. Third, these and other problems seem not to be at the level of motivation (at least for most participants) or even planning of tasks, but at the level of actually getting things done until they are finished. While the electronic communication mode was clearly slowing down this process, the main problem was collaboration itself, represented as a lack of explicit attention to goals and motives. The result of this was a lack of grounding of the discussion at these levels, which may have caused problems at the operational level.

Discussion

The studies that we presented showed a number of characteristics of electronic collaboration in CMC. Study 1 showed that participants in discussion forums engage in content-based discussion, that are explanatory rather than argumentative, individual contributions are not very much linked to one another, and showed that students do not often explicitly refer to each other's messages. Study 2 showed that the connectiveness of individual contributions can be affected by instruction, but that there was an important effect of the degree of grounding or familiarity of the content to be discussed. Study 3 showed that students tend to focus on planning and problem solving rather than on personal motives, which causes a lack of common ground, which in turn

renders the existence of individual differences in the amount, the timing, and the focus of individual contributions as problematic. Moreover, this focus on planning and problem solving did not result in efficient organization of the process. To put it bluntly: students did not effectively collaborate to reach their goals.

Electronic communication still is a new kind of activity for students in current education, and it seems to offer more possibilities for collaboration and learning. However, the development of effective collaboration takes time, but study 3 showed that more time does not lead to better collaboration. There are many things students need to learn in order to engage in fruitful discussions. It seems that most of these results are not due to characteristics of the electronic medium, but that the medium affords new ways of working for which participants lack the appropriate knowledge and skills.

The question now arises what can be done about that. We could explain to students that it is important to argue more, and to provide an "argumentation in electronic dialogue" course to help them acquire the skills needed. We can tell students to connect to previous messages and to explicitly focus on the topic and on coherence. One main problem is that in order to do that effectively, students need to understand the topic of discussion sufficiently. Traditional education does not get them even that far. We could explain to students that it is important to acknowledge and value each other's contributions, which may be new to them. But do we have the knowledge and time to train students that seem to be motivated enough, to assume responsibility for a complex group process, for which not everyone has the same expectations, in all skills required to carry out several subparts of the process? In addition, being open about your personal goals and motives is something that seems crucial for effective knowledge negotiation, but requires a level of group safety that is not found in ordinary university education. And, finally, the

requirement to monitor group processes is something that not many university students, nor their teachers, seem to be capable of (Veerman, Andriessen & Kanselaar, in press). It is obvious that these issues should be taken up at a more general level than that of a single course. There are more ways to collaborate, according to different goals, each requiring different skills to develop. It seems that education in general should more explicitly aim for developing students' insight into the constraints of different collaboration settings.

A Pedagogical Framework for Advancing Effective CMC

The system of secondary and higher education in most countries is not designed for meeting the needs of current and future learning. It functions as transmitting domain-specific content, within a strictly specified period, and compares learner results at the end of a period in terms of explicit evaluation marks. This system works as a selection mechanism rather than fostering learning. Any system that is designed for learning rather than selection must be able to allow flexible individual learning periods and should allow evaluation based on what individuals do rather than by comparing them (Versloot, 2000). In addition, current educational systems have severe problems with the incorporation of collaborative learning tasks. Evaluating learners on the basis of their performance in collaborative and/or project-based tasks is if not impossible, then at least imposes an additional workload on teachers, which far exceeds their regular hours.

Figure 6 is taken from a text by Stahl (2000) and depicts a tentative, and probably incomplete, framework of processes involved in learning as a process of collaborative knowledge building (Brown & Campione, 1994; Lave, 1991; Pea, 1993; Scardamalia & Bereiter, 1999). The diagram attempts to model the mutual (i.e., dialectical) constitution of the individual and the social as a learning process (Brown & Duguid, 1991; Lave & Wenger, 1991). Starting in the lower left corner, it shows the cycle of personal understanding. The rest of the diagram

depicts how personal beliefs that we become aware of in our activity in the world can be articulated in language and enter into a *social* process of interaction with other people and with our shared culture. This culture, in turn, enters into our *personal* understanding, shaping it with ways of thinking, motivational concerns and diverse influences. Personal cognition and social activity can only be separated artificially, as in a model like this designed for analysis.

