UNIVERSITEIT GENT

FACULTEIT PSYCHOLOGIE EN PEDAGOGISCHE WETENSCHAPPEN

The impact of structuring tools on knowledge construction in asynchronous discussion groups

Bram De Wever

Promotor: Prof. Dr. Martin Valcke
Copromotor: Prof. Dr. Myriam Van Winckel

Proefschrift ingediend tot het behalen van de academische graad van Doctor in de Pedagogische Wetenschappen

2006

Voorwoord

Dit proefschrift had ik niet kunnen schrijven zonder de directe en indirecte steun van heel wat mensen. Eerst en vooral wil ik mijn promotor Martin Valcke en mijn copromotor Myriam Van Winckel bedanken. Zonder Martin was ik destijds nooit bij Myriam terechtgekomen voor een stage die het ontwerpen van een online asynchrone discussiegroepomgeving inhield. Zonder Myriam was ik nooit opnieuw bij Martin terecht gekomen om aan het doctoraatstraject te beginnen dat tot dit proefschrift heeft geleid. Myriam, bedankt voor alle hulp bij het organiseren van de discussiegroepen in de geneeskunde en voor de mailtjes om te vragen hoe het schrijven vlotte. Martin, bedankt voor je aanhoudend enthousiasme en je voortdurende ondersteuning doorheen de jaren dat ik aan dit proefschrift heb gewerkt.

Ik wil ook Filip Lievens, Yves Rosseel, Johan Van Braak en Lieven Verschaffel, die samen met mijn promotor en copromotor mijn begeleidingscommissie vormden, bedanken. Met z'n zessen hebben jullie mij van veel nuttige ideeën voorzien die hebben bijgedragen tot dit proefschrift. Bedankt voor de vele tips om de analysetechnieken te optimaliseren, voor de vele suggesties voor het rapporteren van het onderzoek en voor het grondig nalezen van alle hoofdstukken.

Jan Pauly wil ik bedanken voor het grondig controleren van de Engelse spelling en grammatica doorheen de verschillende hoofdstukken van dit proefschrift. Jan, bedankt voor al dit leeswerk.

En ten slotte mag ik in dit rijtje zeker Tammy Schellens en Hilde Van Keer niet vergeten. Bedankt teammaatjes! Jullie stonden doorheen mijn volledig doctoraatstraject altijd klaar om mee te denken, resultaten te bediscussiëren en stukken na te lezen en van feedback te voorzien. Op het eind kon ik bijna permanent op jullie rekenen om aanpassingen door te lezen en de lay-out na te kijken. Met jullie heb ik het samenwerkend leren ook in praktijk kunnen ontdekken. Tammy, bedankt voor de kritische blikken. Hilde, bedankt voor alle stimulansen.

Verder ben ik ook een woordje van dank verschuldigd aan de codeurs voor het nauwkeurig analyseren van de grote hoeveelheden data, aan mijn bureaugenoten voor de vele interessante – al dan niet wetenschappelijke – discussies en aan de collega's van de vakgroep onderwijskunde voor de formele en informele babbels. Het was leuk om met jullie samen te werken.

Er zijn ook heel wat mensen die me indirect hebben ondersteund. Mijn ouders, grootouders, broers en andere familieleden wil ik bedanken voor hun continue ondersteuning. Daarnaast zijn er ook heel wat vrienden die tijdens het schrijven aan dit proefschrift altijd voor me klaar stonden en bereid waren om m'n favoriete pizzeria te gaan bezoeken, een uitstapje naar de Ardennen, Elzas of Provence te maken, me uit te nodigen voor een barbecue, een babbeltje te slaan aan de koffieautomaat, een chili con carne te gaan eten (of voor me klaar te zetten), een smsje of belletje te doen om te vragen hoe het vlotte, ergens "een kleintje" te gaan drinken, of om na een lange dag werken ergens nog een pakje friet te gaan zoeken. Jullie steun werd en wordt echt geapprecieerd.

En last but not least wil ik Saskia bedanken, die het schrijven van dit proefschrift van dichtbij heeft meegemaakt en die altijd bereid was om naar mijn doctoraatsperikelen te luisteren en me aan te moedigen.

Bram De Wever
Gent, 8 september 2006

Contents

Chapter 1*

General introduction

Within the field of computer-supported collaborative learning (CSCL), both researchers and practitioners are engaged in a continuous search for the optimisation of the functioning and effectiveness of online learning environments. The present dissertation fits in with this quest for optimal instructional approaches and focuses in particular on the impact of structuring tools on knowledge construction in asynchronous discussion groups in the context of higher education. More specifically, the impact of assigning roles to students is studied in two different computer-supported collaborative learning settings.

This first chapter presents a general introduction to the studies reported in this dissertation and consists of two sections. In the first section, we focus on the learning environment under investigation. The specific application of asynchronous discussion groups in higher education is situated within the broader field of online learning and key theoretical concepts are discussed. First, we discuss the increasing interest in ICT and blended learning in higher education. Next, we study the assumptions of constructivism, which can be considered as the underlying theoretical background for the development of ICT-based learning environments, and especially helps us to pay attention to the educational practice of collaborative learning. Subsequently, we highlight the research area that arose from combining this instructional strategy with the use of technology, namely computer-supported collaborative learning (CSCL). After that, we focus on the potential value of online asynchronous discussion groups, being the specific CSCL-environments under study in the present dissertation. Finally, the first section is concluded with a discussion about knowledge construction in asynchronous discussion groups and with a review of the theoretical and empirical argumentation behind the notion that knowledge construction can be supported by structuring the communication in asynchronous discussion groups.

---

* Part of this chapter is based on:
Valcke, M., & De Wever, B. (2006). Information and communication technologies in higher education: Evidence-based practices in medical education. *Medical Teacher, 28,* 40-48.
De Wever, B., Valcke, M., Van Winckel, M., & Kerkhof, J. (2002). De invloed van “structuur” in CSCL-omgevingen: een onderzoek met on line discussiegroepen bij medische studenten [The influence of structuring CSCL-environments: A study of online discussion groups with medical students]. *Pedagogisch Tijdschrift, 27,* 105-128.

The second section of this first chapter focuses on the content and organisation of this dissertation. It starts off with describing the main aim of the dissertation, followed by a description of the research settings and the structuring intervention in the different settings. Furthermore, the concrete research questions are presented and related to the different chapters in this dissertation.

Theory and practice of asynchronous discussion groups

ICT and blended learning in higher education

During the last 25 years, there has been an exponential growth in the adoption of information and communication technologies (ICT) in education. Especially in higher education the implementation of ICT-based learning environments has been remarkable. Different applications of this technology have been reviewed in a recent article about evidence-based use of ICT in medical education (see Valcke & De Wever, 2006). With respect to the information component, ICT can be used to foster information presentation, organisation, and integration. With respect to the communication component, ICT can be applied to support the communication with teachers and experts on the one hand and the communication between students on the other hand. Furthermore, ICT is also of great value for the development of games, simulations, and assessment procedures.

Early implementations of ICT in education focused mainly on the information element and on the use by individual learners. Bernard and Lundgren-Cayrol (2001, p. 242) argue that “from its earliest application to education and training, the computer has been viewed as a medium best suited for delivering instruction to individual learners”. However, more recently the communication component received growing attention as well, resulting in more “social-oriented” applications. In this respect, Crook (2002) talks about the interpersonal significance of ICT and Hammond and Bennet (2002, p. 55) stress the relevance and potential of online group-based learning:

> The advent of information technologies means that many new teaching and learning techniques are now available. ICT has the potential of providing means for enhancing the variety or quality of group-based learning, whether through supporting traditional methods, extending them or replacing them with novel forms. Use of ICT to support group-based learning may be local or distant, and its timing may be before, during or after a face-to-face session, as well as a substitute. ICT may provide enhanced content materials for small-group

activities, discussion and simulation tools to support the learning process, or communication tools to facilitate the organisation of small-group activities.

As indicated by Hammond and Bennet (2002), the implementation of ICT in educational practice does not necessarily imply that educational institutions have to abandon their traditional methods based on face-to-face learning and instruction. Especially the idea of combining the best of two worlds has led to the development of a whole range of diverse blended learning environments in higher education. Most – if not all – universities and institutes for higher education all over the world implemented an online content management system, including facilities for the online distribution of knowledge content and online communication facilities. Since these systems are widely available and higher education courses often deal with an increased number of students, it is not surprising that blended learning is put more and more into practice. Blended learning can be considered as a mix of traditional and ICT-based delivery. “The term is commonly associated with the introduction of online media into a course or programme, while at the same time recognising that there is merit in retaining face-to-face contact and other traditional approaches to support students” (Macdonald, 2006, p. 2). This implies that ICT-based learning environments do not replace the face-to-face learning environments but are adopted as an addition or enrichment. Although blended learning is something of a hot topic nowadays, there is a need for guidelines and good practice examples with regard to the design of these blended learning environments. In this respect, information on how to organise the online components and integrate them in the traditional learning environment is especially needed (Macdonald, 2006).

Constructivism

The theoretical foundations for the design, development, and implementation of ICT-based learning environments are often based on constructivist principles. Constructivism and electronic learning environments go hand in hand. Kirschner (2001, p. 1) even argues that “the future (and even the today) of learning is constructivist design and development of collaborative and cooperative learning situations in powerful integrated electronic environments”. However, constructivism has many faces and the concept has become an umbrella term embracing a variety of views (Dougiamas, 1998; Duffy & Cunningham, 1996). Nevertheless, all parts of the complete patchwork called constructivism share one notion: knowledge is actively constructed by the learner. Cognitive constructivism focuses on individual psychological processes and on the learner as constructor

(Duffy & Cunningham, 1996). Knowledge is not passively transferred into a person, but mental models are expected to be constructed by the learner as a result of experience (Merrill, 1991). Social constructivism emphasises in addition the socially and culturally situated context of cognition (Duffy & Cunningham, 1996). This sociocultural approach draws on the insights of Vygotsky who argues that any higher mental function is first external and social before it becomes internal (Cobb & Yackel, 1996; Cook, 2002; Duffy & Cunningham, 1996; Vygotsky, 1978). It highlights that knowledge is constructed through social interaction with others. In this respect, Vygotsky introduced the concept of the zone of proximal development, which is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined by thorough problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Both Vygotsky's concept of the zone of proximal development and his believe that intellectual development takes place between people before internalisation support social constructivists' view that individual learning is socially mediated. This explains the value attached to dialogue and group learning in social constructivism (Reynolds, Sinatra, & Jetton, 1996; Zhu, 1998). In this respect, it is no surprise that contemporary ICT-based learning environments that are particularly based on the theoretical background of social constructivism build heavily on the communication component of ICT. Group settings can foster learning via questioning, criticism, and evaluation (Schrire, 2004) and "dialogue serves as an instrument for thinking because in the process of explaining, clarifying, elaborating, and defending our ideas and thoughts we engage in cognitive processes such as integrating, elaborating and structuring" (Pena-Shaff & Nicholls, 2004, p. 244-245). Moreover, through dialogue cognitive conflicts can rise – and eventually be resolved. Researchers use the concept of socio-cognitive conflict to take account of how understanding may be shifted by interacting with other learners that have a rather different understanding of events. The basic idea is that when two contrasting world views are discussed and shared, this is likely to stimulate cognitive restructuring and improved understanding resulting in learning benefits (Mercer, 1996).

In addition to the importance of dialogue and the fact that knowledge is constructed instead of transferred, some other characteristics are typical for social constructivism. Learning needs to be situated in realistic settings – often called rich contexts – that are, as in real-life, ill-structured, which means that there are no right answers (Brown, Collins, & Duguid, 1989; Kirschner, 2001; Spiro, Feltovich, Jacobson, & Coulson, 1992). In this respect, authentic tasks are advocated for by

Jonassen (1991, p. 29): “authentic tasks are those that have real-world relevance and utility, that integrate appropriate levels of complexity, and that allow students to select appropriate levels of difficulty or involvement”.

To conclude, from the social constructivist point of view learning can be considered as constructing knowledge, active, situated, and collaborative, i.e. meaning is negotiated from multiple perspectives (Merrill, 1991).

Collaborative learning

Taking into account the strong theoretical emphasis on dialogue and group learning in the social constructivist learning theory, collaborative learning is often presented as a key instructional strategy in which “learning occurs in collaboration with others” (Das, 1995, p. 94). Dillenbourg (1999, p. 1) argues that collaborative learning “is a situation in which two or more people learn or attempt to learn something together”. Both definitions are rather broad but they do point at the most important aspects of collaborative learning (italicised by Dillenbourg). In this respect, a large variety of group learning strategies described in the literature are called collaborative learning. However, the same strategies are often called cooperative learning as well. In order to study a comprehensive picture of both concepts and find out the complete body of ideas behind these group learning strategies, the literature was explored. Since there is a lot of confusion about the distinction between collaborative learning and cooperative learning, we start by discussing their differences and similarities. On the one hand the terms collaborative learning and cooperative learning are often used interchangeably (Sener, 1997) while on the other hand, as the different names imply, they seem to point at different characteristics. However, it is not always clear what the difference really is. In order to unravel the diverse approaches, the differences are presented in the next paragraphs.

According to Sener (1997) “sometimes a distinction is made between the two based on the age of the learners served and some practitioners contend that there are important differences between the two based on the unique pedagogical needs of each corresponding age group”. In this case, cooperative learning is related to primary and secondary education; whereas collaborative learning is related to college, university, and adult education (Sener, 1997). Bernard and Lundgren-Cayrol (2001, p. 243) argue that since collaborative learning focuses more on attempting “to capitalize upon the learner’s own intrinsic motivation to participate in learning with others, … [it] is viewed as an approach that is more appropriate for adult learners than cooperative learning, largely because of the freedom / responsibility that is afforded them".

Another difference often mentioned is related to their philosophical roots. According to Henri and Rigault (1996, p. 48) collaborative learning is "an approach rooted in theories and philosophies propounded by certain sociologists, like Karabel". According to Panitz' (1996; 1997) view, collaborative learning has British roots and is based on the work of teachers who tried to stimulate students to take a more active role in their own learning; while cooperative learning has American roots and is based on "the writings of John Dewey stressing the social nature of learning and the work on group dynamics by Kurt Lewin" (Panitz, 1996).

Besides the different roots, Panitz (1996; 1997) makes another distinction. He defines cooperation and collaboration as follows: "cooperation is as structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups" and "collaboration is a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and contributions of their peers" (Panitz, 1997). In this way, the focus of collaboration is on the process of working together, whereas the focus of cooperation is on the product of such work (Panitz, 1996). This corresponds to the view of Kirschner, Dickinson, and Blosser (1996) based on the American Heritage Dictionary (1992) that cooperation equates with working together toward a common end or purpose; while collaboration is working in a joint intellectual effort. In the same way, "the cooperative learning tradition tends to use quantitative methods which look at achievement: i.e., the product of learning. The collaborative tradition takes a more qualitative approach, analyzing student talk in response to a piece of literature or a primary source in history" (Panitz, 1996).

Another difference is related to the nature of the task structure. Hooper (1992) identifies two kinds of tasks: (a) collaborative tasks that require each student to participate parallelly and (b) tasks that require students to work independently on subtasks (task specialisation). According to some authors, cooperative learning refers to situations in which a task is split up in advance into different components. These different components can be solved independently by the partners and can be assembled at the end to produce the final product (Curtis & Lawson, 2001; Dillenbourg & Schneider, 1995; Henri & Rigault, 1996). On the contrary, collaborative learning refers to situations where students solve the whole task together and participate parallelly (Curtis & Lawson, 2001; Dillenbourg & Schneider, 1995; Henri & Rigault, 1996). According to Henri and Rigault (1996, p. 49), the collaborative learning approach results "in underscoring the importance of mutuality in accomplishing the task”. Taking into account the distinction based upon task structure, Curtis and Lawson (2001) note that it is clear that some authors, like Johnson and Johnson (1996), use the term cooperative learning to describe learning environments that can be regarded as forms of collaborative.

Concerning the task, Strijbos and Martens (2001) make the following distinction: the cooperative approach is using well-structured tasks with limited solutions, while the collaborative approach aims at negotiation and/or synthesis tasks, which are ill-structured tasks, with multiple solutions and an open ending. Collaborative learning assumes that “the ‘correctness’ of an answer or solution is seldom absolute” (Bruffee, 1995). To illustrate the difference, we quote Bruffee (1995):

> … take physics as an example, working out a typical problem-set question, such as the formula for determining acceleration under specified conditions, while it could be a cooperative-learning assignment, would not be a task assigned for collaborative learning. Instead, the collaborative-learning task might be to describe two or three different ways of determining accelerations, decide which is likely to be the best way, and explain why ...

In addition to a difference concerning the task, Strijbos and Martens (2001) put forward two other dimensions at which a difference between cooperative and collaborative learning exists: the goal and the level of pre-structuring. The cooperative approach is appropriate for teaching closed skills, skills that are relatively fixed, while the collaborative approach is focusing more on open skills, like argumentation and negotiation (Strijbos & Martens, 2001). The quote of Bruffee suggests a similar distinction. Concerning the level of pre-structuring (e.g. task division, communication protocols) the cooperative approach imposes a high level and the collaborative approach a low level of pre-structuring (Strijbos & Martens, 2001).

In this respect, some authors see collaborative learning as a broader, more general concept covering multiple approaches based on peer collaboration, amongst which for example reciprocal teaching and cooperative learning (Meloth & Deering, 1999). In this view, “cooperative learning can be regarded as a more-structured, hence more-focused, form of collaborative learning” (Millis & Cottell, 1998, p. 4). Collaborative learning strategies are less specific and not easy to define, since they include a broad scope of strategies that are not necessarily systematic or prescriptive (Rose, 2002). Another related view is that both approaches lie on a continuum, “with collaborative learning being the least structured and cooperative learning the most structured" (Millis & Cottell, 1998, p. 7; see also Flynn & Klein, 2001). In general we can conclude that collaborative learning is less structured (Henri & Rigault, 1996; Millis & Cottell, 1998; Bernard & Lundgren-Cayrol, 2001; Flynn & Klein, 2001) and less teacher-centred, leaving greater autonomy for the students (Henri & Rigault, 1996; Flynn & Klein, 2001).

Notwithstanding the differences, "collaborative and cooperative learning share a large number of assumptions and areas of agreement" (Kirschner, 2001, p. 4). Strijbos and Martens (2001) argue that there are more similarities than differences. Bruffee (1995) argues that "cooperative learning and collaborative learning are two versions of the same thing" and that "their long-range goals are strikingly similar". Furthermore, both approaches share a sense of community and share a belief that learning is an active, constructive process (Millis & Cottell, 1998).

It appears that the literature does not provide a single unequivocal definition of collaborative learning. In this respect Davies (2006) argues that

> Definitions of collaborative learning differ, but the following concepts tend to be important: learning together and building an emerging pool of knowledge, learning from each other, working in partnership, creating learning communities, shared responsibility for product or outcome, sharing information and opinions, negotiation of roles, methodology, task and assessment. Not all collaborative learning experiences involve all of the above aspects; many may not have a shared product, and students often do not negotiate the task or its assessment.

Although we agree with this broad description, we want to make clear how the group learning under investigation in the present dissertation is related to the above-mentioned differences between collaborative and cooperative learning. In this dissertation, the term collaborative learning was opted for. We agree with Dillenbourg (1999) that collaborative learning is a situation in which two or more people learn together. The situations in which group learning takes place should be authentic. As mentioned above when discussing constructivism, these learning contexts are ill-structured and therefore are rather collaborative than cooperative. Moreover, we believe that learning together does imply that students go through all learning processes together and do not divide tasks in subtasks that are solved independently. In addition, this means that the focus is more on the process than on the product. These two characteristics are more in line with the collaborative than the cooperative approach to group learning.

Computer supported collaborative learning (CSCL)

As networked computers are ideal to support communication processes, it is not surprising that these tools lend themselves very well to support collaborative learning. Bernard and Lundgren-Cayrol (2001, p. 246) claim that “one consequence of the dramatic rise of computer-based communication technologies in recent years has been the transformation of the use of the computer in education, away from its original roots in individualized instruction, into a tool for facilitating group interaction (Beaudoin, 1990)”. In the early nineties, a new area of study emerged focusing on the practice of using ICT to support collaborative learning and on the study of how collaborative learning can be enhanced by this technology. At first, the acronym CSCL was used for computer support of cooperative learning. However, since cooperative learning has a specific meaning (see above) it was changed to computer support for collaborative learning or computer supported collaborative learning (Koschmann, 1994).

Koschmann (1994) puts forward three dimensions by which CSCL applications can be categorised: location, time, and intended instructional role. With regard to location, CSCL applications can be used in classrooms, across classrooms, and outside the classrooms. Concerning interaction, the CSCL applications can be synchronous (all participants working at the same time) or asynchronous (participants working in their own time on the tasks). In relation to the instructional role, the technological applications could be simulating problems, mediating communications, archiving group work, or supporting representations (Koschmann, 1994).

Although computers are often used within classrooms to support (collaborative) learning, the most revolutionary part of CSCL is to be found in situations where learners are not physically in the same location. This is occasionally referred to as anywhere learning, since students do not necessarily have to come to campus to engage in collaborative learning situations. If this is combined with the asynchronous interaction modus, it even can be called anytime anywhere learning. In this case, learners are not only released from the obligation to be in the same location, but also from the obligation to interact at the same time. In this respect, students are provided with viable choices in when and where they wish to study (Pitman, Gosper, & Rich, 1999).

Online asynchronous discussion groups

In CSCL-environments, online asynchronous discussion groups take a central place. These are known as Computer Mediated Conferencing (CMC), Computer Mediated Discussion (CMD), Computer Conferencing (CC), Networked Learning (NL), or Asynchronous Learning Networks (ALN). In spite of this conceptual variety, most environments have in common that students exchange messages with one another through computers. Next to email, discussion boards are the most commonly used tool in this context (De Wever, Schellens, Valcke, & Van Keer, 2006).

Next to the fact that asynchronous discussion groups can be used to integrate several more isolated curriculum components (e.g. work placements) within the rest of the curriculum (Hagdrup et al., 1999; Stromso, Grottum, & Hofgaard Lycke, 2004) and the fact that integrating ICT gives students the opportunity to get acquainted with essential technologies in order to keep up with the rapid growth of knowledge (Hagdrup et al., 1999), the literature presents a number of advantages of discussing asynchronously.

First, as discussed above, asynchronous discussion groups are independent of time and location, increasing accessibility, opportunities for interaction, and educational flexibility (Bernard & Lundgren-Cayrol, 2001; Hew & Cheung, 2003). The asynchronous nature of participation removes time and space restrictions (Mason, 1992; Hara, Bonk, & Angeli, 2000). Students are able to contribute to the discussions at a time that is convenient for them (Tiene, 2000; Pena-Shaff, Martin, & Gay, 2001; Gilbert & Dabbagh, 2005; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). Moreover, Cecez-Kecmanovic and Webb (2000, p. 73) argue that "by enabling social interactions via an electronic medium, unrestrained by space, time and pace, web technologies actually expand and transform the social interaction space of collaborative learning". Markel (2001) even mentions that online asynchronous discussions do not just redistribute the shares of a constant communication time pie, but they increase the size of the pie.