The figure helps to understand the problem of current education from the viewpoint of learning processes: current education is designed (if anything) for personal understanding and not for social processes involved in knowledge building. The result is that, if one tries to implement a CMC based education course into regular education, one deals with participants that are used to learning for personal understanding and that have no experience with other processes involved in knowledge building.

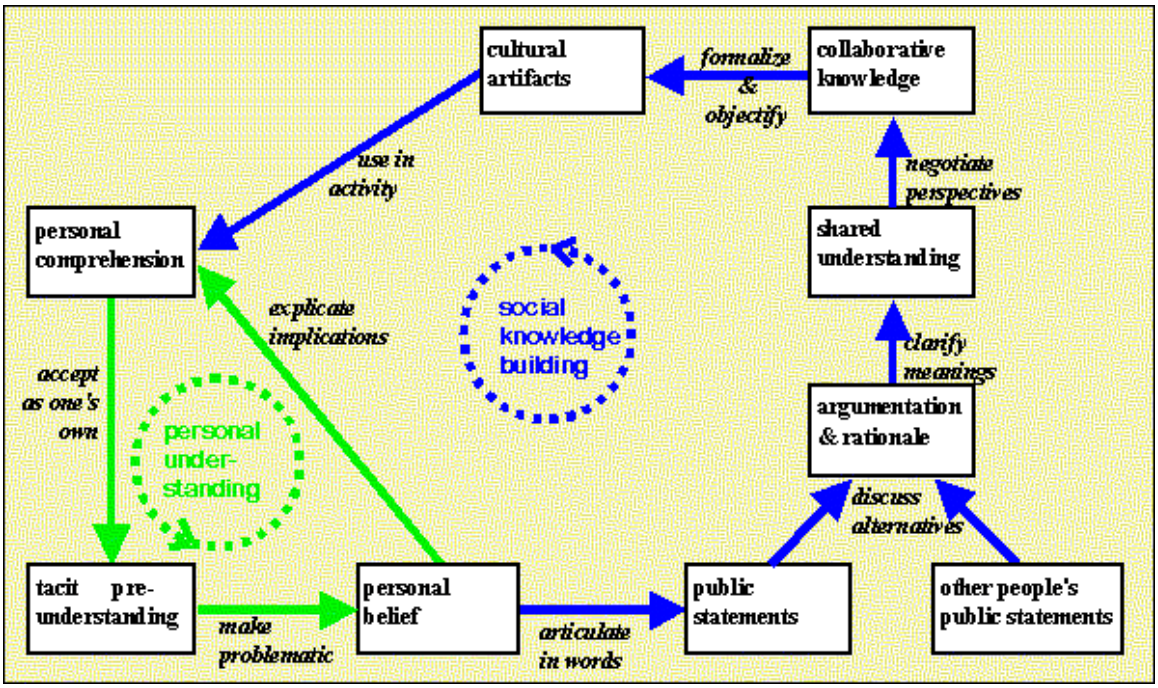


Figure 6: A diagram of knowledge building processes (Stahl, 2000)

What can be supposed is that CMC, given the appropriate and appropriated tools allows social knowledge building, something which traditional education can never achieve. Nevertheless, participants in current education work with the conceptions and expectations of traditional education, whilst more and more often being subjected to collaborative tasks and tools. This is a serious problem not easily overcome, and solving it involves all participants in educational activity, including the redesign of the curriculum. The redesign has as a goal to develop skills for personal understanding, shared understanding as well as for social knowledge building, which are interdependent process, but at the same time can be taken as the basis of a sequence of educational goals that each require advanced awareness about collaborative learning. The framework we are about to present describes three idealized scenarios for education to proceed through, starting from where education currently is supposed to be.

Pedagogic Scenarios

Andriessen & Sandberg (1999) have proposed three basic *pedagogic scenarios* that together represent important dimensions of pedagogic stances and choices. A pedagogic scenario describes an educational arrangement in which the conceptions of the users are characterized with respect to underlying pedagogic goals. These conceptions define the roles users (teachers and learners) play in a collaborative learning task. The idea that we develop here is that the three scenarios also constitute an evolution users should go through in order to become successful knowledge builders, characterized by the ability to engage in all processes depicted in figure 8. This evolution has to be educationally designed in order to change user conceptions. Conceptual change involves collaborative learning, and not domain knowledge and skills. Changing conceptions means making users aware of their roles during different types of collaboration, and those played by others, by designing specific collaboration arrangements. In such collaboration

arrangements, the concerted design of task, software environment and support aim at gradually increasing awareness of collaborative roles by appropriate experience and reflection. It should be noted that in order to reach these goals, more research about collaborative learning is very much needed.

Scenario 1: Transmission. This is the view that knowledge can be more or less directly transmitted to students through a system of lectures, textbooks and testing. This scenario reflects the production and transmission of universal, objective knowledge, and the diminishing of local, subjective, and personal knowledge (Ball, 1997). The transmission view most closely matches traditional education. Transmission scenarios favor closed assignments with criteria determined by the instructor. The ideal learning environment is one with an inspiring tutor teaching with clear demonstrations, expositions, narratives, arguments and examples. Collaboration between students is motivated by efficiency criteria: it will be used if a fixed learning result is attained faster or cheaper. Transmission is about achieving *personal understanding* of what experts mean.

Characterizing current education as knowledge transmission is not doing justice to the fact that in reality many different approaches exist, differing in goals, content matter and didactical strategy. Also, it is not clear whether transmission, as the transfer of expert knowledge from teacher and text to a student is the best way to develop personal understanding. It seems efficient to process large amounts of declarative knowledge from books by trying to understand the most important ideas in the text, and to be able to summarize them and to reproduce them on test occasions. Also, teacher feedback on these activities, on the basis of answers to questions or solutions to problems, seems an effective way of understanding what the teacher, as representative of the expert community, thinks as important. Cognitive learning theory is able to explain such learning quite well (Anderson, 1995). As long as the right conditions are created for

understanding information and producing explanations, it is possible that misconceptions are repaired and personal knowledge is transformed in order to incorporate new insights.

The problem with transmission is in the expectations of learners it generates, which make transmission unsuitable as an approach to collaborative learning. At best, in transmission, collaboration may support participants in trying to understand each other's ideas, by explanation and comprehension processes. Argumentation is mainly considered as a reasoning process, in which learners try to articulate strong and relevant arguments and warrants, to arrive at an approved conclusion. This 'best' is not very often achieved, as the results that were discussed in this chapter have shown. Learners expect answers from teachers, for almost every problem they encounter, and these problems are understood as problems of personal understanding. Someone who understands sufficiently does not need to collaborate. Learners do not develop collaborative learning skills because of this expectation, and because the transmission scenario does not include approaches and goals which treat collaboration as a serious vehicle towards acquisition of personal learning goals. In transmission, knowledge of collaboration is not sought for, and will for the most part be the result of modelling and learning by discovery.

However, the design of specific collaboration arrangements would be possible from a transmission perspective. In the sphere of transmission, such collaboration arrangements would be scripted, focusing on acquisition of domain knowledge (O'Donnell, 1999). Another characteristic of transmission-based collaboration would be its task-specificity, because the success of the collaboration in transmission depends on the attainment of domain-specific knowledge. This may be a reason why problems of transfer and authenticity typically occur in such scenarios (Laurillard, 1993; Petraglia, 1997; Bereiter, in press). Furthermore, one would expect such collaborations to be most successful for students that already have high domain

knowledge (Palincsar & Herrenkohl, 1999; Webb & Farivar, 1999).

Scenario 2: Studio. In a studio scenario users learn how to collaborate with others, by encouraging, scaffolding and critiquing each other, while at the same time sharing information in a safe environment. This should allow them to learn how to reach *shared understanding*. The main assumption here is that responsibility for learning should reside more with the student. The more constructive efforts a student undertakes, the more he will learn. In the current approach, students also need the skills to collaborate with the purpose of personal understanding of information. Now they should learn that different collaboration tasks may involve different forms of peer learning, and that participant roles in this process may require different skills.

In a studio, group tasks are designed for which it is necessary to collaborate with different partners for different reasons. Tasks could be: designing and carrying out a research project, preparing project presentations, evaluating research reports, or modifying a software environment (White, Shimoda & Frederiksen, 2000). Information is distributed between partners, and all information is necessary to accomplish the task. Some partners are more expert than others in certain areas, other partners are good at raising questions, others are good strategic advisors, or investigators, planners, reasoners, debaters, etc. This is what we mean by roles. Roles can be assigned, or users could choose their own role to play. Users learn to play roles, they have to learn which roles are useful for which task, they have to know their own strong and weak points in this respect, and they have to learn what it takes to play a role well. Finally, users have to be able to assess group performance, to be able to evaluate to what extent the collaboration between group members was successful, and how to improve on that.