Second, asynchronous discussions provide students with extra time to reflect, think, and search for additional information before contributing to the discussion (De Wever et al., 2006; Pena-Shaff & Nicholls, 2004). Aviv (2000, p. 53) puts it like this: "the ALN is cooperative learning enhanced by extended think time". Learners feel they are more in control. They have more time to consider the content and wording of a contribution and more opportunities for reflective learning and to process information by the increased wait-time (Bernard & Lundgren-Cayrol, 2001). Since learners have more time to read, reflect, write, and revise their ideas, asynchronous discussions are found to encourage more thoughtful and reflective discussions (Davidson-Shivers, Muilenburg, & Tanner, 2001; Gilbert & Dabbagh, 2005; Hara et al., 2000; Hew & Cheung, 2003; Hmelo-Silver, 2002; Murphy, Drabier, & Epps, 1998; Tiene, 2000).

Third, online asynchronous discussions “are likely to be more egalitarian than face-to-face discussions” (Kiesler, 1992, p. 155), as they mask social cues, cultural differences, and cues indicating status (Kiesler, 1992; Pena-Shaff et al., 2001). Since online asynchronous discussions provide equal access to communication (Murphy et al., 1998) and can break down social barriers (Hew & Cheung, 2003) they are referred to as more democratic than their face-to-face counterpart. Mason (1992) also argues that the focus is more on the message than on the writer. Tiene (2000, p. 375) furthermore argues that students feel “less inhibited about being controversial or confrontational”.

Fourth, all exchanges of information between students are stored in the discussion transcripts (De Wever et al., 2006; Mason, 1992; Weinberger et al., 2005). “These transcripts are like a footprint of the collaborative learning process, a footprint which is not so visible when the interactions occur face to face” (Cecez-Kecmanovic & Webb, 2000). This permanent record of students’ thoughts can be used for later reflection and debate (Hara et al., 2000). In addition, students’ development can be tracked and the transcripts can serve as data for research in order to determine the factors assisting in the development of learning communities (De Wever et al., 2006; Hara et al., 2000; Meyer, 2004).

Despite the numerous advantages, the literature also reports disadvantages that should be overcome when introducing online asynchronous discussions. The first barrier is the unequal access to hardware and software (Murphy et al., 1998). However, currently most universities have put extra effort to provide their students with the necessary equipment. Another difficulty that has to be conquered is the possible overload of information (Bernard & Lundgren-Cayrol, 2001; Hara et al., 2000; Murphy et al., 1998; Tiene, 2000). In this respect, Bernard and Lundgren-Cayrol (2001) argue that the numbers of messages that must be handled by students can quickly become burdensome or overwhelming. Therefore, a good organisation of the messages is necessary since ill-organised discussion threads can get students confused (Murphy et al., 1998). In addition, there is the risk that students get off topic (Tiene, 2000) or tend to express extreme opinions and anger more openly in electronic communication, which is called flaming by Kiesler (1992).

Next, the asynchronous nature has its drawbacks for the discussion speed. Asynchronous discussions require more time to accomplish the tasks and to reach consensus (Bernard & Lundgren-Cayrol, 2001). It is also more difficult to establish a leadership role, to get to know other group members, and to resolve misunderstandings that might occur (Bernard & Lundgren-Cayrol, 2001). The lag-time is also responsible for a delay of immediate feedback or communication (Hara et al., 2000; Vonderwell, 2003).

Another challenge when introducing asynchronous discussion groups is to overcome the occurrence of active listeners – learners who read messages but do not respond (Hara et al., 2000). They are often called lurkers or free riders (Graham, Scarborough, & Goodwin, 1999; Hara et al., 2000). When group members perceive free riding they may reduce their individual effort. This is known as the sucker effect (Hooper, 1992). In this respect, Graham et al. (1999, p. 40) argue that "care needs to be taken to make the groups small enough to avoid free riding while maintaining sufficient numbers to ensure a critical mass for active discussion".

Lastly, one of the most often mentioned disadvantages of online asynchronous discussions is the lack of visual communication clues (Hara et al., 2000; Murphy et al., 1998; Pena-Shaff et al., 2001; Tiene, 2000). This drawback is directly related to the sole reliance on text-based communication. According to Pena-Shaff et al. (2001), it can cause inefficiency and misinterpretations and it can disrupt the natural flow of the discussion and remove it from its logical context. However, Tiene (2000) claims that although students recognise this disadvantage, they do not see it as a major problem. According to Tiene (2000) this was due to the fact that the discussion groups he studied were part of a blended learning environment, which means that students also met each other face-to-face in class. Another factor may have been that the type of communication (information-based and theory-oriented) was not really demanding (compared to discussions focusing on exchanges of a personal nature).

Ellis (2001) gives an overview of advantages and disadvantages that were reported by students in her research. It seems that the most occurring (dis)advantages are congruent with the most reported (dis)advantages found in the literature. The five advantages that were listed the most by students were respectively: (1) it is convenient in time and place, (2) it is more equitable – especially for quieter students – more students participate, (3) details of the discussion remain – one can backtrack and reread a message, (4) allows the more reflective thinking student to participate more, and (5) the asynchronous nature allows for a more considered response. The four most listed disadvantages were respectively: (1) it wasn't possible to read face-to-face nuances such as body language, (2) it took away the features of conversation (e.g. immediacy of response, interactivity), (3) it was difficult to get an indication of depth of feeling or a person's response, and (4) some students relied on others to post.

Knowledge construction in asynchronous discussion groups

Gilbert and Dabbagh (2005, p. 6) claim that "an important instructional benefit of asynchronous communication is its potential to support the co-construction of knowledge". Collaborative learning is seen as a process leading to the social construction of knowledge (Mueller & Fleming, 1994; Verdejo, 1996) and asynchronous discussion groups are especially suited to support collaborative learning. Therefore, this form of CSCL can be regarded as an appropriate social constructivist learning environment.

Discussing online requires deeper thinking about the message you want to send. Students are stimulated to improve their writing, communication, and organisation skills given that they need to articulate their ideas in the discussion carefully (Bernard & Lundgren-Cayrol, 2001; Tiene, 2000). Pena-Shaff et al. (2001, p. 42-43) claim that the need to articulate an argument in online discussion

> forces participants to put their thoughts into writing in a way that others can understand (Koschmann, Kelson, Feltovich, & Barrows, 1996; Valvacich, Ennis, & Connolly, 1994). This helps to promote self-reflective dialogue as well as dialogue with others who read, react, and reply to the ideas posted by others, creating a forum for the creation of knowledge (Gay, Sturgill, Martin, & Huttenlocher, 1999; Pena-Pérez, 2000). Finally, the introduction of CMC in the educational process helps in preparing students for the workforce by providing them a broad range of experiences in using communication technology, working collaboratively, thinking critically, and improving writing skills (Fabos & Young, 1999).

In general, asynchronous discussion tasks are believed to increase student responsibility and self-discipline (Pena-Shaff et al., 2001). In these learning environments, students can work together, achieve shared understanding, and collaboratively solve problems (Cecez-Kecmanovic & Webb, 2000). Rourke and Anderson (2002, p. 3) argue that discussion is an excellent activity for supporting the co-construction of knowledge, since explaining, elaborating, and defending one's position to others "forces learners to integrate and elaborate knowledge in ways that facilitate higher-order learning". By supporting each other, students are more likely to achieve goals that they may not have achieved on their own (Vonderwell, 2003).

Knowledge is socially constructed through a variety of activities. Researchers developed taxonomies to identify and organise these activities (see also preliminary question 1). Most taxonomies list activities such as sharing information, questioning and answering, elaborating, clarifying, exploring disagreement, commenting, negotiating meaning, consensus building, evaluating, summarising, explaining, and applying constructed knowledge. In chapter 2 we elaborate on different taxonomies.

Supporting knowledge construction by structuring asynchronous discussion groups.

Weinberger et al. (2005, p. 10) claim that “the main idea of collaborative knowledge construction in text-based computer-mediated communication is, that learners engage in more active, reflective, and socially supported knowledge construction” and that “text-based computer-mediated communication may be a suitable context for learners to jointly explore complex problems by contributing their individual perspectives in order to acquire knowledge”. However, they also claim that collaborative knowledge construction in asynchronous discussion groups may need additional support.

Research indicates that knowledge construction activities in online collaborative groups are influenced by the design and organisation of the learning environment (Lockhorst, Admiraal, Pilot, & Veen, 2002). It is important to thoroughly design and structure asynchronous discussions, as structure is valuable to trigger meaningful discourse (Gilbert & Dabbagh, 2005; Weinberger et al., 2005). In this respect, a pilot study demonstrated that higher levels of knowledge construction were reached when more structured tasks were offered (De Wever, Valcke, Van Winckel, & Kerkhof, 2002).

Collaborative learning environments are usually equipped with a certain amount of structure, because simply grouping individual students does not guarantee that students will actively participate in the activity nor it is guaranteed that it will bring about effective interaction or collaborative learning (Vonderwell, 2003; Weinberger et al., 2005). Or, as Dillenbourg (2002, p. 61) puts it: “free collaboration does not systematically produce learning”. Asynchronous discussion groups can be structured by introducing specific goals, task types, task prescripts, or forms of structuring. Dillenbourg (2002) argues that collaboration can be influenced by structuring the collaborative process in order to favour the emergence of productive interactions. Structuring or scripting learning environments is found to improve collaboration (Pfister & Mühlpfordt, 2002). A script (the term is actually borrowed from the theatre world) specifies the roles and the nature and timing of the activities of the participants (O'Donnell & Dansereau, 1992). In this respect, a script can be considered as a more or less rigid scheme according to which the collaboration proceeds (Pfister & Mühlpfordt, 2002).

Providing structure can be seen as a form of scaffolding for students to get started in authentic activities. Assistance by means of scripts can be faded in or out whenever needed. When students have integrated the discussion behaviour underlying the scripts into their own functioning and have gained more self-confidence, competence, and control, they move into a more autonomous phase of collaborative learning and probably need less structure, scaffolding, or support (Brown et al., 1989). Adding structure can also be considered from the social constructivist point of view as a way to mediate between the proximate zones of development as discussed earlier in this chapter.

The concept 'script' can be regarded as a collective term, covering a whole range of concrete approaches. Scripts can be imposed by the instructor – either personally or through a computer program (Weinberger, Fischer, & Mandl, 2002) – or can be self-generated by the participants (O'Donnell & Dansereau, 1992). Furthermore, the level of detail of scripts can vary. General scripts – or macro scripts – only provide an overall structure. Dillenbourg (2002) talks in this respect about the degree of coercion. An example of a general script is "a discussion group, moderated by a teacher who tries to structure the discussion along a sequence of specific phases, e.g., brainstorming, critique, and summary" (Pfister & Mühlpfordt, 2002, p. 1). More specific scripts – which we call micro scripts – impose a highly detailed structure. They prescribe in detail what actions should be undertaken and in which order. Such a script for example requires students to identify the type of each contribution or predetermines a specific sequence of contributions (Pfister & Mühlpfordt, 2002; Weinberger et al., 2005).

Within the field of face-to-face collaborative learning, a number of well known scripts have been developed: student team learning, jigsaw, learning together, and group investigation (for an overview see Slavin, 1989). Recently, the idea of implementing scripts to guide collaborative learning has been adopted within computer-supported settings. The interest in using scripts to specify, sequence, and assign collaborative learning activities (Kollar, Fischer, & Hesse, 2003) is growing in view of improving the design of CSCL-environments (Weinberger et al., 2005).

Purpose and organisation of this dissertation

As mentioned at the beginning of this chapter, the main aim of this dissertation is to study the impact of supporting knowledge construction in asynchronous discussion groups in higher education. More in particular, in our studies one specific type of scripting is scrutinised: the assignment of roles to group members. The impact of the introduction of roles on the social knowledge construction in asynchronous discussion groups is studied in two different research settings. In addition, the surplus value of the introduction of self-assessment to enhance knowledge construction was examined in one particular study. In the next part, we successively consider the different research settings, the structuring intervention in these settings, and the main research questions studied throughout this dissertation.

Research settings

The impact of supporting knowledge construction is studied in two different settings. Both are higher education contexts, but they differ with regard to the knowledge domain and the age and study experience of the students.

Medical school setting

The first research setting was situated in the knowledge domain of the medical sciences. More specifically, asynchronous discussion groups were introduced during a clinical rotation in paediatrics of sixth-year medical students at Ghent University. Every month five student-interns rotated at the paediatric ward and during their rotation they were involved in the discussion groups. At the Ghent University Hospital, all student-interns meet weekly for case-based face-to-face discussion groups, guided by a staff member. During these discussions the students present patient problems to their peers, who interactively try to define the patient problem and explore the history, clinical examination, differential diagnosis, and therapeutic options. Since interference with ward-based activities and staff-schedules made the expansion of face-to-face contacts impossible, online asynchronous case-based discussion groups were introduced in order to meet students' and staff's wishes for extra discussions focusing on patient management and therapeutic options. Although both collaborative approaches run in parallel, the online discussions differ from the face-to-face discussions. While the face-to-face discussions focus on the diagnostic process and start from the patients' presenting problem, the main goal for introducing the case-based asynchronous discussion groups was to enhance reflection and critical thinking on patient management. The asynchronous e-discussions focus on treatment options and informing the patients or family members. They start from a complete case description with a given diagnosis, based on real-life cases. The content of the cases stimulates students to learn collaboratively, to reflect, and to use electronic information resources.

Educational sciences setting

The second research setting was situated in the knowledge domain of educational sciences. More particularly, asynchronous discussion groups are organised within the first year course Instructional Sciences. This course has a blended educational design. Next to face-to-face sessions, the learning environment is enriched with an online asynchronous discussion environment (Schellens & Valcke, 2000). The discussion groups were organised in addition to the weekly face-to-face sessions to promote the exchange of ideas and the construction and validation of knowledge by social negotiation and debate on the theoretical concepts dealt with in the course and the course manual. Students were divided at random into discussion groups of 10 persons.

By confronting students with authentic tasks, the processing of the new learning content is fostered and an active discussion of the different concepts presented in the course is promoted. Each group of students discussed four successive authentic tasks lasting three weeks each. Group composition remained the same during the complete semester. The authentic tasks are based on four themes that corresponded to four chapters of the course, namely behaviourism, cognitivism, constructivism, and evaluation and assessment.

Shared characteristics

In both settings, participation in the discussion groups was obligatory and was a formal part of the course. Students were evaluated by university staff members and participation to the discussions represented 25% of the final score. In both settings, students were required to contribute at least four messages per discussion.

The discussion groups were designed with Web Crossing (http://webcrossing.com/). This environment allows users to receive an outline of the discussion thread and to track individual students' input. Due to the specific nature of discussing in a CSCL-environment an introductory session was organised for each group prior to the onset of the discussions, focusing on clarifying the aim of the discussions, the specific planning of the different discussions, the technical issues of the CSCL environment, and the evaluation criteria. In order to ensure that students became familiar with the online discussion approach and the technology, a trial discussion session was organised for each group.

Supporting knowledge construction

The introduction of roles as a structuring tool

Scripts or structuring tools can specify, sequence, and assign collaborative learning activities in online learning environments (Kollar et al., 2003). In the research reported in this dissertation a specific type of scripting is studied, namely the assignment of roles. Roles are assigned to group members in order to support the process of social negotiation in the asynchronous discussion groups. Roles are seen as important factors in determining the quality of knowledge construction in a community (Aviv, Erlich, & Ravid, 2003). They compel students to focus upon their responsibilities in the discussion group and on the content of their contributions. Furthermore, research revealed that roles appear to increase students' awareness of collaboration and elicit more task content statements (Strijbos, Martens, Jochems, & Broers, 2004).

The introduction of roles in small group discussions is not a recent development. Long before the advent of the computer in education, roles have been assigned in collaborative groups in face-to-face settings within learning contexts varying from primary to higher education. One example of scripts involving roles is the cooperation script of O'Donnell and Dansereau (1992). In this script, two students read a section of a text. One is assigned the role of summariser and has to recall the main topics, whereas the other student is assigned the role of listener and should detect errors and omissions. He or she should also comment on the summary. After elaborating the information of the first section, another section is read and both students switch roles.

Instructional collaborative learning approaches focus on assigning roles to students in order to support coordination and promote effective interaction patterns. A number of positive effects are attributed to roles. Groups are expected to work efficiently, smoothly, and productively (Cohen, 1994) and "the practical matter of having critical roles filled in meetings has direct implications for improving task performance and satisfaction" (Zigurs & Kozar, 1994, p. 277). Furthermore, the use of roles can alleviate problems of nonparticipation or domination of the interaction by one group member (Cohen, 1994). Roles that are often used to structure communication and collaboration in asynchronous discussion groups are, amongst others: starter (Hara et al., 2000; Zhu, 1996), summariser (Hara et al., 2000; Tagg, 1994; Zhu, 1996), and moderator (Gray, 2004; Mason, 1991; Tagg, 1994).

A number of studies did already concentrate on introducing roles in online discussion groups. More specifically, these studies aimed at examining the effect of roles on for example students' participation rates, their interaction patterns, or the group efficiency (Hara et al., 2000; Strijbos et al., 2004; Zhu, 1996). The surplus value of the present studies is that roles are introduced with the specific aim of enhancing knowledge construction through social negotiation (De Wever, Van Keer, Schellens, & Valcke, 2006a; De Wever, Van Winckel, & Valcke, 2006; De Wever, Van Keer, Schellens, & Valcke, 2006b). In this respect, the focus is especially on interaction processes, such as reaching shared understanding or building team consensus (Cecez-Kecmanovic & Webb, 2000). We are not merely interested in the impact of roles on participation, interaction patterns, or group efficiency, but we focus on the actual role adoption and on the effect on students' social knowledge construction.

Roles in the medical school setting

In the medical school setting, two different roles were introduced: a moderator and a developer of alternatives for patient management. The task of the *moderator* comprises monitoring the discussions, asking critical questions, and inquiring for the opinion of others. The role of *developer* consists of the exploration of alternative treatments for the ones already discussed (e.g. no medication, soothing medication only, other ways to administer medication, other forms/kinds of medication, etc.). In the medical context, we focus on the difference between instructor-moderated and student-moderated discussions on the one hand, and on discussions with versus without a developer of alternatives on the other hand.

As to the difference between student-moderated and instructor-moderated discussions, the research fits in with two related research fields, namely peer-guided instruction in higher education and peer tutoring in the context of problem-based learning. The selection of the role of developer of alternatives is based on the theoretical concept of socio-cognitive conflict in collaborative learning environments (Joiron & Leclet, 2002). The theoretical background of these roles is described in detail in chapter 3.

Roles in the educational sciences setting

In the educational sciences setting, five different roles were introduced in order to promote high-level interaction, enhanced collaboration, and consequently knowledge construction through social negotiation: starter, summariser, moderator, theoretician, and source searcher.

The starter is required to start off the discussions, add new points where other students can build upon, and give new impulses every time the discussion slacks off. The role of the moderator consists of monitoring the discussion, asking critical questions, and inquiring for others' opinions. Students in the role of theoretician are required to introduce theoretical information and to ensure that all relevant theoretical concepts are used in the discussion. The role of the source searcher comprises seeking external information on the discussion topics in order to stimulate other students to go beyond the scope of the course reader. The summariser is expected to post interim summaries during the discussion and a final synopsis at the end, focusing on identifying dissonance and harmony between the messages and drawing conclusions.

The introduction of these roles is based on examples found in the literature, such as facilitator, resource person, summariser, starter, wrapper, discussion moderator, topic leader, and topic reviewer (Cohen, 1994; Hara et al., 2000; Shotsberger, 1997; Tagg, 1994). On the other hand, the selection of the roles is based on the specific purpose of the discussion tasks, namely to stimulate students to actively discuss the content of the course manual and relevant external sources in order to get a grip on the different theoretical concepts introduced in the course. The origin and the theoretical background of these roles are presented in detail in chapter 5.

Self-assessment in the educational sciences setting

In the educational sciences setting, the additional support of the introduction of self-assessment to enhance knowledge construction was studied as well. Self-assessment refers to the involvement of learners in making judgements about their own learning (Boud & Falchikov, 1989; Boud, 1995) and is considered as a tool providing feedback to students about both learning and educational standards. It requires students to consider the characteristics of competent work in a given area or situation, and to apply these criteria to their own work (Boud, 1999). While making their own regular and structured self-assessment, learners develop a questioning and reflective approach (Robinson & Udall, 2006). Research reveals the considerable impact of self-assessment on students' content-related learning, quality of problem solving, and self-reflection (Sluijsmans, Dochy, & Moerkerke, 1999).

In this respect, self-assessment was introduced in one of the studies as a reflection tool and a tool for learning. Following the claim that self-assessment is clearly an important part of supporting students to improve their own learning (Longhurst & Norton, 1997), it is hypothesised that self-assessment of the individual contributions in a CSCL-environment can elicit readjustment of discourse in forthcoming collaborative activities. The idea is that by rating themselves at the different discussion themes, students reflect upon their actions in order to be able to identify suitable amendments to these actions (Hunt, Hughes, & Rowe, 2002) in forthcoming discussions.

As discussed in detail in chapter 6, self-assessment was introduced as a way of formative assessment in order to enhance reflection (Larres, Ballantine, & Whittington, 2003). The students were asked to evaluate themselves in relation to the knowledge construction processes in their messages. They were informed about the fact that no marks were involved in this self-assessment procedure and about the criteria for the summative assessment by the staff members. The self-assessment was based on an online questionnaire in which students had to rate their knowledge construction through social negotiation after each discussion assignment. Requiring students to evaluate their discussion messages obliges them to reflect upon the nature of their contributions and the position of their contributions in the ongoing discussions.

Research questions

Throughout our study of the impact of structuring on knowledge construction in the asynchronous discussion groups, we deal with a number of issues successively. First, the impact of the introduction of roles on students' knowledge construction is studied in the medical school setting (see research question 1). Moreover, we explore the difference in knowledge construction between contributions of students performing one of the roles and contributions of students not performing a role in this setting (see research question 2). Similarly with research question 1, the effect of role assignment is studied in the educational sciences setting. However, since first-year students are involved in this setting and since Cohen (1994) argues that students are not always performing the assigned roles, it is checked whether the freshmen accurately perform the roles that were assigned to them (see research question 3). After that, the impact of introducing roles on students' knowledge construction is studied in the educational sciences setting (see research question 4). Next, we focus on which roles (research question 5) and which message characteristics (research question 6) have a differential impact on knowledge construction in the educational sciences setting. In addition to the study of the impact of role assignment, the surplus value of the introduction of self-assessment was examined as well. By analogy with research question 3, we also check whether the first-year students educational sciences are capable to assess in an accurate way their own social knowledge construction processes (see research question 7), followed by the study of the added value of self-assessment in the educational sciences setting (see research question 8). Below, we discuss this list of questions in more detail.