Technology could provide a space where these activities can be carried out. Users should be able to work on task documents, organized around a possible sequence of subtasks (Schwarz

et al, in press). They need cognitive maps to display information in different ways (Suthers, 2001). They need a tool to organize their work. They need role advisors that propose what to say next and that may give strategic advice on demand (White et al., 2000). Finally, they need a metaphor for an environment in which all these activities can be authentically carried out. This could be a MOO-type environment, e.g. a building or town setting, in which artificial agents try to disturb or support collaboration. Educational design has to focus on finding innovative ways of promoting user reflection on their own communication, collaboration and learning in this environment.

Learning in a studio setting fosters development of metacognitive knowledge and domain-independent skills. One such a skill is argumentation. Argumentation in studio has to be taken as arguing to learn, not as learning to argue, as in transmission (Veerman, 2000; Andriessen, Baker & Suthers, in press). This eventually should lead to a student having acquired the flexibility of knowing how to learn in new situations. The role of instruction in this scenario is to provide tools and opportunities for learning, commenting and coaching, creating room for collaborative learning, interactive learning, providing feedback, supporting finding and evaluating information, creating flexible environments, and so on. Learning goals are still assumed to be fixed and well defined, and to be individual. Only the way to reach the learning goal is flexible and allows for student initiative in determining through which means the goal is to be reached.

Scenario 3: Negotiation. From a rhetorical perspective on academic learning, education can be framed as an ongoing argumentative process (Petraglia, 1997). It is the process of discovering and generating acceptable arguments and lines of reasoning underlying scientific assumptions and bodies of knowledge. From a socio-cultural perspective on education, students should

acquire practice and expertise in this activity, through sustained and, to some extent, guided efforts in meaning negotiation. However, little is known about what it takes to make such things succeed.

Negotiating implies individuals communicating and debating points of view in order to reach agreement or understanding. In a knowledge negotiation scenario, the focus is on producing *collaborative knowledge* during this process. The most important difference between studio and negotiation scenarios involves the change of focus from the individual as the learning entity in studio to the group as the learning unit in negotiation. This means that individuals in a negotiation scenario are supposed to assume responsibility for the functioning of the group as a whole.

Negotiation happens in learning groups engaged in knowledge building activities (Brown & Campione, 1994; Scardamalia & Bereiter, 1994; Bereiter, in press): creating new knowledge by sharing and negotiating content. All professional practices have found their current shape by long-term interaction and negotiation processes (Brown & Duguid, 1991). Participating in professional groups implies the ability to understand the important debates and problems and to use the right language to examine and influence ongoing discussion. Learning in the negotiation scenario essentially is learning to produce and comprehend discourse. The difference with seemingly similar activities in transmission is that discourse in negotiation is aimed at professional discourse, including its normative, social and political dimensions.

In a collaborative learning situation in a negotiation scenario, participants mutually support each other to produce ideas as much as possible. This requires a safe social environment that supports new knowledge constitution, and allows various organizations and inspections of old and new information. Support should focus on community building and knowledge building.

In addition, technology should work with community models, models in which various contributions are assessed and evaluated with respect to parameters of the effective sharing and creation of knowledge by the group. Users should have easy access to external information on the web, which comprises information of different quality and status. Storage and retrieval of information (knowledge management) is a crucial aspect of this process. All tool support has to be available on demand.

The Evolution from Transmission to Negotiation

When confronted with a negotiation scenario in a transmission context, both students and teachers may feel lost. Students complain about the vagueness of assignments and the lack of explicit guidance, whereas teachers complain about their lack of control of the learning situation. Apparently, the transition induced in such cases is too abrupt to be smoothly adopted by the students as well as the teachers. Therefore, we have to investigate the way students as well as teachers can be guided in a process of change, by gradually moving from transmission to negotiation.