Research question 1: Does the introduction of roles have a significant impact on students' knowledge construction in the medical school setting?

The first two research questions focus on the medical school setting. In this setting, two different roles were introduced: a moderator and a developer of alternatives for patient management. The specific research question examines whether there are differences between discussion groups (1) with a student or an instructor as moderator and (2) with or without a developer of alternatives. In chapter 3, content analysis was performed and multilevel logit analyses were run to investigate whether higher levels of knowledge construction can be expected when the role of moderator is assigned to a student and when a developer of alternatives is involved.

Research question 2: Is there a significant differential impact for the roles in the medical school setting?

This research question focuses specifically on the contributions of the students performing a role in the asynchronous discussions. In order to explore whether students assigned a role perform differently from other students, the knowledge construction in contributions of students performing the role of moderator or developer of alternatives is compared with the knowledge construction in contributions of students without a role in chapter 3.

Research question 3: Do freshmen act up to the assigned roles in the educational sciences setting?

As mentioned above, five different roles were implemented in the discussion groups of freshmen studying instructional sciences. Since Cohen (1994) argues that students are not always performing the assigned roles and since freshmen were involved in this setting, the fifth research question questions whether students accurately perform the roles they were assigned. Chapter 5 focuses therefore on validating our assumptions about the role adoption in this setting and with these students.

Verifying to what extent students perform the roles is interesting from a practical point of view, since this information can be used to make more informed decisions about feasible and relevant role assignments in CSCL environments. Moreover, it is also important to shed light on role adoption and performance from a theoretical and empirical point of view. As roles are introduced as an instructional approach to structure and to optimise online discussions, the question whether students actually act up to the roles merits particular attention before studying the impact of the implementation of roles on the knowledge construction processes in discussion groups. Attention should primarily focus on whether the intervention of role assignment was successful, i.e. did students perform the roles they were assigned? And if so, did they exclusively stick to these roles, or did they engage in other discussion activities as well?

Research question 4: Does the introduction of roles have a significant impact on the knowledge construction in the educational sciences setting?

This question concentrates on the impact of the introduction of roles and is explored in chapter 6. More particularly, the research questions in chapter 6 focus on determining whether role assignment has an impact on the knowledge construction processes in the discussion groups and whether the moment of introduction of the role assignment is an important factor.

By analogy with research question 1, a quantitative content analysis was performed to explore the different levels of knowledge construction through social negotiation. Taking into account the hierarchical nesting of students in discussion groups and the successive nature of the four themes, repeated-measures multilevel modelling was applied to study the research questions.

Research question 5: Is there a significant differential impact for certain roles in the educational sciences setting?

By analogy with research question 2, this question focuses on a more in-depth analysis of the five roles. In chapter 4, discussion groups with role assignment were selected and the knowledge construction of students adopting a role was compared with the knowledge construction of students without roles. The research question explores if students performing the role of starter, moderator, theoretician, source searcher, or summariser perform differently from students without roles in these groups with respect to knowledge construction.

Research question 6: What message characteristics have an impact on knowledge construction in the educational sciences setting?

This research question investigates the relation between different message characteristics on the knowledge construction in students' contributions. In chapter 4, different message characteristics related to the five roles, such as summarising, moderating, introducing new discussion points, and debating theory and various sources, have been identified in order to explore whether messages reflecting certain characteristics have a differential impact on the social knowledge construction reflected in these contributions.

Research question 7: Are freshmen in the educational sciences setting able to assess their own social knowledge construction processes accurately?

Since self-assessment has a considerable impact on self-reflection (Sluijsmans et al., 1999) and reflecting on the personal knowledge construction processes is expected to influence the quality of the knowledge construction processes, we wanted to check to what extent students are able to assess their own knowledge construction processes in an accurate way. This question precedes the study of the impact of the introduction of self-assessment on the knowledge construction processes.

In the first part of chapter 6 we report how well students have been able to asses their own knowledge construction processes. Students were presented with self-assessment questions probing their perception of their achieved levels of knowledge construction through social negotiation. In order to explore whether students are able to assess their own level of knowledge construction through social negotiation, we focus on the convergence between students' self-assessment and the results of the content analysis of their messages.

Research question 8: Does the introduction of self-assessment have a significant additional impact on students' knowledge construction on top of the effect of role assignment in the educational sciences setting?

This question supplements question 4 and focuses on the added value of the introduction of self-assessment in the educational sciences setting. More specifically, the research question in chapter 6 deals with the issue whether or not reflection through self-assessment has a surplus value stimulating students' knowledge construction through social negotiation.

As discussed at the end of the elaboration of question 4, in chapter 6 a quantitative content analysis was combined with multilevel modelling in order to explore this research question.

Preliminary questions

In order to be able to study the research questions formulated above, two issues have to be dealt with at first. First, we need an appropriate approach to measure knowledge construction in asynchronous discussion groups (see preliminary question 1). Next, once we are able to measure the knowledge construction of students collaborating in asynchronous discussion groups, we need to find a suitable technique to analyse these measures (see preliminary question 2).

Preliminary question 1: How to measure students' knowledge construction in asynchronous discussion groups?

The very first question when studying the impact on knowledge construction is related to how we measure knowledge construction in asynchronous discussion groups. In this respect, chapter 2 introduces a technique to study transcripts of asynchronous discussions: quantitative content analysis. Neuendorf (2002, p. 10) defines content analysis as "a summarizing, quantitative analysis of messages that relies on the scientific method and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented". Anderson, Rourke, Garrison, and Archer (2001) argue that the goal of this methodology is to make valid inferences from a text.

Although this research technique is often used, standards are not yet established. The available instruments reflect a wide variety of approaches and differ in their level of detail and the nature of the analysis categories used. Further differences are related to a diversity in their theoretical base, the available information about their validity and reliability, and the choice for the unit of analysis. In order to make a well-founded choice, chapter 2 presents an overview of fifteen content analysis instruments together with research studies in which they have been applied. For each analysis instrument, the theoretical background, the choice for a unit of analysis, and the reliability of the instruments is discussed.

Preliminary question 2: How to analyse knowledge construction measures of students collaborating in asynchronous discussion groups?

Once decided how to measure knowledge construction, it is necessary to analyse these measures in an appropriate way. Analysing knowledge construction through social negotiation in a quantitative way is not a straightforward task, since knowledge construction in collaborative situations is marred by variables both at the level of the individual learner and the group. Chapter 4 goes more deeply into the methodological challenges to take into account the mutual influences between a group and the individuals who make up that group by adopting multilevel modelling to analyse the data obtained through the quantitative content analysis procedure.

Overview of the questions

Both preliminary questions (PQ) and the eight research questions (RQ) are listed below. Each of the questions is studied and answered in one of the chapters of this dissertation. Table 1.1 gives an overview of the questions addressed in the different chapters.

(PQ 1) How to measure students' knowledge construction in asynchronous discussion groups?

(PQ 2) How to analyse knowledge construction measures of students collaborating in asynchronous discussion groups?

(RQ 1) Does the introduction of roles have a significant impact on students' knowledge construction in the medical school setting?

(RQ 2) Is there a significant differential impact for the roles in the medical school setting?

(RQ 3) Do freshmen act up to the assigned roles in the educational sciences setting?

(RQ 4) Does the introduction of roles have a significant impact on the knowledge construction in the educational sciences setting?

(RQ 5) Is there a significant differential impact for certain roles in the educational sciences setting?

(RQ 6) What message characteristics have an impact on knowledge construction in the educational sciences setting?

(RQ 7) Are freshmen in the educational sciences setting able to assess their own social knowledge construction processes accurately?

(RQ 8) Does the introduction of self-assessment have a significant additional impact on students' knowledge construction on top of the effect of role assignment in the educational sciences setting?

Table 1.1
Overview of the research questions addressed in the different chapters

	PQ 1	PQ 2	RQ 1	RQ 2	RQ 3	RQ 4	RQ 5	RQ 6	RQ 7	RQ 8
Chapter 1	*Chapter 1 presents an overview of all questions*									
Chapter 2[a]	X									
Chapter 3[b]			X	X						
Chapter 4[c]		X					X	X		
Chapter 5[d]					X					
Chapter 6[e]						X			X	X
Chapter 7	*Chapter 7 presents an overview of the answers to all questions*									

PQ = Preliminary Question; RQ = Research Question
[a] Manuscript published in *Computers & Education*
[b] Manuscript accepted for publication in *Advances in Health Sciences Education*
[c] Manuscript submitted for publication
[d] Manuscript submitted for publication
[e] Manuscript submitted for publication

Chapter 7 presents a general discussion and conclusion of the results, against the background and the central aims of this dissertation. It provides an overview of the answers to the questions formulated above. Furthermore, this concluding chapter presents an integrated discussion of the results and their practical implications. Finally, the limitations of the studies are discussed and suggestions for future research are outlined.

References

American Heritage Dictionary (3rd ed.) (1992). New York: Houghton Mifflin.

Anderson, T., Rourke, L., Garrison, D. R., & Archer, W. (2001). Assessing teaching presence in a computer conference context. *Journal of Asynchronous Learning Networks, 5*. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v5n2/v5n2_ anderson.asp

Aviv, R. (2000). Educational performance of ALN via content analysis. *Journal of Asynchronous Learning Networks, 4,* 53-72. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v4n2/v4n2_aviv.asp

Aviv, R., Erlich, Z., & Ravid, G. (2003). Cohesion and roles: Network analysis of CSCL communities. In v.Devedzic, J. M. Spector, D. G. Sampson, & Kinshuk

(Eds.), *Proceedings of the 3rd IEEE International Conference on Advanced Learning Technologies* (pp. 145-150). Athens: ICALT. Retrieved September 1, 2006, from http://www.ravid.org/gilad/AthensICALT2003.pdf

Bernard, R. M., & Lundgren-Cayrol, K. (2001). Computer Conferencing: An Environment for Collaborative Project-Based Learning in Distance Education. *Educational Research and Evaluation, 7,* 241-261.

Boud, D. (1995). Enhancing learning through self assessment. London: Kogan Page.

Boud, D. (1999). Avoiding the traps: seeking good practice in the use of self assessment and reflection in professional courses. *Social Work Education, 18,* 121-132.

Boud, D., & Falchikov, N. (1989). Quantitative studies of self-assessment in higher education: A critical analysis of findings. *Higher Education, 18,* 529-549.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18,* 32-42.

Bruffee, K. A. (1995). Sharing our toys. *Change, 27*.

Cecez-Kecmanovic, D., & Webb, C. (2000). Towards a communicative model of collaborative web-mediated learning. *Australian Journal of Educational Technology, 16,* 73-85. Retrieved September 1, 2006, from http://www.ascilite.org.au/ajet/ajet16/cecez-kecmanovic.html

Cobb, P., & Yackel, E. (1996). Constructivist, Emergent, and Sociocultural Perspectives in the Context of Developmental Research. *Educational psychologist, 31*, 175-190.

Cohen, E. G. (1994). *Designing Groupwork. Strategies for the Heterogeneous Classroom.* (2nd ed.) New York: Teachers College Press.

Cook, J. (2002). The role of dialogue in computer-based learning and observing learning: An evolutionary approach to theory. *Journal of Interactive Media in Education*, *5*. Retrieved September 1, 2006, from http://www-jime.open.ac.uk/ 2002/5

Crook, C. (2002). Deferring to resources: collaborations around traditional vs computer-based notes. *Journal of Computer Assisted Learning*, *18*, 64-76.

Curtis, D. D., & Lawson, M. J. (2001). Exploring Collaborative Online Learning. *Journal of Asynchronous Learning Networks, 5,* 21-34. Retrieved September 1, 2006, from http://www.aln.org/publications/ jaln/v5n1/v5n1_curtis.asp

Das, J. P. (1995). Some Thoughts on Two Aspects of Vygotsky's Work. *Educational psychologist, 30,* 93-97.

Davidson-Shivers, G. V., Muilenburg, L. Y., & Tanner, E. J. (2001). How do students participate in synchronous and asynchronous online discussions? *Journal of Educational Computing Research, 25,* 351-366.

Davies, S. (2006, May 26). Definition of collaborative learning. Message posted to http://legacy.uwcm.ac.uk/ltsn/forum/1085047704/ index_html

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46,* 6-28.

De Wever, B., Valcke, M., Van Winckel, M., & Kerkhof, J. (2002). De invloed van “structuur” in CSCL-omgevingen: een onderzoek met on line discussiegroepen bij medische studenten [The influence of structuring CSCL-environments: A study of online discussion groups with medical students]. *Pedagogisch Tijdschrift, 27,* 105-128.

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2006a). *Applying multilevel modelling on content analysis data: Methodological issues in the study of the impact of role assignment in asynchronous discussion groups.* Manuscript submitted for publication.

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2006b). *Structuring asynchronous discussion groups: The impact of role support and self-assessment on students' levels of knowledge construction through social negotiation.* Manuscript submitted for publication.

De Wever, B., Van Winckel, M., & Valcke, M. (2006). Discussing Patient Management Online: The Impact of Roles on Knowledge Construction for Students Interning at the Paediatric Ward. *Advances in Health Sciences Education,* 1-18. Retrieved September 1, 2006, from http://dx.doi.org/10.1007/ s10459-006-9022-6

Dillenbourg, P. (1999). What do you mean by 'collaborative learning'? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches* (pp. 1-15). Amsterdam: Pergamon.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Dillenbourg, P., & Schneider, D. (1995). Collaborative learning and the internet. Retrieved September 1, 2006, from http://tecfa.unige.ch/tecfa/research/CMC/ colla/iccai95_1.html

Dolmans, D. H. J. M., Gijselaers, W. H., Moust, J. C., De Grave, W. S., Wolfhagen, I. H. A. P., & Van Der Vleuten, C. P. M. (2002). Trends in research on the tutor in problem-based learning: conclusions and implications for educational practice and research. *Medical Teacher, 24*, 173-180.

Dougiamas, M. (1998). A journey into Constructivism. Retrieved September 1, 2006, from http://dougiamas.com/writing/constructivism.html

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170-198). London: Prentice Hall International.

Ellis, A. (2001). Student-centred collaborative learning via face-to-face and asynchronous online communication: What's the difference? In G. Kennedy, M. Keppel, C. McNaught, & T. Petrovic (Eds.), *Meeting at the Crossroads. Proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education* (pp. 169-177). Melbourne: Biomedical Multimedia Unit, The University of Melbourne.

Flynn, A. E., & Klein, J. D. (2001). The influence of discussion groups in a case-based learning environment. *Educational Technology Research and Development, 49*, 71-86.

Gilbert, P. K., & Dabbagh, N. (2005). How to structure online discussions for meaningful discourse: A case study. *British Journal of Educational Technology, 36*, 5-18.

Graham, M., Scarborough, H., & Goodwin, C. (1999). Implementing Computer Mediated Communication in an Undergraduate Course - A Practical Experience. *Journal of Asynchronous Learning Networks, 3*, 32-45. Retrieved September 1, 2006, from http://www.aln.org/publications/jaln/v3n1/v3n1_graham.asp

Gray, B. (2004). Informal learning in an online community of practice. *Journal of Distance Education, 19*, 20-35.

Hagdrup, N. A., Edwards, M., Carter, Y. H., Falshaw, M., Gray, R. W., & Sheldon, M. G. (1999). Why? What? and How? IT provision for medical students in general practice. *Medical Education, 33*, 537-541.

Hammond, N., & Bennet, C. (2002). Discipline differences in role and use of ICT to support group-based learning. *Journal of Computer Assisted Learning, 18*, 55-63.

Hara, N., Bonk, C. J., & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science, 28*, 115-152.

Henri, F., & Rigault, C. R. (1996). Collaborative Distance Learning and Computer Conferencing. In T. T. Liao (Ed.), *Advanced Educational Technoloy: Research Issues and Future Potential* (pp. 45-76). Berlin: Springer.

Hew, K. F., & Cheung, W. S. (2003). An exploratroy study on the use of asynchronous online discussion in hypermedia design. *E-Journal of Instructional Science and Technology, 6*. Retrieved September 1, 2006, from http://www.usq.edu.au/electpub/e-jist/docs/Vol6_No1/ an_exploratory_study_on_the_use_.htm

Hmelo-Silver, C. E. (2002). Collaborative Ways of Knowing: Issues in Facilitation. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of CSCL 2002.* Retrieved September 1, 2006, from http://newmedia.colorado.edu/cscl/237.pdf

Hooper, S. (1992). Cooperative Learning and Computer-Based Instruction. *Educational Technology Research and Development, 40,* 21-38.

Hunt, N., Hughes, J., & Rowe, G. (2002). Formative Automated Computer Testing (FACT). *British Journal of Educational Technology, 33,* 525-535.

Johnson, D. W., & Johnson, R. T. (1996). Cooperation and the use of technology. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 1017-1044). London: Prentice Hall International.

Joiron, C., & Leclet, D. (2002). Architecture of a learning system for between-peers distance continuing medical education: The DIACOM forum. In P. Kommers, V. Petrushin, Kinshuk, & I. Galeev (Eds.), *Proceedings of IEEE International Conference on Advanced Learning Technologies* (pp. 161-164). Kazan, Katarsan: ICALT-2002. Retrieved September 1, 2006, from http://lttf.ieee.org/ icalt2002/ proceedings/

Jonassen, D. H. (1991). Evluating Constructivistic Learning. *Educational Technology, 31,* 28-33.

Kiesler, S. (1992). Talking, Teaching, and Learning in Network Groups: Lessons from Research. In A. R. Kaye (Ed.), *Collaborative Learning Through Computer Conferencing* (pp. 147-165). London: Springer-Verlag.

Kirschner, B. W., Dickinson, R., & Blosser, C. (1996). From Cooperation to Collaboration: The Changing Culture of a School/University Partnership. *Theory Into Practice, 35,* 205-213.

Kirschner, P. A. (2001). Using integrated electronic environments for collaborative teaching/learning. *Research Dialogue in Learning and Instruction, 2,* 1-9.

Kollar, I., Fischer, F., & Hesse, F. W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning, CSCL 2003 - Community events, communication, and interaction* (pp. 59-61). Bergen: Intermedia.

Koschmann, T. D. (1994). Toward a Theory of Computer Support for Collaborative Learning. *Journal of the Learning Sciences, 3,* 219-225.

Larres, P. M., Ballantine, J. A., & Whittington, M. (2003). Evaluating the validity of self-assessment: Mearsuring computer literacty among entry-level undergraduates within accounting degree programmes at two UK universities. *Accounting Education, 12,* 97-112.

Lockhorst, D., Admiraal, W., Pilot, A., & Veen, W. (2002). Design elements for a CSCL environment in a teacher training programme. *Education and Information Technologies, 7,* 377-384.

Longhurst, N., & Norton, L. S. (1997). Self-assessment in coursework essays. *Studies In Educational Evaluation, 23,* 319-330.

Macdonald, J. (2006). *Blended learning and online tutoring: A good practice guide.* Hampshire: Gower.

Markel, S. L. (2001). Technology and education online discussion forums: It's in the response. *Online Journal of Distance Learning Administration, 4*. Retrieved September 1, 2006, from http://www.westga.edu/~distance/ojdla/summer42/markel42.html

Mason, R. (1991). Moderating educational computer conferencing. *Deosnews, 1*. Retrieved September 1, 2006, from http://www.emoderators.com/papers/mason.html

Mason, R. (1992). Evaluating Methodologies for Computer Conferencing Applications. In A. R. Kaye (Ed.), *Collaborative Learning Through Computer Conferencing* (pp. 105-116). London: Springer-Verlag.

Meloth, M. S., & Deering, P. D. (1999). The Role of the Teacher in Promoting Cognitive Processing During Collaborative Learning. In A. M. O'Donnell & A. King (Eds.), *Cognitive Perspectives on Peer Learning* (pp. 235-255). Mahwah, NJ: Lawrence Erlbaum.

Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning and Instruction, 6,* 359-377.

Merrill, M. D. (1991). Constructivism and Instructional Design. *Educational Technology, 31,* 45-53.

Meyer, K. A. (2004). Evaluating online discussions: Four different frames of analysis. *Journal of Asynchronous Learning Networks, 8*. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/ jaln/v8n2/v8n2_meyer.asp

Millis, B. J., & Cottell, P. G. (1998). *Cooperative learning for higher education faculty*. Phoenix: Oryx Press.

Mueller, A., & Fleming, T. (1994). Cooperative Learning: Listening to How Children Work at School. *Journal of Educational Research, 94,* 259-265.

Murphy, K. L., Drabier, R., & Epps, M. L. (1998). A constructivist look at interaction and collaboration via computer conferencing. *International Journal of Educational Telecommunications, 4*, 237-261.

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

O'Donnell, A. M., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups. The theoretical anatomy of group learning* (pp. 120-141). New York: Cambridge University Press.

Panitz, T. (1996). *A Definition of Collaborative vs Cooperative Learning.* Retrieved September 1, 2006, from http://www.lgu.ac.uk/deliberations/ collab.learning/panitz2.html

Panitz, T. (1997). Collaborative versus cooperative learning - a comparison of the two concepts will help us to understand the underlying nature of interactive learning. *Cooperative Learning and College Teaching, 8*. Retrieved September 1, 2006, from http://home.capecod.net/~tpanitz/tedsarticles/coopdefinition.htm

Pena-Shaff, J. B., Martin, W., & Gay, G. (2001). An epistemological framework for analyzing student interactions in computer-mediated communication environments. *Journal of Interactive Learning Research*, *12*, 41-48. Retrieved September 1, 2006, from http://www.aace.org/dl/files/JILR/Jilr-12-01-41.pdf

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42*, 243-265.

Pfister, H. R., & Mühlpfordt, M. (2002). Supporting discourse in a synchronous learning environment: The learning protocol approach. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of CSCL 2002.* Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://newmedia.colorado.edu/cscl/178.pdf

Pitman, A. J., Gosper, M., & Rich, D. C. (1999). Internet based teaching in geography at Macquirie University: An analysis of student use. *Australian Journal of Educational Technology, 15*, 167-187. Retrieved September 1, 2006, from http://cleo.murdoch.edu.au/ajet/ ajet15/pitman.html

Reynolds, R. E., Sinatra, G. M., & Jetton, T. L. (1996). Views of Knowledge Acquistion and Representation: A Continuum From Experience Centered to Mind Centered. *Educational psychologist, 31,* 93-104.