The progress from knowledge transmission to knowledge negotiation can be taken as a gradual evolution during which mastery of a previous phase is required for moving to the next phase. Each phase has its own goals and learning results, and offers more possibilities for collaboration while at the same time requiring more insight into and experience with collaborative learning. Collaboration arrangements have to be explicitly designed to allow users to collaborate according to their pedagogic scenario, while at the same time making them reflect on further options allowed in the next phase. New educational design approaches are needed here. The further users advance towards knowledge building, the more constraints they are able to deal with, and the more responsibility and insight by users can be expected.

As an example, in a pioneering study on moving the teaching of proofs from a knowledge transmission scenario to a negotiation scenario (Schwarz, Neuman, Gil & Ilya, in press), designers, teachers and students first began to solve problems in geometry in a knowledge transition mode (without taking into consideration the motives of the learners). The teacher then moved to a studio mode by giving new activities (designed by a designer according to the teacher specifications) in which problem solving served as a device for being convinced of the correctness of conclusions. Teacher and students reflected then on what they did (to convince the other, to rise an ambiguity, to explain a surprise, etc.). Teachers and students interacted then with a designer for choosing new activities to understand more about proofs. The creation of new activities was in fact a process of modification to manipulate learners' motives and goals.

The study by Schwarz et al. (in press) was done with extraordinary teachers, though. Other preliminary studies indicate that in order to change conceptions about learning, teachers must be empowered through the help of designers who can translate intentions for specific learning scenarios into "real activities" and who can point out the constraints that some choices of tasks may put on the realisation of the curriculum. As suggested in Schwarz & Glassner (in press), in multiple cycles of curricula in which teachers and designers are engaged in the creation of series of activities, the activity of the teachers turn to be progressively more autonomous.

Conclusion

In this contribution we showed some of the characteristics of current electronic discussions in higher education. We think the discussions that we obtained rate among the more successful implementations of CMC in this context. Nevertheless, we feel much more can be achieved if a carefully designed approach to educational practice in terms of educational scenarios is implemented.

Our ideas as they have been presented still remain at the level of intentions. Even in transmission not much collaboration is designed in practice. In our descriptions of scenarios not all details of the complex processes students are engaged in are well known or enough articulated. Projects that test some of these ideas are underway, and when results appear, more detail can be provided.

The most important message of this chapter is that new learning has to be designed and needs more careful study. Changing educational practice has to be an engineered approach, in which goals change as a function of the scenario users are engaged in. If the goal of education is personal understanding, maybe any scenario will do as long as it is properly designed. Results in this case will depend on the appropriate interplay of individual and task situation characteristics. However, if the goal of education is shared understanding, transmission is not good enough. Design of learning arrangements in which awareness of collaboration is raised and encouraged are then a necessary requirement.

References

Anderson, J. R. (1995). Cognitive psychology and its implications.

Andriessen, J., Baker, M., Suthers, D. (Eds) (in press). *Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments*. Dordrecht: Kluwer.

Andriessen, J.E.B. & Sandberg, J.A.C. (1999). Where is Education heading and how about AI? *International Journal of Artificial Intelligence in education 10 (2)*, 130-150.

Baker, M. (1996). Argumentation and Cognitive Change in Collaborative Problem-Solving Dialogues. *COAST Research Report Number CR-13/96*, France.

Baker, M. (1999) Argumentation and constructive interaction. In: J. Andriessen and P. Coirier (eds.) *Foundations of argumentative text processing*. Amsterdam: Amsterdam University Press, pp. 179-202.

Baker, M., & Bielaczyc, K. (1995). Missed opportunities for learning in collaborative problem-solving interactions. In J. Greer (Ed.), *Proceedings of AI-ED 95 - 7th World Conference on Artificial Intelligence in Education* (pp. 210-218). Charlottesville: Association for the Advancement of Computing in Education (AACE).

Baker, M., Hansen, T., Joiner, R. & Traum, D. (1999). The role of grounding in collaborative learning tasks. In P. Dillenbourg (Ed.), *Collaborative Learning: cognitive and computational approaches* (pp. 31-63). Oxford: Pergamon.

Ball, G. (1997). Constructivism in educational technology. Unpublished paper, Dept. of Educational Sciences, Utrecht University.

Bereiter, C. (in press). Education and mind in the knowledge age. Mahwah, NJ: Erlbaum.