Robinson, A., & Udall, M. (2006). Using formative assessment to improve student learning through critical reflection. In C. Bryan & K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 92-99). London: Routledge.

Rose, M. A. (2002). *Cognitive dialogue, interaction patterns, and perceptions of graduate students in an online conferencing environment under collaborative and cooperative structures.* Unpublished doctoral dissertation, Indiana University, Bloomington, IN. Retrieved September 1, 2006, from http://www.bsu.edu/web/arose/Vita/MARose.pdf

Rourke, L., & Anderson, T. (2002). Using Peer Teams to Lead Online Discussions. *Journal of Interactive Media in Education, 1*. Retrieved September 1, 2006, from http://www-jime.open.ac.uk/2002/1

Schellens, T., & Valcke, M. (2000). Re-engineering conventional university education: Implications for students' learning styles. *Distance Education, 21*, 361-384.

Schrire, S. (2004). Interaction and cognition in asynchronous computer conferencing. *Instructional Science, 32*, 475-502.

Sener, J. (1997). ALN's relations: Current educational trends and concepts and their relation to ALN. *ALN Magazine, 1*. Retrieved September 1, 2006, from http://www.aln.org/publications/magazine/v1n1/sener/sener.asp

Shotsberger, P. G. (1997). Emerging Roles for Instructors and Learners in the Web-Based Instruction Classroom. In B. H. Khan (Ed.), *Web-based Instruction* (pp. 101-106). New Jersey: Educational Technology Publications.

Slavin, R. E. (1989). Cooperative Learning and Student Achievement. In R. E. Slavin (Ed.), *School and classroom organization* (pp. 129-156). Mahwah, NJ: Lawrence Erlbaum.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1999). Creating a Learning Environment by Using Self-, Peer- and Co-Assessment. *Learning Environments Research*, *1*, 293-319.

Spiro, R. J., Feltovich, P. J., Jacobson, M., & Coulson, R. L. (1992). Cognitive Flexibility, Constructivism, and Hypertext: Random Access Instruction for Advanced Knowledge Acquisition in Ill-Structured Domains. Retrieved September 1, 2006, from http://www.ilt.columbia.edu/publications/papers/Spiro.html

Strijbos, J. W., & Martens, R. L. (2001). Group-based learning: Dynamic interaction in groups. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), *European perspectives on computer-supported collaborative learning. Proceedings of the first european conference on computer supported collaborative learning* (pp. 569-576). Maastricht, The Netherlands. Retrieved

September 1, 2006, from http://www.mmi.unimaas.nl/euro-cscl/Papers/154.doc

Strijbos, J. W., Martens, R. L., Jochems, W., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35,* 195-229.

Stromso, H. I., Grottum, P., & Hofgaard Lycke, K. (2004). Changes in student approaches to learning with the introduction of computer-supported problem-based learning. *Medical Education, 38,* 390-398.

Tagg, A. C. (1994). Leadership from Within: Student Moderation of Computer Conferences. *The American Journal of Distance Education, 8,* 40-50.

Tiene, D. (2000). Online discussions: A survey of advantages and disadvantages compared to face-to-face discussions. *Journal of Educational Multimedia and Hypermedia, 9,* 369-382.

Valcke, M., & De Wever, B. (2006). Information and communication technologies in higher education: evidence-based practices in medical education. *Medical Teacher, 28,* 40-48.

Verdejo, M. F. (1996). Interaction and Collaboration in Distance Learning Through Computer Mediated Technologies. In T. T. Liao (Ed.), *Advanced Educational Technoloy: Research Issues and Future Potential* (pp. 77-88). Berlin: Springer.

Vonderwell, S. (2003). An examination of asynchronous communication experiences and perspectives of students in an online course: A case study. *Internet and Higher Education, 6,* 77-90.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, Mass.: Harvard University Press.

Weinberger, A., Fischer, F., & Mandl, H. (2002). Fostering individual transfer and knowledge convergence in text-based computer-mediated communication. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community: Proceedings of CSCL 2002*. Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://home.emp.paed.uni-muenchen.de/~weinberg/download/153.pdf

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2005). Facilitating collaborative knowledge construction in computer-mediated learning environments with cooperation scripts. In R. Bromme, F. W. Hesse, & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication* (pp. 15-38). Boston: Kluwer.

Zhu, E. (1996). Meaning Negotiation, Knowledge Construction, and Mentoring in a Distance Learning Course. In *Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technolgy*. (pp. 821-844). Indianapolis, IN. Retrieved September 1, 2006 from http://www.eric.ed.gov/ sitemap/ html_0900000b8014818b.html

Zhu, E. (1998). Learning and mentoring: Electronic discussion in a distance-learning course. In C. J. Bonk & K. S. King (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship and discourse* (pp. 233-259). Mahwah, NJ: Lawrence Erlbaum.

Zigurs, I., & Kozar, K. A. (1994). An exploratory study of roles in computer-supported groups. *MIS Quarterly, 18*, 277-297.

Chapter 2*

Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review

Abstract

Research in the field of CSCL is based on a wide variety of methodologies. In this article we focus upon content analysis, which is a technique often used to analyse transcripts of asynchronous, computer mediated discussion groups in formal educational settings. Although this research technique is often used, standards are not yet established. The applied instruments reflect a wide variety of approaches and differ in their level of detail and the type of analysis categories used. Further differences are related to a diversity in their theoretical base, the amount of information about validity and reliability, and the choice for the unit of analysis.

This article presents an overview of different content analysis instruments, building on a sample of models commonly used in the CSCL-literature. The discussion of fifteen instruments results in a number of critical conclusions. There are questions about the coherence between the theoretical base and the operational translation of the theory in the instruments. Instruments are hardly compared or contrasted with one another. As a consequence the empirical base of the validity of the instruments is limited. The analysis is rather critical when it comes to the issue of reliability. The authors put forward the need to improve the theoretical and empirical base of the existing instruments in order to promote the overall quality of CSCL-research.

Introduction

Current educational practice reflects a growing adoption of computer tools to foster online collaboration. This practice is commonly described as the field of Computer Supported Collaborative Learning (CSCL). In CSCL-environments, online asynchronous discussion groups take a central place. These are known as Computer Mediated Conferencing (CMC), Computer Mediated Discussion (CMD), Computer Conferencing (CC), Networked Learning (NL), or Asynchronous Learning Networks (ALN). In spite of this conceptual variety, most environments have in common that students exchange messages through computers with one another. In this article we focus on text-based CSCL-tools. Next to email, discussion boards are the most commonly used tool in this context. Asynchronous

---

* Based on: De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education*, *46*, 6-28.

text-based discussions present several advantages as compared to synchronous discussions: students get more opportunities to interact with each other and students have more time to reflect, think, and search for extra information before contributing to the discussion (De Wever, Schellens & Valcke, 2004; Pena-Shaff & Nicholls, 2004). The fact that all communication elements are made explicit in the written contributions to the discussions “makes the process of collaboration more transparent [for the researcher], because a transcript of these conference messages can be used to judge both the group collaborative process and the contribution of the individual to that process […]” (Macdonald, 2003, p. 378). All exchanges of information between students are stored in the discussion transcripts. These transcripts can be used by students for reflection purposes or they can serve as data for research (Meyer, 2004).

In the last decade, online asynchronous discussion groups have become a primary focus of educational research (Pena-Shaff & Nicholls, 2004). Researchers seem to agree that collaboration can foster learning (Lazonder, Wilhelm, & Ootes, 2003) and present a variety of theoretical frameworks to ground their assumptions (Schellens & Valcke, 2006). Cognitive constructivists claim that the input in the CSCL-environment fosters learning due to the explicitation of individual knowledge elements (retrieval from memory) and the consecutive reorganisation of knowledge elements in the course of the social transaction. Social constructivists argue that CSCL promotes the collaborative process in which meaning is negotiated and knowledge is co-constructed (Lazonder et al., 2003). Both views “acknowledge the importance of interaction in collaborative learning” (Lazonder et al., 2003, p. 292). This interaction, confined in the transcripts of the discussion, is thus the object of a large body of recent educational research.

At a first stage, research based on the discussion transcripts was mainly restricted to gathering quantitative data about levels of participation (Henri, 1992). However, these quantitative indices about numbers of student contributions hardly helped to judge the quality of the interaction (Meyer, 2004). At a later stage, content analysis was adopted as a technique to unlock the information captured in transcripts of asynchronous discussion groups. Therefore, Henri calls CMC a “gold mine of information concerning the psycho-social dynamics at work among students, the learning strategies adopted, and the acquisition of knowledge and skills” (1992, p. 118). Other researchers use the transcripts of online discussion to investigate the process of the social construction of knowledge (Gunawardena, Lowe, & Anderson, 1997; Gunawardena, Carabajal, & Lowe, 2001) or critical thinking (Bullen, 1997; Newman, Webb, & Cochrane, 1995). In general, the aim of content analysis is to reveal information that is not situated at the surface of the transcripts. To be able to provide convincing evidence about the learning and the knowledge construction that is taking place, in-depth understanding of the online discussions is needed.

The present study focuses on transcript analysis. This content analysis technique can be defined as “a research methodology that builds on procedures to make valid inferences from text” (Anderson, Rourke, Garrison, & Archer, 2001). Although this research technique is often used, standards are not yet established. The applied instruments reflect a wide variety of approaches and differ in their level of detail and the type of analysis categories used. Further differences are related to a diversity in their theoretical base, the amount of information about validity and reliability, and the choice for the unit of analysis. In the present article fifteen content analysis instruments are discussed and research studies in which they have been applied are analysed.

In order to present an overview of the current state of the art, a number of instruments were selected, based on the following criteria: instruments applied, cited, or reflected upon in ISI-journals and CSCL-conferences, since these are the most important fora where scientific discussions about the development, use, and study of such instruments take place. Further, this selection was extended with recently developed instruments and instruments with a unique approach or a noticeable theoretical background. The list of instruments is not exhaustive, but reflects a balanced sample of what is currently used in the research field: Henri's model (1992); the model of Newman et al. (1995); the model of Gunawardena et al. (1997); the instrument of Zhu (1996); the instrument of Bullen (1997); the TAT of Fahy and colleagues (Fahy, Ally, Crawford, Cookson, Keller, & Prosser, 2000; Fahy, Crawford, & Ally, 2001); the instrument developed by Veerman and Veldhuis-Diermanse (2001); instruments for measuring cognitive, social, and teaching presence (Garrison, Anderson, & Archer, 2001; Anderson et al., 2001; Garrison, Anderson, & Archer, 2000; Rourke, Anderson, Garrison, & Archer, 1999); the instrument of Järvelä and Häkkinen (2002); the instrument of Veldhuis-Diermanse (2002); the instrument of Lockhorst, Admiraal, Pilot, and Veen (2003); the instrument developed by Pena-Shaff and Nicholls (2004); and the instrument of Weinberger and Fischer (2006).

Within the context of the present article, we discuss the quality of the analysis instruments, more specifically the theoretical background, the choice for a unit of analysis, and the reliability of the instruments. When available, we refer to other studies that applied the same analysis instrument. This helps to qualify the current state-of-the art of CSCL-research based on content analysis instruments.

The quality of analysis instruments

Content analysis instruments should be accurate, precise, objective, reliable, replicable, and valid (Rourke, Anderson, Garrison, & Archer, 2001; Neuendorf, 2002). These criteria are strongly interrelated. Accuracy is the extent to which a measuring procedure is free of bias (nonrandom error), while precision is the fineness of distinction made between categories or levels of a measure (Neuendorf, 2002). Accuracy should be as high as possible, while precision should be high, but not exaggerated. Objectivity should be attained at all time (Rourke et al., 2001). Although interpretation is necessary and subjectivity might be unavoidable, one should be aware that subjectivity affects the reliability and the validity of studies. The latter is clearly related to the theoretical base of the studies and is discussed together with replicability in the next section. In subsequent sections we elaborate further on the unit of analysis and the interrater reliability.

Theoretical base of the instruments

Although researchers seem to agree that collaboration can foster the learning process (Lazonder et al., 2003), there is no unambiguous theory available to guide research on computer mediated interaction (Stahl, 2003). Without a theoretical model of the collaborative learning process it is impossible to identify empirical indicators that will form the basis of a coding instrument as a standard against which to evaluate whether or not effective learning is occurring in the online discussions (Gunawardena et al., 2001). As Perraton (1988) argues: without a theoretical basis, research is unlikely to go beyond data gathering. The theoretical base is also of importance to ground the validity of the instruments. Internal validity focuses on the match between the conceptual definition and the operationalisation (Neuendorf, 2002). This refers to systematic coherence which defines the relation between the theory and the models used. External validity is the possibility to generalise the findings to different settings (often called generalisability). This external validity can be supported by replications of (parts of) the research. Therefore, it is important to achieve high replicability (Neuendorf, 2002).

Unit of analysis

One of the issues under discussion is the choice of the unit of analysis to perform content analysis. Researchers can consider each individual sentence as a single unit of analysis (Fahy et al., 2001). A second option is to identify a consistent "theme" or "idea" (unit of meaning) in a message and to approach this as the unit of analysis (Henri, 1992). A third option is to take the complete message a student posts at a certain moment in the discussion as the unit of analysis (Gunawardena et al., 1997; Rourke et al., 2001). Every researcher has his or her reasons to choose for one of these possibilities, and there is not really an agreement. The choice for a unit of analysis is dependent on the context and should be well-considered, because changes to the size of this unit will affect coding decisions and comparability of outcome between different models (Cook & Ralston, 2003). In this respect, Schrire (2006) refers to a dynamic approach in which data is coded more than once and the grain size of the unit of analysis is set, depending on the purpose and the research question. We refer to Strijbos, Martens, Prins, and Jochems (2006) for a more in-depth discussion of the issue of unitization.

Interrater reliability

According to Rourke et al. (2001, p. 7) "the reliability of a coding scheme can be viewed as a continuum, beginning with coder stability (intra-rater reliability; one coder agreeing with herself over time), to interrater reliability (two or more coders agreeing with each other), and ultimately to replicability (the ability of multiple and distinct groups of researchers to apply a coding scheme reliably)." Interrater reliability is a critical concern in relation to content analysis. It is regarded as the primary test of objectivity in content studies and defined as "the extent to which different coders, each coding the same content, come to the same coding decisions" (Rourke et al., 2001, p. 6). Unfortunately, a large subset of studies do not report interrater reliability, which – according to Lombard, Snyder-Duch, and Bracken (2002) – "can be seen as the consequence of a lack of detailed and practical guidelines and tools available to researchers regarding reliability". Next to reporting interrater reliability, it is also vital to report information about the training of the coders and the coding process. A clear and transparent coding procedure can guarantee the quality and the reliability of the research. In the next paragraphs, we elaborate on the calculation of the interrater reliability because it is a conditio sine qua non for content analysis.

There are a number of indexes used to report interrater reliability: percent agreement, Holsti's method, Scott's pi, Cohen's kappa, Krippendorff's alpha, Spearman rho, Pearson correlation coefficient, Lin's concordance correlation coefficient, Kupper-Hafner index, etc. (Krippendorff, 1980; Kupper & Hafner, 1989; Lombard et al., 2002; Neuendorf, 2002; Rourke et al., 2001). There is no general consensus on what index should be used. Below we discuss two coefficients that provide a good estimation on the interrater reliability.

Percent agreement is the result of the ratio between the number of codes which is agreed upon and the total number (agree + disagree) of codes. It is by far the most simple and most popular reliability index. It can accommodate any number of coders, but it has a major weakness: it fails to account for agreement by chance (Lombard et al., 2002; Neuendorf, 2002). Furthermore, the matching of the codes has to be very precise, codes that are close but not exactly the same result in disagreement. Holsti's method is a variation on this percent agreement index. However, it takes situations into account in which the two coders evaluate different units. When it is calculated across a set of variables, it is not considered as a good measure because it can veil variables with unacceptably low levels of reliability (Lombard et al., 2002).

Krippendorff's alpha is one of the three coefficients that account for chance agreement. The other two are Scott's pi and Cohen's kappa. Krippendorff's alpha is to be favored for several reasons. First, to calculate Scott's pi and Cohen's kappa, the only information taken into account is the nominal level of the data. Krippendorff's alpha takes into account the magnitude of the misses, adjusting for whether the variable is measured as nominal, ordinal, interval, or ratio (Krippendorff, 1980; Lombard et al., 2002; Neuendorf, 2002). Furthermore, it allows for any number of coders, whereas pi and kappa are only applicable for research based on two coders. Following Lombard et al. (2002), the "biggest drawback to its use has been its complexity and the resulting difficulty of 'by hand' calculations, especially for interval and ratio level variables". We do not consider this calculation as a major problem, since software exists to calculate this coefficient from the reliability data matrix (a matrix with for each coder the code he or she has given to the unit), for example R. R is available as freeware (http://www.r-project.org/).

As written above, there is no general agreement on what indexes should be used. Percent agreement is considered an overly liberal index by some researchers, and the indices which do account for chance agreement, such as Krippendorff's alpha, are considered overly conservative and often too restrictive (Lombard et al., 2002; Rourke et al., 2001). Therefore we suggest calculating and reporting both indices. In this way, more information is given to the reader of research studies in order to judge the reliability. Interpretation of levels of interrater reliability is not straightforward, since there are no established standards available. There seems to be no real consensus for the percent agreement statistic. Often a cut-off figure of .75 to .80 is used; others state that a value of .70 can be considered as reliable

(Neuendorf, 2002; Rourke et al., 2001). Also for chance correcting measures, no standard is available to judge the level of interrater reliability. When Cohen's kappa is used, the following criteria have been proposed: values above .75 (sometimes .80 is used) indicate excellent agreement beyond chance; values below .40, poor agreement beyond chance; and values in between represent fair to good agreement beyond chance (Krippendorff, 1980; Neuendorf, 2002).

Irrespective of the coefficients used, Lombard and colleagues formulate a number of guidelines. They identify the minimum information that should be provided (Lombard et al., 2002, p. 602):

- the size of and the method used to create the reliability sample, along with a justification of that method;
- the relationship of the reliability sample to the full sample;
- the number of reliability coders and whether or not they include the researchers;
- the amount of coding conducted by each reliability and non-reliability coder;
- the index or indices selected to calculate reliability and a justification of these selections;
- the inter-coder reliability level for each variable, for each index selected;
- the approximate amount of training (in hours) required to reach the reliability levels reported;
- where and how the reader can obtain detailed information regarding the coding instrument, procedures and instructions (for example, from the authors).

Only when all this information is reported, readers can make conclusions about the reliability of the instrument used in the context of a study. We consider it of crucial importance that more information about reliability is reported. It will advance the quality of research in the field of content analysis.

Discussion of instruments for content analysis

Rourke and Anderson (2003) suggest that instead of developing new coding schemes, researchers should use schemes that have been developed and used in previous research. Applying existing instruments fosters replicability and the validity of the instrument (Stacey & Gerbic, 2003). Moreover, supporting the accumulating validity of an existing procedure has another advantage, namely the possibility to use and contribute to a growing catalogue of normative data (Rourke & Anderson, 2003). In the CSCL-literature, many researchers do create new instruments, or modify existing instruments. Below, we discuss fifteen of these instruments in order of development and publication. For each instrument, we focus on the scientific criteria discussed above: the theoretical framework, the unit of analysis, and the interrater reliability data. An overview is presented in Table 2.1.

Henri (1992)

One of the instruments most often cited and used as a starting point in many CSCL-studies, is the model of Henri (1992). Her instrument to analyse the transcripts of discussions is based on a cognitivist approach to learning; although she also refers to particular concepts, such as learning in a cooperative mode and to the concept of collective knowledge (Henri, 1992). A central concept in view of the content analysis instrument is interactivity. The definition of interactivity is borrowed from Bretz (1983), who states that interactivity is a three-step process: (1) communication of information, (2) a first response to this information, and (3) a second answer relating to the first.

The whole analytical framework of Henri (1992) consists of five dimensions: a participative, social, interactive, cognitive, and metacognitive dimension. The participative dimension comprises two categories: (1) overall participation, which is the total number of messages and accesses to the discussion and (2) the active participation in the learning process, which is the number of statements directly related to learning made by learners and educators. As she believes that messages of unequal length can not serve as precise measures of active participation, she proposes to divide messages into statements corresponding to units of meaning (Henri, 1992).

The social dimension comprises all statements or part of statements not related to the formal content of the subject matter. This operationalisation is derived from the model of Berger, Pezdek, and Banks (1987) that states that social presence is at work in any statement not related to the formal content of the subject matter.

The interactive dimension is first divided in two parts: interactive versus non-interactive (independent) statements. Secondly, the interactive statements can be further subdivided into explicit versus implicit interactions. Furthermore, two different types of interactive messages are distinguished: responses and commentaries. This leads to five categories, namely (1) direct (explicit) responses, (2) direct (explicit) commentaries, (3) indirect (implicit) responses, (4) indirect (implicit) commentaries, and (5) independent statements.

The cognitive dimension consists out of five categories: (1) elementary clarification: observing or studying a problem identifying its elements, and observing their linkages in order to come to a basic understanding, (2) in-depth clarification: analysing and understanding a problem which sheds light on the values, beliefs, and assumptions which underlie the statement of the problem, (3) inference: induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true, (4) judgment: making decisions, statements, appreciations, and criticisms, and (5) strategies: proposing coordinated actions for the application of a solution, or following through on a choice or a decision. Furthermore, surface processing is distinguished from in-depth processing, in order to evaluate the skills identified.

The metacognitive dimensions comprise metacognitive knowledge and metacognitive skills. Metacognitive knowledge is declarative knowledge concerning the person, the task, and the strategies. Metacognitive skills refer to "procedural knowledge relating to evaluation, planning, regulation, and self-awareness" (Henri, 1992, p. 131). Henri does notice however that although the messages can reveal useful information, it is impossible to reveal the totality of the metacognitive processes. This means that "even if no metacognitive activity was noticed, one could not conclude that the students are weak in this area" (Henri, 1992, p. 133).

As Lally (2001, p. 401) points out: "One of the major strengths of Henri's approach to content analysis using categories is that it focuses on the social activity and the interactivity of individuals in a group at the same time as giving a picture of the cognitive and metacognitive processes of those individuals. However, one of its major limitations is that it gives us no impression of the social co-construction of knowledge by the group of individuals as a group, in a discussion or a seminar." Henri (1992) does not provide information about the code-recode reliability or the interrater reliability of her instrument. She did not empirically test the instrument. Although the instrument has been criticised (Bullen, 1997; Gunawardena et al., 1997; Newman et al., 1995; Pena-Shaff, Martin, & Gay, 2001; Pena-Shaff & Nicholls, 2004), it can be considered as pioneering work and has been the base for subsequent research.

The instrument was for example used in a study of Hara, Bonk, and Angeli (2000), involving 20 master and doctoral students in a 12 weeks course. The coding of 271 messages reflected a percent agreement of .78 for the social dimension, .75 for the cognitive dimension and .71 for the metacognitive dimension. McKenzie and Murphy (2000) applied Henri's model as a basis for their study, based on 157 messages from 25 students, working during 11 weeks. Based on a random sample of one-third of the messages, they report a percent agreement of .76 for the interactive dimension, .44 for the cognitive dimension and .95 for the analytical model that distinguishes in-depth processing from surface processing. Reanalysing the data after collapsing the five categories of the cognitive dimension into only three categories resulted in a percent agreement of .68.

Newman, Webb, and Cochrane (1995)

The theoretical concepts that support the instrument of Newman et al. (1995) are group learning, deep learning, and critical thinking. The authors argue that there is a clear link between critical thinking, social interaction, and deep learning. They developed a content analysis instrument based on Garisson’s (1991) five stages of critical thinking and Henri’s (1992) cognitive skills. They identify 10 categories: relevance, importance, novelty, outside knowledge, ambiguities, linking ideas, justification, critical assessment, practical utility, and width of understanding. For each category, a number of positive and negative indicators are formulated and most indicators are fairly obvious opposites (Newman et al., 1995). A critical thinking ratio is calculated using the totals for each positive or negative indicator, with a minimum of -1 (all uncritical thinking, all surface-level learning) and a maximum of +1 (all critical thinking, all deep-level learning) (Newman et al., 1995). The authors adopt themes as the unit of analysis. The units may be phrases, sentences, paragraphs or messages illustrating at least one of the indicators. They only mark and count the obvious examples, and ignore less clear indicators (Newman et al., 1995). Furthermore, they claim that some indicators rely on subject knowledge and should therefore be identified by an expert in the domain. This makes it more difficult to involve multiple evaluators and limits control for subjective scoring. Although the authors urge others to replicate their work, they do not report reliability data and hardly information is presented about the empirical validation of the instrument. Marra, Moore, and Klimczak (2004) argue that calculating interrater reliability is not possible given that the unit of analysis varies from phrases, to paragraphs, or the entire posting.

Zhu (1996)

The theoretical framework of Zhu’s study is based on a combination of Vygotsky’s theory and theories of cognitive and constructive learning (Zhu, 1996). The zone of proximal development and the importance of social negotiation are put forward, together with the notion of reflective thinking of Dewey (1933). The instrument is based on the theory of group interaction of Hatano and Inagaki (1991) and the theory of question analysis of Graesser and Person (1994). Building on these theories, Zhu divides social interaction into vertical interaction, when “group members will concentrate on looking for the more capable member’s desired answers rather than contribute to and construct knowledge" (Zhu, 1996, p. 824) and horizontal interaction when "members' desires to express their ideas tend to be strong, because no authoritative correct answers are expected to come immediately". In relation to the latter, two types of questions are distinguished: type I questions or information-seeking questions are posed when information is missing, while type II questions or discussing questions are used to provide some kind of information, to seek opinions or to start a dialogue (Zhu, 1996). Other categories are answers, information sharing, discussion, comment, reflection and scaffolding. The category answers comprises messages with specific information in order to answer type I questions, while information sharing comprises more general information. Discussion refers to messages that focus on elaborating and sharing ideas. Comments refer to any non-interrogative statements concerning readings, while reflective notes focus on evaluation, self-appraisal, relating or linking messages, and adjusting learning goals and objectives. Scaffolding notes provide guidance or suggestions. Zhu (1996) uses entire messages as the units of analysis. She does not report information about the reliability of the coding scheme.

Gunawardena, Lowe, and Anderson (1997)

The instrument of Gunawardena et al. (1997) is presented as a tool to examine the social construction of knowledge in computer conferencing. It is based on grounded theory and uses the phases of a discussion to determine the amount of knowledge constructed within a discussion. The authors refer to the models of Henri (1992) and the model of Newman et al. (1995). They indicate that these models served as a useful starting point for analysing asynchronous discussions, but that they are "not very specific on how to evaluate the process of knowledge construction that occurs through social negotiation in CMC" (Gunawardena et al., 1997, p. 402). The theoretical framework for the instrument results from social constructivist principles, more definitely the processes of negotiating meaning and coming to an understanding by discussing and contributing knowledge, thus resulting in the shared construction of knowledge (Kanuka & Anderson, 1998).

In an initial version of the analysis instrument, two types of learning were distinguished. First, a basic type of learning through which participants "were active in each other's learning processes only by providing additional examples of concepts which in essence were already understood. This type of learning is called 'learning by accretion,' or pooling of knowledge" (Gunawardena et al., 1997, p. 413). Second, a type of learning: "that which actually required participants to adjust their ways of thinking to accommodate new concepts or beliefs inconsistent with their pre-existing cognitive schema" (Gunawardena et al., 1997, p. 413).

This distinction was evaluated as too artificial (ibid, p. 413). It is at this point that they presented a model based on 5 levels "reflecting the complete process of negotiation which must occur when there are substantial areas of inconsistency or disagreement to be resolved" (ibid, p. 413).

In contrast to Henri (1992) and Newman et al. (1995), Gunawardena et al. (1997) use the entire message as the unit of analysis. Furthermore, they argue that knowledge construction evolves through a series of levels. The first level is sharing and comparing of information, which comprises observations, opinions, statements of agreement, examples, clarifications, and identifications of problems. This is followed by level 2: the discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements. The third level is negotiation of meaning and/or co-construction of knowledge, which includes negotiation, identifications of areas of agreement, and proposing new co-constructions on topics where conflict exists. The fourth level is characterised by testing and modification of proposed synthesis or co-construction. These co-constructed statements are tested against existing cognitive schema, experiences, and literature. The fifth and final level refers to statements of agreement and application of newly-constructed meaning, and encompasses summarising agreements, applications of new knowledge, and metacognitive statements revealing new knowledge construction (Gunawardena et al., 1997; Kanuka & Anderson, 1998; Lally, 2001).

Lally (2001, p. 402) affirms that "the analytical model of Gunawardena and her colleagues contains several important features in terms of understanding teaching and learning in networked collaborative learning environments: (a) it focuses on interaction as the vehicle for the co-construction of knowledge, (b) it focuses on the overall pattern of knowledge construction emerging from a conference, (c) it is most appropriate in social constructivist and collaborative (student-centered) learning contexts, (d) it is a relatively straightforward schema, and (e) it is adaptable to a range of teaching an learning contexts."

With respect to the reliability of the coding scheme, Gunawardena et al. (1997) mention that the messages were coded independently by two researchers, but they do not report interrater reliability coefficients. They note that, in case of discrepancies, a single code was determined after discussion between the two coders, but they do not mention how often discrepancies have arisen.

Schellens and Valcke (2005) for example, applied this content analysis scheme to study the discussions of 230 students, during a 12 week undergraduate course. The percent agreement when coding the 1428 messages by three independent coders was .69. The analysis scheme was also linked to the analysis scheme of Veerman and Veldhuis-Diermanse (2001). The results of this analysis are discussed below.

Marra et al. (2004) employed the instrument of Gunawardena et al. (1997) and report a Krippendorff's alpha of .59 for the initial codes and .93 for "codes postinter-rater reliability discussions" (p. 31). They furthermore compared this model with the model of Newman et al. (1995) and argue that the former provides "a more holistic view of discussion flow and knowledge construction", whereas the latter provides "focused and segmented coding on certain potential indicators of critical thinking" (Marra et al., 2004, p. 39).

Bullen (1997)

Bullen's instrument focuses on critical thinking. The theoretical framework is based on different conceptualisations of this concept (Dewey, 1933; Ennis, 1987; Garrison, 1991). It is described as a purposeful mental process, involving a variety of cognitive and metacognitive skills. Critical thinking is reflective, evaluative, and reasonable (Bullen, 1997).

Bullen's instrument consists of four different categories of critical thinking skills. The analysis focuses on finding evidence of the use of these skills (positive indicators), and also on finding evidence of uncritical thinking (negative indicators). A ratio of positive indicators to negative indicators was used to determine the level of critical thinking of students. For the first category, clarification, positive indicators are: (a) focusing on a question, (b) analysing arguments, (c) asking and answering questions of clarification, and (d) defining terms and judging definitions; while negative indicators are (a) focusing on a question unrelated to the problem, (b) analysing arguments inappropriately, (c) asking inappropriate or irrelevant questions, or (d) incorrectly answering questions of clarification and incorrectly defining terms and inappropriately judging definitions. The positive indicators for the second category assessing evidence are (a) judging the credibility of a source and (b) making and judging observations; while the negative indicators are judgments and observations based on inappropriate criteria. The third category, making and judging inferences, has a long list of criteria for making and judging deductions, inductions, and value judgments as positive indicators, while negative indicators are making and judging inferences that do not follow the listed criteria. Positive indicators of the final category, using appropriate strategies and tactics, are for example using models, metaphors, drawings, and symbols to simplify problems or talking through a confusing issue with another person. Negative indicators are the inappropriate use of strategies and tactics. For the complete list of indicators and criteria, we refer to Bullen (1997).

Empirical research was based on a 14 week bachelor degree course, involving 13 students and 1 instructor. 207 messages were analysed. Bullen reports data on the reliability of his instrument. Three coders were involved, but there was only 17 percent agreement between the three judges (Bullen, 1997). The scoring of one of the judges differed extremely due tot ambiguity in the indicators. The percent agreement was .58 when the scoring of the two other judges were compared (Bullen, 1997).

Fahy, Ally, Crawford, Cookson, Keller, and Prosser (2000)

The theoretical context of the study of Fahy et al. (2001) is based on the definition of interaction of Gunawardena et al. (1997): “the totality of interconnected and mutually-responsive messages” (Fahy et al., 2001, p. 2). Fahy (2001) and Fahy et al. (2000; 2001; 2002a; 2002b) use a sentence in a message as the unit of analysis. They argue that the unit of analysis must be something obvious and constant within transcripts and that sentences are used to convey ideas.

Fahy et al. (2001) promote a holistic approach to transcript analysis. They apply the concept of a social network: social networks contain and are sustained both by context, and by the social interaction opportunities they offer. They focus on two network concepts: the structural and interactional exchange patterns observed in transcripts. Structural features are represented by the size (number of members), the density (ratio of the actual numbers of links to the possible total), and intensity (responsiveness and attentiveness of members to each other) of the social network. Interactional features include the kinds of content exchanged in the interaction and the exchange flow or the directness of the resulting interaction (Fahy et al., 2001). The interactional features are analysed with the Text Analysis Tool (TAT). The TAT is based on the instrument of Zhu (1996). It distinguishes five categories: vertical questioning, horizontal questioning, statements and supports, reflecting, and scaffolding. At a later stage (Fahy et al., 2001) the TAT was updated by adding one category “References/authorities” that includes references, quotations, and paraphrases on the one hand and citations or attributions on the other hand.

The authors (Fahy et al., 2001) report reliability data based on three studies and involving three independent coders: (1) a code-recode intra-rater reliability of 86 percent agreement, (2) an interrater reliability of 60 to 71 percent agreement and (3) Cohen’s kappa interrater reliability coefficient of .45 to .65. The studies build on the work of small groups of student (n = 13), working during about 15 weeks in a graduate course setting. Not the number of units of analysis is reported (sentences) but the number of words: 53671 words.

Veerman and Veldhuis-Diermanse (2001)

Veerman and Veldhuis-Diermanse situate the use of CSCL within a constructivist framework: "From a constructivist perspective, collaborative learning can be viewed as one of the pedagogical methods that can stimulate students to negotiate such information and to discuss complex problems from different perspectives"; furthermore "collaboration with other students provokes activity, makes learning more realistic and stimulates motivation" (Veerman & Veldhuis-Diermanse, 2001, p. 625). They present an analysis procedure for two categories of messages: task-related and not task-related messages. The categories reflect their specific interest in messages that contain explicit expressions of knowledge construction. They subdivide the task-related messages into three categories: new ideas (content not mentioned before), explanations (refining or elaborating already stated information), and evaluation (critical view on earlier contributions). They applied the instrument in four different settings (synchronous and asynchronous) and compared the outcomes, but they do not report information about reliability. Messages are the units of analysis, except for a single study, where messages were divided into separate contributions, depending on the theme of the content (thematic unit).

The authors applied the scheme in four consecutive studies, involving 40, 20, 30, and 14 students and during 6 to 12 weeks in the context of an undergraduate course. Large numbers of messages were analysed (2040, 1287, 952, and 1088), but no information about reliability indices was made available.

Schellens and Valcke (2005) applied the model of Veerman and Veldhuis-Diermanse (2001) in a CSCL-setting involving 230 students during a 12 week first year university course. 1428 messages were coded by three independent coders. Assessment of interrater reliability resulted in quite high percent agreement measures. The initial value of this statistic was .81. Percent agreement for independent recoding after negotiation between the coders was .87.

De Laat and Lally (2004) analysed discussions of a workshop in a fully virtual master's program in e-learning. The data consisted of the transcripts of discussions of 7 professionals, during three periods of 10 days (160 messages). They calculated a Cohen's kappa of .86, based on a 10% sample.

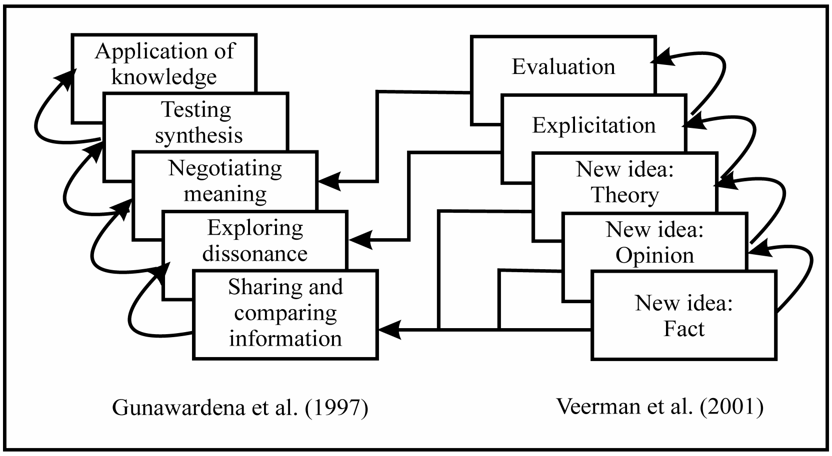

Figure 2.1. Interrelations between two instruments to determine levels of knowledge construction (Schellens & Valcke, 2005).

The research of Schellens and Valcke (2005) is one of the studies that tried to study the validity of the instrument by Veerman and Veldhuis-Diermanse (2001) by simultaneously coding the discussions using the instrument of Gunawardena et al. (1997). In this way, the authors could relate the theoretical position of both models (see Figure 2.1). Category 1, 2, and 3 in the instrument of Veerman and Veldhuis-Diermanse (2001) relates respectively to level 1 in the instrument of Gunawardena et al. (1997), whereas category 4 and 5 relates respectively to category 2 and 3. Both models are parallel to one another for the first three levels of knowledge construction. However, the coding scheme of Gunawardena et al. (1997) does not differentiate between lower cognitive processes. On the other hand, this scheme goes beyond the scheme of Veerman and Veldhuis-Diermanse (2001) and discriminates more advanced levels of knowledge construction, such as testing and applying newly constructed mental models.

Rourke, Anderson, Garrison, and Archer (1999)

Social presence is one of the three elements of the community of inquiry as conceptualised by Rourke et al. (1999). The other two elements are cognitive presence and teaching presence. It “supports cognitive objectives through its ability to instigate, sustain, and support critical thinking in a community of learners” (Rourke et al., 1999, p. 54). Social messages, such as jokes, compliments, and greetings do occur a lot in online asynchronous discussions (Rourke et al., 1999) and are considered to be important to motivate students. The social presence analysis model consists of three main categories: affective responses, interactive responses and cohesive responses. In their studies thematic units are used as the units of analysis. The authors claim that the units have the reliable identification attributes of syntactical units (Rourke et al., 1999). Two studies are reported in which the social presence analysis scheme was applied. Both studies were set up in the context of graduate level courses, involving 11 to 14 students, 2 moderator students and 1 instructor. A total of 90 and 44 messages were coded. The authors report Holsti's percent agreement indices from .91 to .95.

Garrison, Anderson, and Archer (2001)

Cognitive presence is another element in the community of inquiry model. "Cognitive presence reflects higher-order knowledge acquisition and application and is most associated with the literature and research related to critical thinking" (Garrison et al., 2001, p. 7). They operationalise cognitive presence through the practical inquiry process, which comprises four phases: (a) an initiation phase, which is considered a triggering event, (b) an exploration phase, characterised by brainstorming, questioning, and exchange of information, (c) an integration phase, characterised by constructing meaning and (d) a resolution phase, characterised by the resolution of the problem created by the triggering event (Garrison et al., 2001). Complete messages were chosen as the units of analysis. The model was tested in 2 empirical studies that lasted 13 and 2 weeks. A limited amount of students were involved: 11 students, 2 student moderators and 1 instructor. A total of 51 messages was analysed. Varying levels of interrater reliability were reported: Holsti's coefficient of reliability (C.R.) of .45 to .84 and Cohen's kappa of .35 to .74.

Anderson, Rourke, Garrison, and Archer (2001)

Teaching presence is the third element in the overarching theoretical framework of the community of inquiry. The authors see "the function of the teacher as consisting of three major roles: first, as designer of the educational experience, including planning and administering instruction as well as evaluating and certifying competence; second, as facilitator and co-creator of a social environment conducive to active and successful learning; and finally, as a subject matter expert who knows a great deal more than most learners and is thus in a position to 'scaffold' learning experiences by providing direct instruction" (Anderson et al., 2001, p. 2). These three roles are the basis for their instrument to assess teaching presence. As unit of analysis the authors opt for the message, but they allowed “for the possibility that a single message might exhibit characteristics of more than one category” (Anderson et al., 2001, p. 11). Empirical research of the authors was based on a 13 week graduate level course, involving 1 instructor. A total amount of 139 students and 32 instructor messages were analysed. Cohen’s kappa interrater coefficients are reported and vary from .77 to .84.

Järvelä and Häkkinen (2002)

Järvelä and colleagues focus on three aspects: (a) the type of postings, (b) the level of discussions, and (c) the stage of perspective taking in discussions (Häkkinen, Järvelä, & Byman, 2001; Järvelä & Häkkinen, 2002). Their theoretical framework has its foundation in socio-constructivist learning theories in general, and more specifically in the idea of apprenticeship in thinking. With regard to the type of postings, the following categories are derived from the transcript data: (a) theory, (b) new point or question, (c) experience, (d) suggestion, and (e) comments. The message served as unit of analysis for this categorisation. The concrete link between the analysis categories and the theoretical framework is not explained. No interrater reliability data when using this categorisation are mentioned. Concerning the level of discussions, three categories are presented: (a) higher-level discussions, (b) progressive discussions, and (c) lower-level discussions. A complete discussion is considered as the unit of analysis for this categorisation. An interrater agreement of 90% between two coders was reported. Negotiations resulted in a 100% consensus. The third aspect, stages of perspective taking in discussions, has been derived from Selman’s (1980) perspective-taking categories. Selman (1980) defined five levels of the coordination of social perspectives, which served as a theoretical basis for the instrument, namely: (a) stage 0: undifferentiated and egocentric; (b) stage 1: differentiated and subjective role-taking; (c) stage 2: self-reflective, second person and reciprocal perspective; (d) stage 3: third-person and mutual perspective taking; and (d) stage 4: in-depth and societal-symbolic perspective taking. The unit of analysis for this aspect was again a complete discussion. Interrater agreement between two raters added up to 80%. Discussions between coders resulted in a 100% consensus (Järvelä & Häkkinen, 2002).

Veldhuis-Diermanse (2002)

Veldhuis-Diermanse (2002) developed a method to analyse students’ learning in CSCL-environments. It is based on a constructivist view on learning and focuses on knowledge construction. More specifically it is partially rooted in the classification of Vermunt (1992), who distinguishes cognitive, affective, and metacognitive learning activities. Velduis-Diermanse's method consists of three steps. In a first step, the participation and interaction is analysed. Both written and read notes are taken into account, together with the density of the discourse. The density is an indicator for the level of engagement in the discussions, and is measured by the proportion of actual connections between students to the maximum possible connections (Veldhuis-Diermanse, 2002). In the second step, the focus is on the different learning activities. This comprises cognitive learning activities, such as debating, using external or internal information; affective learning activities; and metacognitive learning activities, such as planning, keeping clarity, and monitoring. The third step focuses on the quality of constructed knowledge and is based on the structure of the observed learning outcome (SOLO) taxonomy of Biggs and Collis (1982), as described by Schrire (2006). Four levels are identified: level D (unistructural), where one relevant aspect of the task is picked up and used; level C (multistructural), where several relevant aspects of the task are acquired but not connected; level B (relational), where the learned components are integrated into a coherent whole; and finally the highest level A (extended abstract), where the acquired structure becomes transferable to the overall meaning (Veldhuis-Diermanse, 2002).

Meaningful units and whole messages were chosen as unit of analysis for respectively the first (step 2) and the second coding scheme (step 3). The author reports a Cohen's kappa of .82 (based on 20 randomly selected notes) for the analysis of cognitive learning activities (step 2) and a Cohen's kappa of .72 and percent agreement of .80 (based on 25 randomly selected notes) for the analysis of the quality of the knowledge constructed (step 3).

Lockhorst, Admiraal, Pilot, and Veen (2003)

Lockhorst et al. (2003) base their instrument on a constructivist framework. They focus on online cooperation, and more specifically on the learning strategies that lead to an in-depth level of information exchange. They depart from the individual in the social state of affairs, and are less focused on the quality of the information exchanged or the knowledge constructed, but their main interest is the quality of the learning strategies used to construct knowledge.

The method developed by Lockhorst et al. is based on the analytical framework of Henri (1992). It includes five different instruments based on five perspectives. The first perspective is participation. This is measured by the number of statements and by Freeman's degree, which represents the centrality of a person in a social network. The second perspective is the nature of the content, which comprises four codes: (1) content related, (2) procedural, (3) social, and (4) no code. The third perspective is interaction and focuses on threads or chains of semantically or conceptually connected messages. For each thread the length, the number of layers, and the content is described. The fourth dimension focuses on information processing and is measured by a Likert scale from surface to deep information on a number of learning activities: (a) repeating, (b) interpreting, (c) argumentative, (d) adding new elements, (e) explaining, (f) judgmental, (g) asking questions, (h) offering solutions, (i) offering strategies and, (j) questioning. The fifth perspective is procedural information. Procedural statements are analysed with an instrument that consists of six categories: (a) evaluative, (b) planning, (c) communication, (d) technical, (e) description, and (f) rest.

In accordance with Henri (1992), Lockhorst et al. use the unit of meaning as unit of analysis. For the second perspective (nature of content) a Cohen's kappa of .73 was calculated, comparing the work of two independent raters.