Brand, M. (1999). Leren als sociaal proces in een universitaire, CSCL omgeving.[Learning as a social process in academic CSCL situations]. Unpublished master's thesis, Utrecht University, The Netherlands.

Brown, A. & Campione, J. (1994). Guided discovery in a community of learners. In K. McGilly (Ed.) Classroom lessons:Integrating cognitive theory and classroom practice., Cambridge, MA: MIT Press, pp. 229-270.

Brown, J. S. & Duguid, P. (1991). Organizational learning and communities of practice: Toward a unified view of working, learning, and innovation. Organization Science 2 (1), pp. 40-57.

Clark, H. H. & Schaefer, E. F. (1989). Contributing to discourse. Cognitive Science, 13, 259-294.

Doise, W. & Mugny, G. (1984). *The social development of the intellect.* Oxford: Pergamon Press.

Erkens, G. (1997). *Coöperatief probleemoplossen met computers in het onderwijs: Het modelleren van coöperatieve dialogen voor de ontwikkeling van intelligente onderwijssystemen* [Co-operative problem solving with computers in education: Modelling of co-operative dialogues for the design of intelligent educational systems]. Utrecht, The Netherlands: Brouwer Uithof.

Goodfellow, R. & Manning, P. (1999, march). *Expert, Assessor, Co-Learner - Conflicting Roles and Expanding Workload for the Online Teacher.* Presented at CAL99. London.

Hansen, T., Dirckinck-Holmfeld, L., Lewis, R. & Rugelj, J. (1999). Using telematics for collaborative knowledge construction. In P. Dillenbourg (Ed.), *Collaborative Learning: cognitive and computational approaches* (pp. 169-196). Oxford: Pergamon.

Heeren, E. & Lewis, R. (1997). Selecting communication media for distributed communities. Journal of computer assisted learning, 13 (2), 85-98.

Kiesler, S. (1986). The hidden message in computer networks. *Harvard Business Review, 64* (1), 46-58.

Kuhn, D. (1991). *The Skills of Argument.* Cambridge: University Press.

Laurillard, D. (1993). *Rethinking university teaching: a framework for the effective use of educational technology*. Routledge, London.

Lave, J. (1991). Situating learning in communities of practice. In L. Resnick, J. Levine & S. Teasley (Eds.). Perspectives on socially shared cognition. Washington, DC: American Psychological Association, pp 63-83.

Lave, J. & Wenger, E. (1991). Situated learning: legitimate peripheral participation. Cambridge, UK: Cambridge University Press.

Leontiev, A. N. (1978). Activity, Consciousness, Personality. Englewood Cliffs, NJ: Prentice Hall.

Mason, R. (1991) Moderating Educational Computer Conferencing. DEOSNEWS 1 (19) (electronic periodical).

O'Donnell, A. M. & King, A. (Eds.) (1999). Cognitive perspectives on peer learning. Mahwah, NJ: Lawrence Erlbaum Associates.

Palincsar, A.S. & Herrenkohl, L. R. (1999). Designing collaborative contexts: Lessons from three research programs. In A. M. O'Donnell & A. King (Eds.) Cognitive perspectives on peer learning. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 151-178.

Pea, R. (1993). The collaborative visualization project. Communications of the ACM, 36 (5), pp. 60-63.

Petraglia, J. (1997). *The rhetoric and technology of authenticity in education.* Mahwah, NJ: Lawrence Erlbaum.

Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures*. New York: Viking Penguin.

Roschelle, J. & Teasley, S.D. (1995). Construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), *Computer-supported collaborative learning*. New York: Springer-Verlag.

Rutter, D. R. (1987). *Communicating by Telephone*. Oxford: Pergamon Press.

Savery J. & Duffy, T. M. (1996). Problem based learning: An instructional model and its constructivist framework. In B. Wilson (Ed.) *Constructivist learning environments: Case studies in instructional design* (pp. 135-148). Englewood Cliffs, NJ: Educational Technology Publications.

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the learning sciences, 3*(3), 265-283.

Scardamalia, M., & Bereiter, C., (1999). Schools as Knowledge Building Organizations. In: D. Keating & C. Hertzman (Eds.), Today's children, tomorrow's society: The Developmental health and wealth of nations. New York: Guilford., 274-289

Schwarz, B. B., & Glassner, A. (in press). The blind and the paralytic: fostering argumentation in social and scientific domains. In J. Andriessen, M. Baker, and D. Suthers (Eds.) Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments. Kluwer Academic Publishers.