Pena-Shaff and Nicholls (2004)

Pena-Shaff and Nicholls (2004) developed an instrument to evaluate the knowledge construction processes in online discussions. Social constructivist learning theory served again as the theoretical framework for this instrument. The authors also concentrate on the quantitative analysis of participation and interaction rates (Pena-Shaff & Nicholls, 2004). Discussions with peers are considered to foster learning. The construction of knowledge is a social, dialogical process in which students should be actively involved (Pena-Shaff & Nicholls, 2004). Pena-Shaff and Nicholls (2004) make a distinction between 11 categories: question, reply, clarification, interpretation, conflict, assertion, consensus building, judgment, reflection, support and other. They further state that statements of clarification, interpretation, conflict, assertion, judgment, and reflection appear to be most directly related to the knowledge construction process.

The authors used sentences within messages as the basic unit of analysis, but also complete paragraphs are used as the unit of analysis, in order to maintain the meaning of a given sentence (Pena-Shaff & Nicholls, 2004). In their research, involving undergraduates, graduates, and university employees that worked together during 3 weeks, 152 messages of 35 students were analysed. Coding and recoding was used to check for ambiguity in the coding. Two other independent coders were involved in the procedure. However, no reliability data have been reported.

Weinberger and Fischer (2006)

Weinberger and Fischer (2006) argue that learners in a CSCL-environment are often supposed to discuss their perspectives on a problem and engage in argumentative discourse with the goal to acquire knowledge. They propose a multi-dimensional approach to analyse argumentative knowledge construction. Four different process dimensions are identified: participation, epistemic, argumentative, and social mode. The participation dimension consists of two indicators, namely the quantity of participation, which designates whether learners participate at all, and the heterogeneity of participation, which specifies whether the learners participate on an equal basis. The epistemic dimension is divided into off-task and on-task discourse. The latter is further subdivided in three categories: the construction of problem space, the construction of conceptual space, and the construction of relations between conceptual and problem space. The argument dimension comprises the construction of single arguments, which encompasses claims, grounds with warrants, or qualifiers; and it comprises the construction of sequences of arguments, which includes arguments, counterarguments, and replies. The last dimension is the dimension of social modes of co-construction. It contains five categories: externalisation, elicitation, quick consensus building, integration-oriented consensus building, and conflict-oriented consensus building. For an in-depth discussion of this framework, we refer to Weinberger and Fischer (2006).

The authors apply units of analysis on both micro- and macro-level. A micro-segment contains a relation between two elements; these elements can be theoretical concepts or pieces of case information. Usually, micro-segments are a part of a sentence. A macro-segment consists of at least two micro-segments and is used to examine the relationship between these micro-segments. They report a percent agreement on micro-segmentation of .87, with a Cohen’s kappa of .72. Furthermore, interrater reliability data for the different dimensions is available. A Cohen’s kappa of .90 is reported for the epistemic dimension. For the argument dimension and the social modes dimension the authors report a Cohen’s kappa of respectively .78 and .81.

Table 2.1
Overview of the content analysis schemes.

Instrument	Theoretical background	Unit of analysis	Interrater reliability
Henri (1992)	Cognitive and metacognitive knowledge	Thematic unit	Not reported
Newman, Webb, & Cochrane (1995)	Critical thinking	Thematic unit	Not reported
Zhu (1996)	Theories of cognitive and constructive learning Knowledge construction	Message	Not reported
Gunawardena, Lowe, & Anderson (1997)	Social constructivism Knowledge construction	Message	Not reported
Bullen (1997)	Critical thinking	Message (several indicators possible)	Percent agreement
Fahy, Ally, Crawford, Cookson, Keller, & Prosser (2000)	Social network theory Interactional exchange patterns	Sentence	Percent agreement Cohen's kappa
Veerman & Veldhuis-Diermanse (2001)	Social constructivism knowledge construction	Message	Percent agreement
Rourke, Anderson, Garrison, & Archer (1999)	Community of inquiry Social presence	Thematic unit	Holsti's coefficient
Garrison, Anderson, & Archer (2001)	Community of inquiry Cognitive presence	Message	Holsti's coefficient Cohen's kappa
Anderson, Rourke, Garrison, & Archer (2001)	Community of inquiry Teaching presence	Message	Cohen's kappa
Järvelä & Häkkinen (2002)	Social constructivism Perspective taking	Message – Complete discussion	Percent agreement
Velduis-Diermanse (2002)	Social constructivism Knowledge construction	Thematic unit	Percent agreement Cohen's kappa
Lockhorst, Admiraal, Pilot, & Veen (2003)	Social constructivism Learning strategies	Thematic unit	Cohen's kappa
Pena-Shaff & Nicholls (2004)	Social constructivism Knowledge construction	Sentence (sometimes paragraphs)	Code-recode and interrater procedures, but no reported coefficients
Weinberger & Fischer (2006)	Social constructivism Argumentative knowledge construction	Micro-level and macro-level units of analysis	Percent agreement Cohen's kappa

Discussion of the state-of-the-art in content analysis approaches

Theoretical framework

Stahl (2003) argues that the form of communication that appears in computer-mediated interaction "has special requirements and needs its own theory of communication". Studying the approaches discussed above, we can conclude that concepts from other theories or frameworks are borrowed, but a powerful theory to guide research is still lacking (De Laat & Lally, 2004; Stahl, 2004). When studying the theoretical frameworks of the instruments, a large variety of concepts are mentioned: cognitive and metacognitive knowledge and skills (Henri, 1992); critical thinking (Bullen, 1997; Newman et al., 1995); knowledge construction (Gunawardena et al., 1997; Pena-Shaff & Nicholls, 2004; Veerman & Veldhuis-Diermanse, 2001; Veldhuis-Diermanse, 2002; Weinberger & Fischer, 2006; Zhu, 1996); cognitive, social, and teaching presence (Anderson et al., 2001; Garrison et al., 2001; Rourke et al., 1999); perspective-taking (Järvelä & Häkkinen, 2002); interactional exchange patterns (Fahy et al., 2001); or learning strategies (Lockhorst et al., 2003). Although elements of the theoretical background are mentioned in all cases, not all studies present a clear link between the theory and the instruments. In this respect, the importance of systematic coherence is to be stressed. Some instruments elaborate the operational definition of theoretical concepts, while this is missing in other instruments. From the overview it is also clear that a number of researchers build on earlier work, but at the empirical level, links are hardly made between the new and previous analysis approaches.

A separate point of discussion is the differences between the instruments in the number of categories and the level of detail. Fahy et al. (2001) complain in this respect about the lack of discriminating capability of instruments. They are concerned that the communicative richness of transcripts may not be fully revealed when large portions of the transcripts are coded into very few interaction categories.

A last issue is the weak empirical base of the models. The majority of instruments has been developed in the context of limited empirical studies, building on small numbers of participants, restricted numbers of messages and discussions during short periods of time. Moreover, most empirical studies were descriptive in nature and did not primarily focus on hypotheses testing. This small research base does not favor the validation of the instruments nor does it help to underpin the theoretical foundation.

The unit of analysis

The unit of analysis determines how the overall discussion is to be broken down into manageable items for subsequent coding according to the analysis categories. The choice for the unit of analysis affects the accuracy of the coding and the extent to which the data reflect the true content of the original discourse (Hearnshaw, 2000). Four of the instruments discussed above use thematic units (units of meaning) (Henri, 1992; Lockhorst et al., 2003; Newman et al., 1995; Rourke et al., 1999). Seven recommend the use of complete messages as units of analysis (Anderson et al., 2001; Bullen, 1997; Garrison et al., 2001; Gunawardena et al., 1997; Järvelä & Häkkinen, 2002; Veerman & Veldhuis-Diermanse, 2001; Zhu, 1996). One study focuses on both thematic units and messages (Veldhuis-Diermanse, 2002) and another one uses micro- and macro-segments (Weinberger & Fischer, 2006). Only two studies use sentences as the unit of analysis (Fahy et al., 2001; Pena-Shaff & Nicholls, 2004). In one instrument, the whole discussion is the unit of analysis (Järvelä and Häkkinen, 2002).

The unit of analysis determines the granularity in looking at the transcripts in the online discussion. To get a complete and meaningful picture of the collaborative process, this granularity needs to be set appropriately. As is discussed in Strijbos et al. (2006) each choice represents advantages and disadvantages. It is striking that the choice for a specific unit of analysis is hardly linked to the theoretical base of the analysis instruments. What is for instance the best option when focusing on critical thinking? Most authors refer to criteria that are linked to objectivity and reliability in choosing the unit of analysis. The issue is however never related to validity questions. Garrison et al. (2000) indicate that opting for themes as the unit of analysis presents problems in terms of the reliable identification of each individual theme, resulting in subjectivity and inconsistency.

The fact that most studies opt for complete messages as the unit of analysis, is explained by the argument of Rourke et al. (2001) that this is the most objective identification of units of analysis, and that in this way researchers work with the unit as it has been defined by the author of the message.

Apart from the difficulties with regard to the choice of an appropriate unit of analysis, current reporting practices can be criticised. Most authors do not mention arguments for selecting or determining the unit of analysis; moreover a clear definition of the unit of analysis and the segmentation procedure is not always available and most of the studies do not report interrater reliability measures concerning the segmentation procedure (see also Strijbos et al., 2006).

Interrater reliability

The importance of a clear and transparent coding procedure and the inter/intra-rater reliability has been stressed throughout this article. We encouraged the use of multiple coefficients to determine interrater reliability, such as percent agreement and Krippendorff's alpha. Reporting multiple reliability indices is of importance considering the fact that no unambiguous standards are available to judge reliability values. Next to the concrete values, also information about the sample, the coding procedure, and the training should be reported carefully in order to improve the quality of research in the field of content analysis.

When studying the fifteen instruments from this perspective, the picture is rather critical. In most studies, the procedure to determine the reliability is not reported. In five studies no reliability indices were reported. In two cases the authors reported Cohen's kappa interrater reliability coefficients, in four cases percent agreement or an equivalent measure was made available, and in four other cases both were reported. In order to give readers an overview of the interrater reliability of the coding schemes and procedures, calculating and reporting these measures is necessary.

Limitations and conclusions

The critical discussion of content analysis models, presented in this article, has some limitations. Only a selection of content analysis instruments has been presented. Specific criteria were used to develop the list, but the overview is not complete. The same is true for the selection of studies that build on the work of the authors of the analysis instruments. Furthermore, we only discussed a basic set of criteria in relation to each instrument: the theoretical base, the unit of analysis, and reliability data. But these three aspects are crucial. The systematic coherence between theory and analysis categories, a grounded choice for the unit of analysis, and information about the (interrater) reliability and procedure are necessary conditions for applying content analysis in the context of a sound research methodology.

The picture that results from the analysis carried out in this article is on some points unfavorable. As discussed above, coherent and empirically validated content analysis instruments are still lacking and so far these instruments have not fully resulted in progress in the development of the CSCL-research tradition. Therefore, the authors of the present article call for replication studies that focus on the validation of existing instruments in larger empirical studies. Hypothesis testing should be a central focus in these studies. The authors are convinced that this research reorientation will be helpful to foster the scientific quality and status of CSCL-research.

References

Anderson, T., Rourke, L., Garrison, D. R., & Archer, W. (2001). Assessing teaching presence in a computer conference context. *Journal of Asynchronous Learning Networks, 5*. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v5n2/pdf/ v5n2_anderson.pdf

Berger, D. E., Pezdek, K., Banks, W. P. (1987). *Applications of cognitive psychology: Problem solving, education and computing*. Mahwah, NJ: Lawrence Erlbaum.

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: the SOLO Taxonomy.* New York: Academic Press.

Bretz, R. (1983). Media for interactive communication. London: Sage.

Bullen, M. (1997). *A Case Study of Participation and Critical Thinking in a University-Level Course Delivered by Computer Conferencing.* Unpublished doctoral dissertation. University of Britisch Columbia, Vancouver, Canada. Retrieved September 1, 2006, from http://www2.cstudies.ubc.ca/~bullen/Diss/ thesis.doc

Cook, D., & Ralston, J. (2003). Sharpening the focus: methodological issues in analysing online conferences. *Technology, Pedagogy and Education, 12,* 361-376.

De Laat, M., & Lally, V. (2004). It's not so easy: Researching the complexity of emergent participant roles and awareness in asynchronous networked learning discussions. *Journal of Computer Assisted Learning, 20*, 165-171.

Dewey, J. (1933). *How we think*. Boston, MA: D. C. Heath.

De Wever, B., Schellens, T., & Valcke, M. (2004). Samenwerkend leren via informatie- en communicatietechnologie [Collaborative learning through ICT]. In I. D'haese & M. Valcke (Eds.), *Digitaal leren. ICT Toepassingen in het hoger onderwijs [Digital Learning. ICT applications in higher education]*. Tielt: Lannoo Campus.

Ennis, R. H. (1987). A taxonomy of critical thinking dispositions and abilities. In J.B. Baron, R.J. Sternberg (Eds.), *Teaching thinking skills: theory and practice* (pp. 9-26). New York: W.H. Freeman.

Fahy, P. (2001). Addressing some common problems in transcript analysis. *International Review of Research in Open and Distance Learning 1*. Retrieved

September 1, 2006, from http://www.irrodl.org/content/v1.2/research.html/ #Fahy

Fahy, P. (2002a). *Assessing critical thinking processes in a computer conference.* Centre for Distance Education, Athabasca University. Retrieved September 1, 2006, from http://cde.athabascau.ca/softeval/ reports/mag4.pdf

Fahy, P. J. (2002b). Coding Transcripts: An illustration of issues and approaches. In J. Baggaley, P. J. Fahy, & C. O'Hagan (Eds.), *Educational Conferencing: video and text traditions. Proceedings of the 1ste International Symposium on Educational Conferencing (ISEC).* Bannff, Alberta. Retrieved September 1, 2006, from http://cde.athabascau.ca/ISEC2002/papers/fahyMDDE.pdf

Fahy, P., Ally, M., Crawford, G., Cookson, P. S., Keller, V., & Prosser, F. (2000). The development and testing of a tool for analysis of computer mediated conferencing transcripts. *Alberta Journal of Educational Research, 46,* 85-88.

Fahy, P., Crawford, G., & Ally, M. (2001). Patterns of Interaction in a Computer Conference Transcript. *International Review of Research in Open and Distance Learning, 2*. Retrieved September 1, 2006, from http://www.irrodl.org/content/v2.1/fahy.pdf

Garrison, D. R. (1991). Critical thinking and adult education: A conceptual model for developing critical thinking in adult learners. *International Journal of Lifelong Education*, 10, 287-303.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical thinking in a text-based environment: Computer conferencing in higher education. *Internet and Higher Education, 11,* 1-14. Retrieved September 1, 2006, from http://communitiesofinquiry.com/documents/ CTinTextEnvFinal.pdf

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education, 15*, 7-23. Retrieved September 1, 2006, from http://communitiesofinquiry.com/documents/CogPresPaper_June30_.pdf

Graesser, A. C., & Person, N.K. (1994). Question asking during tutoring. *American Educational Research Journal*, 31, 104-137.

Gunawardena, C. N., Carabajal, K., & Lowe, C. A. (2001). Critical Analysis of Models and Methods Used to Evaluate Online Learning Networks. In *American Educational Research Association Annual Meeting.* Seattle: American Educational Research Association.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17,* 397-431.

Häkkinen, P., Järvelä, S., & Byman, A. (2001). Sharing and making perspectives in web-based conferencing. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), *European Perspectives on Computer-Supported Collaborative Learning. Proceedings of the First European Conference on CSCL*. Maastricht: McLuhan Institute, University of Maastricht.

Hara, N., Bonk, C. J., & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science, 28,* 115-152.

Hatano, C., & Inagaki, K. (1991). Sharing cognition through collective comprehension activity. In Resnick, L., Levin, J., & Teasley, S.D. (Eds.). *Perspectives on socially shared cognition* (pp. 331-349). Washington, D.C.: American Psychology Association.

Hearnshaw, D. (2000). Towards an objective approach to the evaluation of videoconferencing. *Innovations in Education and Training International, 37,* 210-217.

Henri, F. (1992). Computer Conferencing and Content Analysis. In A. R. Kaye (Ed.), *Collaborative Learning Through Computer Conferencing. The Najadan Papers* (pp. 117-136). London: Springer-Verlag.

Järvelä, S., & Häkkinen, P. (2002). Web-based cases in teaching and learning: The quality of discussions and a stage of perspective taking in asynchronous communication. *Interactive Learning Environments, 10,* 1-22.

Kanuka, H., & Anderson, T. (1998). Online Social Interchange, Discord, and Knowledge Construction. *Journal of Distance Education, 13*. Retrieved September 1, 2006, from http://cade.athabascau.ca/vol13.1/kanuka.html

Krippendorff, K. (1980). *Content Analysis, an Introduction to Its Methodology*. Thousand Oaks, CA: Sage Publications.

Kupper, L. L., & Hafner, K. B. (1989). On assessing interrater agreement for multiple attribute responses. *Biometrics, 45,* 957-967.

Lally, V. (2001). Analysing Teaching and Learning Interactions in a Networked Collaborative Learning Environment: issues and work in progress. In *Euro CSCL 2001* (pp. 397-405). Maastricht McLuhan Institute. Retrieved September 1, 2006, from http://www.mmi.unimaas.nl/euro-cscl/Papers/97.doc

Lazonder, A. W., Wilhelm, P., & Ootes, S. A. W. (2003). Using sentence openers to foster student interaction in computer-mediated learning environments. *Computers & Education, 41,* 291-308.

Lockhorst, D., Admiraal, W., Pilot, A., & Veen, W. (2003). Analysis of electronic communication using 5 different perspectives. Paper presented at ORD 2003. In Heerlen.

Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content Analysis in Mass Communication: Assessment and Reporting of Intercoder Reliability. *Human Communication Research, 28,* 587-604.

Macdonald, J. (2003). Assessing online collaborative learning: process and product. *Computers & Education, 40,* 377-391.

Marra, R. M., Moore, J. L., & Klimczak, A. K. (2004). Content analysis of online discussion forums: A comparative analysis of protocols. *Educational Technology Research & Development, 52, 23-40.*

McKenzie, W., & Murphy, D. (2000). "I hope this goes somewhere": Evaluation of an online discussion group. *Australian Journal of Educational Technology, 16,* 139-257.

Meyer, K. (2004). Evaluating Online Discussions: Four different frames of analysis. *Journal of Asynchronous Learning Networks*, *8* (2), 101-114.

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

Newman, D. R., Webb, B., & Cochrane, C. (1995). A content analysis method to measure critical thinking in face-to-face and computer supported group learning. *Interpersonal Computing and Technology, 3,* 56-77. Retrieved September 1, 2006, from http://www.qub.ac.uk/mgt/papers/methods/contpap.html

Pena-Shaff, J. B., Martin, W., & Gay, G. (2001). An epistemological framework for analyzing student interactions in computer-mediated communication environments. *Journal of Interactive Learning Research*, *12,* 41-48. Retrieved September 1, 2006, from http://www.aace.org/dl/files/JILR/Jilr-12-01-41.pdf

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42,* 243-265.

Perraton, H. (1988). A theory for distance education. In D. Sewart, D. Keegan, & B. Holmberg (Eds.), Distance education: International perspectives (pp. 34-45). New York: Routledge.

Rourke, L., & Anderson, T. (2003). *Validity in quantitative content analysis.* Retrieved September 1, 2006, from http://communitiesofinquiry.com/sub/papers.html

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (1999). Assessing social presence in asynchronous text-based computer conferencing. *Journal of Distance Education, 14,* 51-70. Retrieved September 1, 2006, from http://cade.athabascau.ca/vol14.2/ rourke_et_al.html

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Methodological Issues in the Content Analysis of computer conference transcripts. *International Journal of Artificial Intelligence in Education*, *12*, 8-22.

Schellens,T., & Valcke, M. (2002). Asynchrone discussiegroepen: een onderzoek naar de invloed op cognitieve kennisverwerving [Asynchronous discussion groups: Investigating the influence on cognitive knowledge construction]. *Pedagogische Studiën* 79, 451-468.

Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior, 21,* 957-975.

Schellens, T., & Valcke, M. (2006). Fostering knowledge construction in university students through asynchronous discussion groups. *Computers & Education*, 46, 349-370.

Schrire, S. (2006). Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis. *Computers & Education, 46,* 49-70.

Selman, R. L. (1980). *The growth of interpersonal understanding.* New York: Academic Press.

Stacey, E., & Gerbic, P. (2003). Investigating the impact of computer conferencing: Content analysis as a manageable research tool. In G. Crisp, D. Thiele, I. Scholten, S. Barker, & J. Baron (Eds.), *Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*. Adelaide, 7-10 December 2003. Retrieved September 1, 2006, from http://www.ascilite.org.au/conferences/adelaide03/docs/pdf/495.pdf

Stahl, G. (2003). *Communication and Learning in Online Collaboration.* Paper presented at GROUP '03. In Sannibel Island, Florida. Retrieved September 1, 2006, from http://www.cis.drexel.edu/faculty/gerry/publications/conferences/2003/group/group03.doc

Stahl, G. (2004). Building Collaborative Knowing: Contributions to a Social Theory of CSCL. In J. W. Strijbos, P. Kirschner, & R. L. Martens (Eds.), *What We Know About CSCL in Higher Education*. Amsterdam: Kluwer.

Strijbos, J. W., Martens, R. L., Prins, F. J., & Jochems, W. M. G. (2006). Content analysis: What are they talking about? *Computers & Education, 46,* 29-48.

Veerman, A., & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In *Euro CSCL 2001* (pp. 625-632). Maastricht: McLuhan institute, University of Maastricht.

Veldhuis-Diermanse, A.E. (2002). *CSCLearning? Participation, learning activities and knowledge construction in computer-supported collaborative learning in* *higher education.* Unpublished doctoral dissertation. Wageningen Universiteit, Nederland. Retrieved September 1, 2006, from http://www.gcw.nl/dissertations/3187/dis3187.pdf

Vermunt, J.D. (1992). *Leerstijlen en sturen van leerprocessen in het hoger onderwijs. Naar procesgerichte instructie in zelfstandig denken* [Learning styles and regulating of learning in higher education: Towards process-oriented instruction in autonomous thinking]. PHdissertation. Lisse: Swets & Zeitlinger.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education, 46,* 71-95.

Zhu, E. (1996). Meaning Negotiation, Knowledge Construction, and Mentoring in a Distance Learning Course. In *Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technolgy.* (pp. 821-844). Indianapolis, IN. Retrieved September 1, 2006 from http://www.eric.ed.gov/sitemap/ html_0900000b8014818b.html

Chapter 3*

Discussing patient management online: The impact of roles on knowledge construction for students interning at the paediatric ward

Abstract

The objectives of this study are to explore the use of asynchronous discussion groups during medical students' clinical rotation in paediatrics. In particular, the impact of role assignment on the level of knowledge construction through social negotiation is studied.

Case-based asynchronous discussion groups were introduced to enhance reflection and critical thinking on patient management and treatment, and to offer an exercise in evidence-based medical practice. Groups of approximately 4 to 5 students were asked to discuss 4 authentic cases during clinical rotation in paediatrics. 49 students interning at the paediatric ward participated in this study.

With respect to role assignment, differences between groups (1) with a student or an instructor as moderator and (2) with or without a developer of alternatives for patient management were explored. A content analysis was performed to explore the different levels of social construction of knowledge.

The results of multilevel logit analyses show a significant difference in knowledge construction through social negotiation between conditions with a student moderator and conditions where the instructor is moderating, but only when a developer of alternatives is involved. No significant difference was revealed between student-moderated and instructor-moderated groups without a developer of alternatives.

It can be concluded that when both the moderator and developer role are assigned to students, their contributions are more likely to reflect a high level of knowledge construction.

Introduction

Current educational practice in medical education shows a growing use of Information and Communication Technologies (ICT). The information component of ICT is essential: recent articles argue that "the full text of medical journals is becoming increasingly available electronically" (Wallace, 2001, p. 778) and the

---

* Based on: De Wever, B., Van Winckel, M., & Valcke, M. (in press). Discussing Patient Management Online: The Impact of Roles on Knowledge Construction for Students Interning at the Paediatric Ward. *Advances in Health Sciences Education*, 1-18. Retrieved September 1, 2006, from http://dx.doi.org/10.1007/s10459-006-9022-6

use of ICT to access medical information in general has important implications in medical education (Carney et al., 2004). But also the communication component of ICT has its importance for medical education, as “computer technologies can support a wide range of learning activities which engage students in a continuous collaborative process of building and reshaping understanding” (Greenhalgh, 2001, p. 40). The present study is primarily connected to this communication component and focuses on asynchronous online discussion groups as a rich environment for active learning in which learners actively build knowledge (Greenhalgh, 2001; Grabinger, 1996).

The advantages of the application of asynchronous discussion groups are fourfold. First, integrating ICT gives students the opportunity to get acquainted with essential technologies in order to keep up with the rapid growth in medical knowledge (Hagdrup et al., 1999). Second, asynchronous discussion groups are independent of time and location, increasing educational flexibility (Bernard & Lundgren-Cayrol, 2001). Third, asynchronous discussions provide students with extra time to reflect, think, and search for additional information before contributing to the discussion (De Wever, Schellens, Van Keer, & Valcke, 2006; Pena-Shaff & Nicholls, 2004). Fourth, asynchronous discussion groups can be used to integrate clinical placements within the rest of the curriculum (Hagdrup et al., 1999; Stromso, Grottum, & Hofgaard Lycke, 2004).

Building on these advantages, online discussion groups were introduced in the context of this study to stimulate reflection and critical thinking on patient management during a clinical rotation in paediatrics. The present study focuses more specifically on enhancing the process of active knowledge construction in the online discussion groups. The concept of collaborative learning and knowledge construction through social negotiation is borrowed from social constructivist theory. Constructivists see learning as a process of engaging in self-regulated, constructive, and reflective activities. Social constructivists furthermore consider individual learning as socially mediated. In this view, group settings can foster learning via questioning, criticism, and evaluation (Schrire, 2004). Therefore, it is argued that, in addition to individual cognitive processes, social processes play an important role in learning (Gunawardena, Lowe, & Anderson, 1997; Schrire, 2004). Within collaborative learning, learners engage in shared knowledge building processes: knowledge is not just transferred, but co-constructed.

Research indicates that knowledge construction activities in online collaborative groups are influenced by the design and organisation of the learning environment (Lockhorst, Admiraal, Pilot, & Veen, 2002). It is important to thoroughly compose and structure asynchronous discussions, as structure is valuable to trigger meaningful discourse (Gilbert & Dabbagh, 2005; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). In this respect, this article focuses specifically on the impact of role assignment on knowledge construction through social negotiation.

The introduction of roles as a structuring tool

Scripts or structuring tools can specify, sequence, and assign collaborative learning activities in online learning environments (Kollar, Fischer, & Hesse, 2003). Roles in particular can serve as a scripting tool to support the process of social negotiation in the discussions. They are seen as important factors in determining the quality of knowledge construction in a community (Aviv, Erlich, & Ravid, 2003). Furthermore, research revealed that roles appear to affect the perceived level of group efficiency and elicit more task content statements (Strijbos, Martens, Jochems, & Broers, 2004). In this study, roles are introduced to structure the discussion process. Two different roles were assigned: a moderator and a developer of alternatives for patient management. The task of the moderator comprises monitoring the discussions, asking critical questions, and inquiring for the opinion of others. The role of developer consists of the exploration of alternative treatments for the ones already discussed (e.g. no medication, soothing medication only, other ways to administer medication, other forms/kinds of medication, etc.). This study focuses more specifically on the difference between instructor-moderated and student-moderated discussions on the one hand, and on discussions with versus without a developer of alternatives on the other hand.

As to the difference between student-guided versus instructor-guided discussions, the present study joins in with a number of studies in two related research fields, namely peer-guided instruction in higher education and peer tutoring in the context of problem-based learning. Concerning achievement of students, research in the former research field mostly showed no differences or rather conflicting results: sometimes better performances of student-guided groups are reported and sometimes instructor-guided groups perform better (Moust & Schmidt, 1994). Research in the latter field revealed either no differences or differences in favour of instructor-guided groups (Moust & Schmidt, 1994; Dolmans et al., 2002). Research furthermore shows that novice students are more dependent on their tutor’s expertise (Schmidt, Van Der Arend, Moust, Kokx, & Boon, 1993). In addition, Dolmans et al. (2002) mention a shift from outcome-oriented studies to more process-oriented studies. They conclude that the content expertise of a tutor leads to more teacher-directed activities. Non-content-experts tend to use their process-facilitation expertise more to direct the discussion groups, resulting in more student-initiated activities.

As to the difference between discussions with and without a developer of alternatives, it can be argued that the search for – and the development of – alternative solutions or heterogeneous answers is regarded as important, since one of the theoretical fundaments of between-peers learning environments is the socio-cognitive conflict (Joiron & Leclet, 2002). Researchers use the concept of socio-cognitive conflict to take account of how understanding may be shifted by interacting with other learners that have a rather different understanding of events. The basic idea is that when two contrasting world views are brought into contact, this is likely to stimulate some cognitive restructuring, learning, and improved understanding (Mercer, 1996). Solving socio-cognitive conflicts can increase the amount of explicit comparisons of information and engage the different interaction partners into joint knowledge construction through social negotiation. Furthermore, processes of reasoning and explaining are fruitful for collaborative learning (Joiron & Leclet, 2002).

Taking into account that our context involves advanced level medical students, that the role of moderator is to guide the discussions (and not to deliver subject matter), that our focus is on the process of constructing knowledge through social negotiation, that developers of alternatives should stimulate heterogeneous contributions, and that roles increase students' awareness of collaboration (Strijbos et al., 2004), this study aims to show that enhanced collaboration resulting in higher levels of knowledge construction can be expected when the role of moderator is assigned to a student and when a developer of alternatives is involved.

Method

Participants

The study involved a total of 49 students, interning at the paediatric ward of Ghent University Hospital. They were enrolled as sixth-year medical students and participated in this study during their clinical rotation. They were on average 24 years (SD = 3, range 23-43) and there were 32 females (65%) and 17 males (35%). Each student usually rotated for one month at the paediatric ward. On average, four to five student-interns per month were involved in the asynchronous discussions.

Context

At the Ghent University Hospital asynchronous discussion groups were introduced during the clinical rotation in paediatrics. All student-interns meet weekly for case-based face-to-face discussion groups, guided by a staff member. During these discussions students present patient problems to their peers, who interactively try to define the patient problem and explore the history, clinical examination, differential diagnosis, and therapeutic options. Since interference with ward-based activities and staff-schedules made the expansion of face-to-face contacts impossible, online case-based discussion groups were introduced in order to meet students' and staff's wishes for extra discussions focusing on patient management and therapeutic options. Although both collaborative approaches run in parallel, the online discussions differ from the face-to-face discussions. While the face-to-face discussions focus on the diagnostic process and start from the patients' presenting problem, the main goal for introducing the case-based asynchronous discussion groups was to enhance reflection and critical thinking on patient management. The asynchronous e-discussions focus on treatment options and informing the patients or parents. They start from a complete case description with a given diagnosis, based on real-life cases. The content of the cases stimulates students to learn collaboratively, to reflect, and to use electronic information resources. Several links to electronic resources, such as journals, Medline, and Evidence Based Medicine information databases were provided and their employment was encouraged, as McGlade, McKeveney, Crawfored, and Brannigan (2001) pointed out that students' use of and skills in ICT is more influenced by specific course demands than by undertaking a single module in medical informatics.

Due to the specific nature of discussing in a computer-supported collaborative learning (CSCL) environment and the integrated use of ICT, an introductory session was organised for each group prior to the onset of the discussions. The introduction focused on the use of ICT in general, on the available electronic information resources, and on the applications in the CSCL environment. In order to ensure that students became familiar with the online discussion approach and the technology, they were confronted with a sample case which had to be solved through online discussion. To ensure commensurable training for all research groups, all introductory information could be retrieved online.

After the sample case, each group of students (including all students interning at the paediatric ward during one month) tackled four authentic cases. Each case was dealt with asynchronously over a two-week period. Participation in the discussion groups was obligatory and formed a formal part of the curriculum. Students were evaluated by a university staff member (25% of final score). Students were required to post a minimum of 4 messages per case discussion. Further, they were asked to support their contributions with arguments, scientific data, and information about the sources they referred to. For each case to be discussed, the students received information about the patient, the signs and symptoms, and the diagnosis. Three learning objectives were presented to the students: determining the ensuing patient management and treatment procedure, based on the analysis of the clinical problem; adducing argumentations to support the solutions and strategies put forward while evaluating the value of information found (Hagdrup et al., 1999); and verifying one's own contributions with other students' input.

During the first three days of every new discussion period, all students had to develop a solution to the case individually. During this period, they could not read each other's messages. From day four on, all posts were made visible and students started the discussion. Some of the discussions were moderated by a senior staff member of the medicine faculty, while others were moderated by one of the students in the group. In the first two weeks, students worked simultaneously on case one and two, while case three and four where both tackled in the following two weeks. The discussion groups were designed with Web Crossing (http://webcrossing.com/). This environment allows users to receive an outline of the discussion thread and to track individual students' input.

Research Design

Since the assignment of students to the specific research conditions could not be completely controlled, a quasi-experimental design was set up. Eleven groups of students, assigned to one-month clinical rotations in paediatrics, were involved in the study.

In order to study the impact of role assignment on the social construction of knowledge in this CSCL environment, different conditions were created on the basis of two variables: (1) the position of the moderator and (2) the presence of a developer of alternatives for patient management.

Concerning the first variable, the discussion groups were divided in two experimental conditions: a condition where the instructor was asked to moderate the discussions versus a condition where a student was requested to moderate the debates. In the latter condition, the assignment of the moderator role was clearly mentioned on the website of the discussion boards. A cross-over design was applied, so all students participated in both instructor-moderated and student-moderated discussions. Only one student per group was assigned the role of moderator, so not all students performed this role.

With regard to the second variable, two conditions were distinguished as well: in the first condition no one was asked to perform the role of developer of alternatives, while in the second condition one group member was explicitly asked to develop alternative treatments. By combining both variables, four different conditions were created. For each discussion information was obtained on the status of the moderator (instructor versus student), the developer of alternatives (absent versus present), and the discussion moment (first two weeks versus last two weeks of the month).

Hypotheses

This study examines the impact of role assignment on knowledge construction through social negotiation. As the role of moderator is carried out by either the instructor or a student, the differences between these two conditions are explored. Further, the study examines the impact of the allocation of a developer of alternatives for patient management to discussion groups. In addition, we want to check for an interaction effect between both experimental variables and for the effect of the point in time the discussions are organised (first two weeks versus last two weeks of the month). Finally, the levels of knowledge construction in contributions of students performing the role of moderator or developer of alternatives are examined. Building on previous research emphasising the importance attributed to structure in general (De Wever, Valcke, Van Winckel, & Kerkhof, 2002; Gilbert & Dabbagh, 2005; Schellens & Valcke, 2005) and more specifically to roles (Schellens, Van Keer, & Valcke; Aviv et al., 2003; Aviv, 2000; Strijbos et al., 2004), building on the literature of related research fields mentioned in the introduction, and taking into account that specific guidelines were provided to student moderators, the following hypotheses are tested: higher levels of knowledge construction can be observed in contributions of students in conditions with (1) a student as moderator (versus instructor-moderated discussions) and (2) a developer of alternatives; (3) an interaction effect between both variables exists: the combination of a student moderator and a developer of alternatives leads to higher levels of knowledge construction; and (4) students performing the role of moderator and developer of alternatives both contribute messages reflecting higher levels of knowledge construction.

Data set and analysis instrument

Data were gathered from March 2003 to January 2004. The data set comprises the transcripts of all messages posted by the students during the discussions. All messages in the transcripts were divided into thematical units of analysis. These message units were coded independently by two trained coders. Message units reflect specific levels of social construction of knowledge and differ in the amount of explicit comparison, contrasting, and discussion. In order to determine the level of social construction of knowledge, the interaction analysis model of Gunawardena et al. (1997) was applied. This model distinguishes different levels of knowledge construction activities: (1) sharing and comparing information, (2) identifying areas of disagreement, (3) negotiating meaning and co-construction of knowledge, (4) evaluation and modification of new schemas that result from co-construction, and (5) reaching and stating agreement and application of co-constructed knowledge. It is important to notice that, although messages at level 1 are a prerequisite for a discussion, all levels in the model are important and eventually the highest levels should be reached (Schellens & Valcke, 2005). This analysis scheme was selected on the basis of the social constructivist theoretical background, while taking into account that it is one of the few content analysis models with an existing research base (De Wever et al., 2006; Marra, Moore, & Klimczak, 2004; Schellens & Valcke, 2005).

Statistical analysis

To examine the interrater reliability, the statistical package R 1.8.1. was employed for the calculation of Krippendorff's alpha, while the descriptive results were calculated with SPSS 11.0.1. In order to take the hierarchical nesting of message units within students and students within groups into account, multilevel modelling was opted for. Multilevel models are developed to analyse data that have a hierarchical or clustered structure (Hox, 1998). To test the hypotheses, multilevel models based on a logit-link function are used. Both Predictive/Penalised Quasi-likelihood Procedure (PQL) second approximation procedures (Rasbash, Steele, Browne, & Prosser, 2004) and Markov chain Monte Carlo (MCMC) methods (Browne, 2004) were applied within MLwiN 2.01. No substantial differences between both methods were encountered. As MCMC methods are less biased (Browne, Subramanian, Jones, & Goldstein, 2005), all reported estimates are based on MCMC methods with at least 20000 iterations. All analyses assume a 95% confidence interval (alpha(α) = 0.05).

Coding strategy and reliability

Two independent coders were trained during approximately 3 hours to carry out the coding activity. First, they received an introduction to the research set-up. Next, they were informed on how to identify units of meaning and on how to assign codes to these units of analysis: they were introduced to the coding model, they discussed the theoretical basis, and explored coding examples for each level in the hierarchical interaction analysis model (Gunawardena et al., 1997).

Interrater reliability was checked. Due to the fact that thematic units were used as analysis units, calculating the interrater reliability was not easy. The problem is more specifically connected to the fact that every coder could identify her own thematic units. In case the distinguished units of different coders did not correspond, the units were broken up into parts equal to the smallest unit. If, for instance, coder A recognised two units in one message and coded the first unit as level 1 and the second as level 2; and coder B codes the whole message as level 1, we were forced to break down the message in two parts in order to analyse both codes. (Part one was coded level 1 by both raters, while part two was coded level 2 by the first rater and level 1 by the second).

All the coding was done independently with 25% of overlap (randomly selected) to calculate coding reliability. Both raters agreed upon 67% of all messages (percent agreement, PA = .67). However, the data were rearranged for analysis purposes (see results section). This resulted in a percent agreement of .74 for the categories on which the multilevel logit analyses are based. This can be considered reliable because, although no real consensus about a rule of thumb for the percent agreement statistic seems to exist, often a cut-off figure of .75 to .80 is used, while others declare .70 to be considered reliable (Rourke, Anderson, Garrison, & Archer, 2001; Neuendorf, 2002).

Results

In total 885 messages were analysed (11124 lines of text) and 1813 message units were identified. 291 message units (13.4% of the messages) were posted by the instructor and are not taken into account in the multilevel analyses. In total, 1522 student message units were analysed using the interaction analysis model of Gunawardena et al. (1997). 80 student message units were not coded, mainly because they did not contain information (empty messages), or contained duplicated information (double messages). Table 3.1 gives an overview of the messages coded and shows that 69 percent of the messages have been coded as level 1 (sharing and comparing of information). Further, it can be noticed that messages of level 2 and 3 (exploration of dissonance and negotiation of meaning) occur regularly (approximately 10 and 15 percent). Messages at level 5 (agreement statements and applications of newly-constructed meaning) occur less (approximately 6 percent), while messages of level 4 (testing synthesis) are quite rare (approximately 1 percent).

Table 3.1
Levels of knowledge construction through social negotiation based on the interaction analysis model of Gunawardena et al. (1997)

Level	Frequency	Percent
1. Sharing and comparing information	995	69.0
2. Exploration of dissonance	140	9.7
3. Negotiation of meaning	213	14.8
4. Testing synthesis	11	.8
5. Agreement statements and applications of newly-constructed meaning	83	5.8
Total	1442	100.0

As a relatively large proportion of the message units was coded as level 1, a dichotomous variable for knowledge construction was created by collapsing all the higher levels (level 2 to 5). This variable was the basis for all multilevel logit models. 69 percent of the message units (993 message units) were situated in the first category (low level of knowledge construction) and 31 percent (444 message units) in the second category (which will be referred to as high level of knowledge construction). By rearranging the data in this way, a distinction was made between messages focusing on sharing and comparing of information on the one hand and messages that go beyond this level and focus on the exploration of dissonance, negotiation of meaning, testing synthesis, or reflecting on the knowledge construction process on the other hand. This distinction can be compared with two stages in online learning distinguished by Salmon (2000): seeking and giving information versus knowledge construction (Greenhalgh, 2001; Salmon, 2000).

The first multilevel logit model (see model A in Table 3.2) was a three-level analysis, with message units at level 1, students at level 2, and groups at level 3. Large variation between groups is not assumed, partly because groups were composed equally and were considered equal and partly due to the cross-over design of the study (there were no groups in which all discussions were student-moderated or instructor-moderated and no groups in which all discussions had a developer of alternatives). Nevertheless, as individual learners are influenced by the social group and context to which they belong, and since the properties of this group are in turn influenced by the individuals who make up that group (Hox & Maas, 2002), the assumption of significant variance at the different hierarchical levels was checked. However, model A shows that both the between-group and the within-group between-student variance are not significantly different from zero ($\chi^2 = 1.147$, df = 1, p = .284 and $\chi^2 = 1.334$, df = 1, p = .248 respectively).

The second model is simplified and analyses message units at level 1, clustered within students at level 2 (see model B in Table 3.2). The variance at level 2 is significantly different from zero ($\chi^2 = 5.847$, df = 1, p = .016), so further simplification to one-level analyses is unsuitable.

In the third model the predictors concerning condition are added in the fixed part of the model. The reference category comprises message units in discussions where the instructor was moderating and a developer of alternatives was absent. Two dummy variables (one for the condition with student moderators and one for the condition with a developer of alternatives) and one interaction effect (student moderator * developer of alternatives) were added to the model. Model C in Table 3.2 shows that the parameter for the student moderator is not significant, whereas the parameter for the developer of alternatives points towards a significant negative impact on the level of knowledge construction reflected in the message units. The odds of reflecting a high level of knowledge construction are about two times (OR = 0.50) lower for messages in the condition with a developer of alternatives as compared to the reference category. However, the parameter for the interaction between both conditions points towards a significant positive impact: the odds of reflecting a high level of knowledge construction are about 1.6 times (OR = 1.58) higher for messages in the student-moderated condition with a developer of alternatives as compared to the reference category.

In the fourth model (model D in Table 3.2) the period when the discussions took place was controlled for, in order to check whether discussions during the last two weeks reflected differences in the level of knowledge construction as compared to discussions in the first two weeks. However, no significant differences were found. As parsimonious models are striven for, this variable was excluded from the subsequent analysis.

In the fifth model (model E in Table 3.2), a variable indicating the specific role assignment was added. The results of this final model are discussed in detail. The reference category consists of message units in conditions where the instructor is moderating and where no developer of alternatives is involved. The average

Table 3.2
Multilevel estimates for impact on knowledge construction

Parameter	Model A	Model B	Model C	Model D	Model E	OR&CI E
Fixed						
Intercept	-0.924 (0.143) [-6.462] {< .001}	-0.950 (0.113) [-8.407] {< .001}	-1.040 (0.149) [-6.980] {< .001}	-1.011 (0.145) [-6.966] {< .001}	-1.029 (0.131) [-7.855] {< .001}	
Condition: Student-moderator			0.236 (0.150) [1.573] {.116}	0.249 (0.146) [1.705] {.088}	-0.012 (0.157) [-0.076] {.939}	OR: 0.99 CI: 0.73–1.34
Condition: Developer alternatives			-0.689 (0.273) [-2.524] {.012}	-0.519 (0.299) [-1.736] {.083}	-0.553 (0.259) [-2.135] {.033}	OR: 0.58 CI: 0.35–0.96
Student-moderator* Developer alternatives			0.910 (0.378) [2.407] {0.016}	0.919 (0.376) [2.444] {.015}	0.815 (0.364) [2.239] {.025}	OR: 2.26 CI: 1.11–4.61
Period: End of month				-0.217 (0.158) [-1.373] {.170}		
Student role: Moderator					0.945 (0.184) [5.136] {< .001}	OR: 2.57 CI: 1.79–3.69
Student role: Developer alternatives					-0.394 (0.343) [-1.149] {.251}	OR: 0.67 CI: 0.34–1.32
Random						
L3:group						
σ^2_{v0}	0.138 (0.129) [1.070] {.285}					
L2: student						
σ^2_{u0}	0.107 (0.093) [1.151] {.250}	0.287 (0.119) [2.412] {.016}	0.351 (0.149) [2.356] {.018}	0.370 (0.152) [2.434] {.015}	0.236 (0.128) [1.844] {.065}	
Model fit						
Deviance	1726.46	1731.05	1708.23	1706.18	1690.46	
p_D	23.27	25.78	30.22	31.65	28.24	
DIC	1749.73	1756.83	1738.46	1737.82	1718.69	
Ref. model		A	B	C	C	

(Standard Error) [t-ratio / z-value] {p-value} OR = Odds Ratio; CI = 95% Confidence Interval probability of message units reflecting a high level of knowledge construction for this reference category is 35.7 %.