Schwarz, B. B., Neuman, Y. & Gil, J., & Ilya, M. (in press). Construction of collective and individual knowledge in argumentative activity: An empirical study. To appear in the Journal of the Learning Sciences.

Short, J., E. Williams, and B. Christie (1976). *The social psychology of telecommunications.* New York: Wiley.

Smith, J. B. (1994). Collective intelligence in computer-based collaboration. Hillsdale, NJ: Lawrence Erlbaum.

Spears, R. & Lea, M. (1992) Social influence and the influence of the social in computer mediated communication In: *Context of computer mediated communication*. Ed: Martin Lea, Bodmin, Great Brittain.

Stahl, G. (2000). A Model of Collaborative Knowledge-Building. Available at: http://orgwis.gmd.de/~gerry/projects/communications/model/model.html

Steeples, C., Unsworth, C., Bryson, M., Goodyear, P., Riding, P., Fowell, S., Levy, P., & Duffy, C. (1996). Technological support for teaching and learning: Computer-mediated

communications in higher education (CMC in HE). *Computers & Education, 26* (1-3), 71-80.

Suthers, D. D. (2001). Towards a systematic study of representational guidance for collaborative learning discourse. Journal of Universal Computer Science, 7, 3, 254-277.

Tolmie, A. & Boyle, J. (2000). Factors influencing the success of computer mediated communication (CMC) environments in university teaching: a review and case study. Computers & Education 34, 119-140.

Van de Groep, J. A. H. (2000). OnderhandelingsOnderwijs: rollen van studenten in een elektronische discussie. [Negotiative Education: roles of students in an electronic discussion] Unpublished Masters Thesis. Dept. of Educational Sciences, Utrecht University.

van der Pol, J. (1998). Argumentatie in elektronisch gevoerde discussies en het effect van verschillende manieren om een discussie op te zetten [Argumentation in electronic discussions and effects of different ways of designing them] (Internal report). Department of Educational Sciences, Utrecht University.

van der Pol, J. (2001). Aansluiten in electronische discussies [Connecting in electronic discussions] Unpublished Masters Thesis. Dept. of Educational Sciences, Utrecht University.

Veerman, A.L. (2000). Computer-supported collaborative learning through argumentation. Print Partners Ipskamp: Enschede. Available at: http://www.library.uu.nl/digiarchief/dip/diss/1908992/inhoud.htm

Veerman, A. L. (in press). Constructive discussions through electronic dialogue. . In J. Andriessen, M. Baker, and D. Suthers (Eds.) Arguing to Learn: Confronting Cognitions in Computer-Supported Collaborative Learning environments. Kluwer Academic Publishers.

Veerman, A.L., Andriessen, J.E.B. & Kanselaar, G. (2000) Enhancing learning through synchronous discussion. *Computers & Education, 34*(2-3), 1-22.

Veerman, A.L., Andriessen, J.E.B. & Kanselaar, G. (in press). Question asking and collaborative argumentation in academic education. Instructional Science.

Versloot, B. (2000). Een andere facilitering van de leerfunctie [A different facilitation of learning functions]. In: K. Stokking, G. Erkens, B. Versloot & L. van Wessum (Eds.), Van Onderwijs naar Leren [From Education to Learning] (pp. 299-312). Leuven/Apeldoorn: Garant.

Wan, D. & Johnson, P. M. (1994). Experiences with CLARE: A computer supported Collaboratoive environment. Proceedings of the 1994 ACM Conference on Computer Supported Work. Chapel Hill, North Carolina.

Webb, N. M. & Farivar, S. (1999). Developing productive group interactions in middle school mathematics. In A. M. O'Donnell & A. King (Eds.) (1999) Cognitive perspectives on peer learning. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 117-150.

White, B. Y., Shimoda, T. A. & Frederiksen, J. R. (2000). Facilitating students' inquiry learning and metacognitive development through modifiable software advisers. In S. P. Lajoie (Ed.) Computers as cognitive tools, vol 2 (pp. 97-132). Mahwah, NJ: Erlbaum.