Concerning the different research conditions, the same effects as in model C can be noticed. The odds of reflecting a high level of knowledge construction are still significantly lower for messages in the condition with a developer of alternatives and still significantly higher for messages in the student-moderated condition with a developer of alternatives. These results are depicted in Figure 3.1.

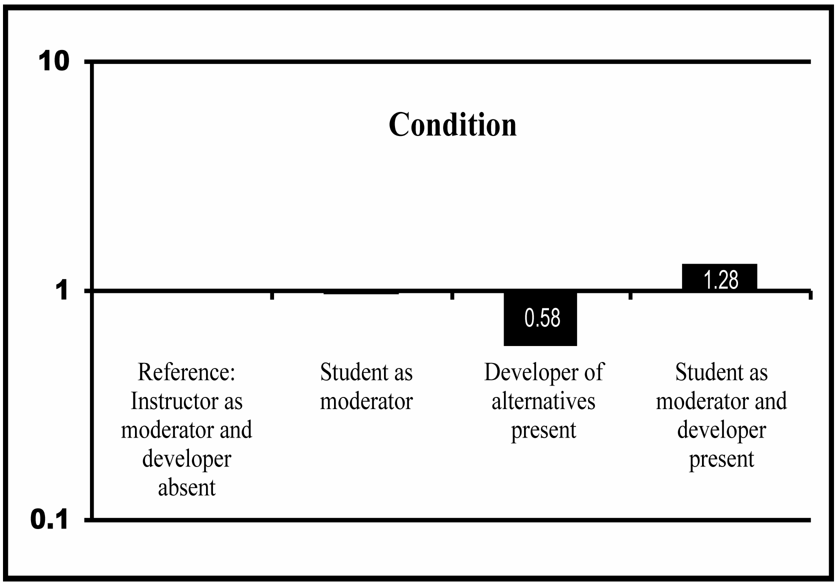

Figure 3.1. Odds of reflecting a high level of knowledge construction for the different conditions (based on model E in Table 3.2).

Concerning the specific roles, messages from students assigned the role of moderator are about 2.57 times more likely to reflect a high level of knowledge construction. No significant differences were found for the messages from students performing the role of developer of alternatives. Figure 3.2 presents the odds ratios for both roles.

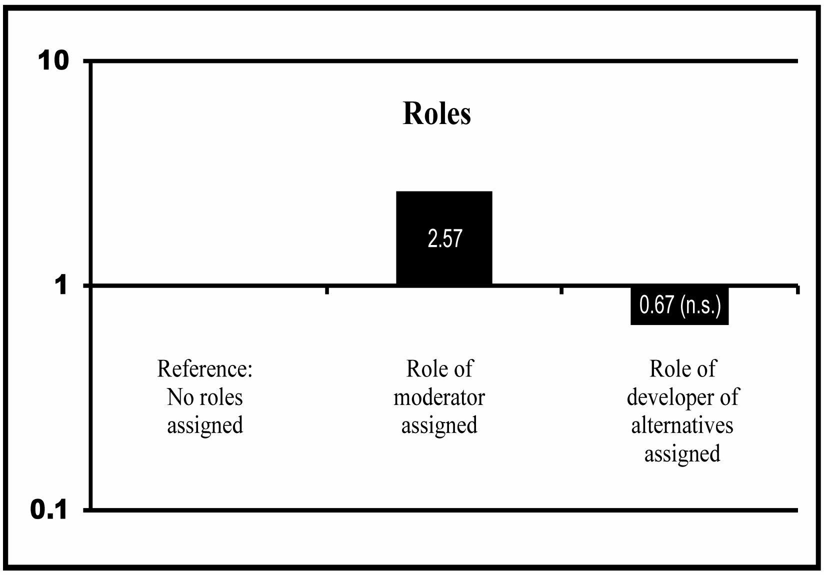

Figure 3.2. Odds of reflecting a high level of knowledge construction for students assigned the role of moderator or developer of alternatives (based on model E in Table 3.2).

Discussion

The distribution of students' contributions across the five levels of knowledge construction corresponds with findings in previous studies. The study of Gunawardena et al. (1997) reported few messages in level 4 and 5, and numerous messages in level 1. Another study of McLoughlin and Luca (2000), using the same analysis model, reported that most of the messages are situated within the first level, viz. 'sharing and comparing information'. Gunawardena, Carabajal, & Lowe (2001) also state that the majority of messages in a discussion usually are situated at the first two levels. One explanation for the small number of messages situated at level 4 and 5 could be the learning culture of the students. Students are not used to test syntheses, to summarise agreements, and to apply newly constructed knowledge. Moreover, even if they would engage in this type of learning activities, they are not used to write it down explicitly in a discussion. Concluding that students do not perform any kind of metacognitive activity might be wrong, as the absence of metacognitive statements might be caused by the fact that students do not communicate explicitly about these activities. As mentioned before, messages at level 1 are a prerequisite for a discussion. However, all levels in the model are important and eventually the highest levels should be reached (Schellens & Valcke, 2005).

The differences in knowledge construction between the conditions are presented by the results of the multilevel models. Model C clearly shows that there is no significant difference between the instructor-moderated and student-moderated conditions if no developer of alternatives is involved. This might be due to the fact that except for the different tutor guidance, the learning environment in both research conditions was equivalent: Dolmans et al. (2002) argue that tutor characteristics are not only dependent from the level of expertise of the tutor, but are also influenced by differential contextual circumstances. These circumstances, such as the quality of the cases, the structure of the course, the link with students' level of prior knowledge, and the functioning of the groups are hardly different in both conditions. Both the fact that the learning environment was equivalent and the fact that sixth year students are involved might explain these findings. Although Strijbos et al. (2004) mention that roles appear to affect the perceived level of group efficiency and elicit more task content statements, recent research of Schellens et al. (2005) in the domain of educational sciences reports no significant differences between a role and a no role condition on knowledge construction.

However, when a developer of alternatives is involved, a significant difference between instructor-moderated and student-moderated discussions occurs: significantly more messages reflect a low level of knowledge construction in the instructor-moderated condition with a developer, while significantly more messages reflect a high level of knowledge construction in the student-moderated condition with a developer. In other words: the messages from students in groups where both roles are assigned to students are more likely to reflect a high level of knowledge construction, whereas the messages in groups where the instructor is moderating and a student is assigned the role of developer of alternatives are more likely to reflect a low level of knowledge construction. A possible explanation for these findings can be found in the assumption that students performing the role of developer of alternatives behave in a different way when the moderator is an instructor or a peer. Moust and Schmidt (1994) argue that when staff tutors are involved, students may feel less free to speculate about the problem-at-hand and to explain subject-matters to each other. This might especially be the case for the developer of alternatives in the present study. However, a post hoc analysis did not point to any differences in the level of knowledge construction between messages from students with the role of developer in the instructor-moderated and the student-moderated condition, which implies that all students in the former condition feel inhibited. It seems that the autonomy students experience when the instructor is not moderating the discussion stimulates them more to engage in mutual interchange and in-depth discussions, to search for dissonance or inconsistencies, and to go into negotiation. Follow-up research on this data, including additional detailed analysis of the interaction patterns, may shed a light on the ongoing communicative processes. Moreover, further research should try to reveal why this difference between instructor-moderated and student-moderated conditions only occurs when a developer of alternatives is involved.

Concerning the specific student roles, the present results pointed out that moderators are more likely to write contributions reflecting a high level of knowledge construction, whereas no differences are found for developers of alternatives. It seems that moderating the discussions coerces students to identify dissonance and harmony between the messages and to move towards the negotiation of meaning and co-construction of knowledge. The above-mentioned study of Schellens et al. (2005) has studied the impact of different roles on knowledge construction and reported a significant difference in knowledge construction for one specific role, namely summariser. These findings, combined with the results of our study, could lead to the conclusion that performing different roles might be important, as is the formulation of specific guidelines for the roles. Future research should aim to identify the factors within role assignment that are crucial for stimulating knowledge construction. However, narrow role descriptions should be avoided. Stringent roles might restrict students' autonomy, and force them to do only what is mentioned in their role description. Moreover, a too rigid script that imposes a structure alienated from the content of the discussions should be avoided (Schellens et al., 2005).

We are aware of the fact that the study has some limitations. First, the use of online discussions in an ecologically valid setting challenges the ability of the researcher to control all variables in the context. This control may have been achieved to a certain extent by the very systematic nature of the discussions. Although we used existing student groups, it is important to note that they were composed at random by the student administration.

The fact that the study is related to a specific knowledge domain is a second limitation. However, this study provides information on the use of asynchronous discussion groups and guidelines for the application of roles to structure them. Furthermore, it sheds light on the importance of the operationalisation of roles and on the underlying relations between roles. This can be further explored in future research in order to make more general statements and conclusions.

Taken into account that the present study dealt with advanced level students, a practical implication of this study does exist. By assigning the role of moderator to a student, the instructor can part with the – rather time consuming – moderation task. However, it is important to emphasise the surplus value of the instructor's presence and of a thorough description of the different roles. The instructor's role, to keep an expert eye on the content of the discussion, can not be neglected. Regarding the practical organisation, a number of characteristics, such as the formal character, the position in the curriculum, and the scripted task of the discussion groups are brought forward, which can serve as design guidelines for developing CSCL-environments.

References

Aviv, R. (2000). Educational performance of ALN via content analysis. *Journal of Asynchronous Learning Networks, 4,* 53-72. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v4n2/v4n2_aviv.asp

Aviv, R., Erlich, Z., & Ravid, G. (2003). Cohesion and roles: Network analysis of CSCL communities. In V. Devedzic, J. M. Spector, D. G. Sampson, & Kinshuk (Eds.), *Proceedings of the 3rd IEEE International Conference on Advanced Learning Technologies* (pp. 145-150). Athens: ICALT.

Bernard, R. M., & Lundgren-Cayrol, K. (2001). Computer Conferencing: An Environment for Collaborative Project-Based Learning in Distance Education. *Educational Research and Evaluation, 7,* 241-261.

Browne, W. (2004). *MCMC estimation in MLwiN, version 2.0*. London: Centre for Multilevel Modeling, Institute of Education, University of London. Retrieved September 1, 2006, from http://www.mlwin.com/ download/manuals.html

Browne, W. J., Subramanian, S. V., Jones, K., & Goldstein, H. (2005). Variance partitioning in multilevel logistic models that exhibit overdispersion. *Journal of the Royal Statistical Society: Series A (Statistics in Society), 168,* 599-613.

Carney, P. A., Poor, D. A., Schifferdecker, K. E., Gephart, D. S., Brooks, W. B., & Nierenberg, D. W. (2004). Computer use among community-based primary care physician preceptors. *Academic Medicine, 79,* 580-590.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46,* 6-28.

De Wever, B., Valcke, M., Van Winckel, M., & Kerkhof, J. (2002). De invloed van "structuur" in CSCL-omgevingen: een onderzoek met on line discussiegroepen bij medische studenten [The influence of structuring CSCL-environments: A study of online discussion groups with medical students]. *Pedagogisch Tijdschrift, 27,* 105-128.

Dolmans, D. H. J. M., Gijselaers, W. H., Moust, J. C., De Grave, W. S., Wolfhagen, I. H. A. P., & Van Der Vleuten, C. P. M. (2002). Trends in research on the tutor in problem-based learning: conclusions and implications for educational practice and research. *Medical Teacher, 24,* 173-180.

Gilbert, P. K., & Dabbagh, N. (2005). How to structure online discussions for meaningful discourse: A case study. *British Journal of Educational Technology, 36,* 5-18.

Grabinger, R. S. (1996). Rich environments for active learning. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 665-692). London: Prentice Hall International.

Greenhalgh, T. (2001). Computer assisted learning in undergraduate medical education. *British Medical Journal, 322,* 40-44.

Gunawardena, C. N., Carabajal, K., & Lowe, C. A. (2001). Critical Analysis of Models and Methods Used to Evaluate Online Learning Networks. In *American Educational Research Association Annual Meeting*. Seattle: American Educational Research Association.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17,* 397-431.

Hagdrup, N. A., Edwards, M., Carter, Y. H., Falshaw, M., Gray, R. W., & Sheldon, M. G. (1999). Why? What? and How? IT provision for medical students in general practice. *Medical Education, 33,* 537-541.

Hox, J. J. (1998). Multilevel modeling: When and why. In R. Balderjahn, R. Mathar, & M. Schader (Eds.), *Classification, data analysis, and data highways* (pp. 147-154). New York: Springer-Verlag.

Hox, J. J., & Maas, C. J. M. (2002). Sample sizes for multilevel modeling. In J. Blasius, J. J. Hox, E. De Leeuw, & P. Schmidt (Eds.), *Social Science Methodology in the New Millennium. Proceedings of the Fifth International Conference on Logic and Methodology. Second expanded edition.* Retrieved September 1, 2006, from http://www.fss.uu.nl/ms/jh/publist/simnorm1.pdf

Joiron, C., & Leclet, D. (2002). Architecture of a learning system for between-peers distance continuing medical education: The DIACOM forum. In P. Kommers, V. Petrushin, Kinshuk, & I. Galeev (Eds.), *Proceedings of IEEE International Conference on Advanced Learning Technologies* (pp. 161-164). Kazan, Katarsan: ICALT-2002. Retrieved September 1, 2006, from http://lttf.ieee.org/ icalt2002/proceedings/

Kollar, I., Fischer, F., & Hesse, F. W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning, CSCL 2003 - Community events, communication, and interaction* (pp. 59-61). Bergen: Intermedia.

Lockhorst, D., Admiraal, W., Pilot, A., & Veen, W. (2002). Design elements for a CSCL environment in a teacher training programme. *Education and Information Technologies, 7,* 377-384.

Marra, R. M., Moore, J. L., & Klimczak, A. K. (2004). Content analysis of online discussion forums: A comparative analysis of protocols. *Educational Technology Research and Development, 52,* 23-40.

McGlade, K. J., McKeveney, C. J., Crawford, V. L. S., & Brannigan, P. (2001). Preparing tomorrow's doctors: the impact of a special study module in medical informatics. *Medical Education, 35,* 62-67.

McLoughlin, C., & Luca, J. (2000). Cognitive engagement and higher order thinking through computer conferencing: We know why but do we know how? In A. Herrmann & M. M. Kulski (Eds.), *Flexible Futures in Tertiary Teaching.* Perth: Curtin University of Technology.

Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning and Instruction, 6,* 359-377.

Moust, J. C., & Schmidt, H. G. (1994). Effects of staff and student tutors on student achievement. *Higher Education, 28,* 471-482.

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42,* 243-265.

Rasbash, J., Steele, F., Browne, W., & Prosser, B. (2004). *A user's guide to MLwinN, version 2.0*. London: Centre for Multilevel Modeling, Institute of Education, University of London. Retrieved September 1, 2006, from http://www.mlwin.com/download/manuals.html

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Methodological Issues in the Content Analysis of computer conference transcripts. *International Journal of Artificial Intelligence in Education, 12,* 8-22.

Salmon, G. (2000). *E-moderating. The key to Teaching and Learning Online.* London: Kogan Page.

Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior, 21,* 957-975.

Schellens, T., Van Keer, H., & Valcke, M. (2005). The impact of role assignment on knowledge construction in asynchronous discussion groups: A multilevel analysis. *Small Group Research, 36,* 704-745.

Schmidt, H. G., Van Der Arend, A., Moust, J. C., Kokx, I., & Boon, L. (1993). Influence of tutors' subject-matter expertise on student effort and achievement in problem-based learning. *Academic Medicine, 68,* 784-791.

Schrire, S. (2004). Interaction and cognition in asynchronous computer conferencing. *Instructional Science, 32,* 475-502.

Strijbos, J. W., Martens, R. L., Jochems, W., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35,* 195-229.

Stromso, H. I., Grottum, P., & Hofgaard Lycke, K. (2004). Changes in student approaches to learning with the introduction of computer-supported problem-based learning. *Medical Education, 38,* 390-398.

Wallace, G. (2001). Information technology and telemedicine. *Canadian Medical Association Journal, 165,* 777-779.

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2005). Facilitating collaborative knowledge construction in computer-mediated learning environments with cooperation scripts. In R. Bromme, F. W. Hesse, & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication* (pp. 15-38). Boston: Kluwer.

Chapter 4[*]

Applying multilevel modelling on content analysis data: Methodological issues in the study of the impact of role assignment in asynchronous discussion groups

Abstract

This study focuses on the process, output, and interpretation of *multilevel analyses* on *quantitative content analysis data* derived from asynchronous discussion group transcripts. The impact of role assignments on the level of knowledge construction reflected in students' contributions and the relation between message characteristics and these levels of knowledge construction is studied. Results show that summarisers' contributions and contributions focusing on theory, content moderating, or summaries result in significantly higher levels of knowledge construction. Multilevel modelling handles the hierarchical nesting, interdependency, and unit of analysis problem and is presented as an ideal technique for studying content analysis data from CSCL-environments.

Introduction

Within the field of computer-supported collaborative learning (CSCL), asynchronous discussion groups are often introduced as promising learning environments. The power of asynchronous text-based discussions lies in enhanced opportunities for students to interact with each other and in an increased time frame to reflect and search for additional information before contributing to the discussion (De Wever, Schellens, Valcke, & Van Keer, 2006; Pena-Shaff & Nicholls, 2004).

Researchers within this field are interested in the ongoing collaboration and the underlying interactive processes and more specifically in the impact of CSCL-environments on specific process and performance variables. However, analysing collaborative learning in a quantitative way is not a straightforward task, since the impact is marred by variables both at the level of the individual learner and the group. Individual learners are influenced by the social group and context to which they belong, and the properties of this group are in turn influenced by the

---

[*] Based on: De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2006). *Applying multilevel modelling on content analysis data: Methodological issues in the study of the impact of role assignment in asynchronous discussion groups*. Manuscript submitted for publication to *Learning and Instruction.*

individuals who make up that group (Hox & Maas, 2002). To take this into account, multilevel modelling techniques can be adopted to analyse the data at multiple levels. Although there is no general consensus about statistical procedures to study data that results from content analysis of discussion transcripts, a number of methodological issues have been addressed by Chiu and Khoo (2005). They more specifically support our opinion that multilevel analyses are an appropriate method to model content analysis data. These multilevel analysis techniques are highlighted in the present article. This article is not intended as a theoretical introduction to multilevel modelling, or as a complete overview of multilevel analysis approaches. However, this article presents a practical example of applying the analysis technique in the context of studying discussions groups.

The example fits in with the research tradition exploring the impact of different structuring approaches in online discussion tasks on the joint construction of knowledge. More specifically, the example builds on a study examining the effect of assigning roles to students on the knowledge construction processes in asynchronous discussion groups. To unravel students' knowledge construction, the discussion transcripts are analysed, as they contain information about both the group's collaborative process and the individuals' contributions and thus can serve as data for research (Meyer, 2004). In this respect, quantitative content analysis focusing on students' knowledge construction processes is performed to unlock the information captured in transcripts. This content analysis is based on the analysis model of Gunawardena, Lowe, and Anderson (1997) and is combined with multilevel modelling techniques in order to take the hierarchical structure of the data into account. Before starting a more elaborated discussion about this analysis technique, role assignment is discussed in short and presented as a critical scripting tool.

Roles as scripting tool

This study focuses on the impact of assigning roles as a scripting tool to support the process of social negotiation in asynchronous discussion groups. Roles compel students to focus upon their responsibilities in the discussion group and on the content of their contributions. Moreover, as roles are supposed to increase students' awareness of collaboration (Strijbos, Martens, Jochems, & Broers, 2004), we might expect students to collaborate better, resulting in higher levels of knowledge construction.

In the present study, the impact of the following roles has been studied: starter, theoretician, source searcher, moderator, and summariser. The starter is required to start off and give new impulses each time the discussion slacks off. The role of the moderator consists of monitoring the discussion, asking critical questions, and inquiring for others' opinions. The theoretician is asked to ensure that all relevant theoretical concepts were used in the discussion. The role of the source searcher comprises seeking external information on the discussion topics in order to stimulate other students to go beyond the scope of the course reader. The summariser is expected to post interim summaries during the discussion, focusing on identifying dissonance and harmony between the messages and drawing provisional conclusions, and a final summary at the end of the discussion.

The introduction of these roles is based on examples found in the literature, such as facilitator, resource person, summariser, starter, wrapper, discussion moderator, topic leader, and topic reviewer (Cohen, 1994; Hara, Bonk, & Angeli, 2000; Shotsberger, 1997; Tagg, 1994). On the other hand, the selection of the roles is based on the specific purpose of the discussion tasks, namely to stimulate students to actively discuss the content of the course manual and relevant external sources in order to get a grip on the different theoretical concepts introduced in the course. From an empirical point of view, earlier research already pointed at the positive impact of the role of a summariser in a discussion, resulting in significantly higher levels of knowledge construction (Schellens, Van Keer, & Valcke, 2005).

Content analysis

Neuendorf (2002, p. 10) defines content analysis as "a summarizing, quantitative analysis of messages that relies on the scientific method and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented". The aim of content analysis is to go beyond analyses based on counting the number of messages and to reveal information below the surface of the transcripts. In a previous article (De Wever et al., 2006), 15 different content analysis schemes were discussed in detail. In the present study, the interaction analysis model of Gunawardena et al. (1997) was applied. It focuses on the construction of knowledge through social negotiation, and distinguishes 5 levels, namely (a) sharing and comparing information, (b) identifying areas of disagreement, (c) negotiating meaning and co-construction of knowledge, (d) evaluation and modification of new schemas resulting from co-construction, and (e) reaching and stating agreement and application of co-constructed knowledge. This analysis scheme is one of the few content analysis models focusing on knowledge construction from a theoretical and empirical base (Marra, Moore, & Klimczak, 2004; Schellens & Valcke, 2005).

Multilevel modelling

The critical position of statistical analysis techniques has only recently been raised in CSCL-research. Within collaborative learning, learners are members of a group. The individual students and the social group can be "conceptualised as a hierarchical system of individuals and groups, with individuals and groups defined at separate levels of this hierarchical system" (Hox & Maas, 2002, p. 2). In this respect, the surplus value of multilevel modelling is highlighted, since these models tackle problems that traditional unilevel statistical techniques are unable to cope with correctly.

In hierarchically structured settings, the assumption of independency for using the traditional analysis techniques is violated. With regard to the present study this means that data from students within a discussion group cannot be considered as completely independent because of the shared group history (Hox, 1994). In this respect, Hox and Maas (2002, p. 2) claim that "even if the analysis includes only variables at the lowest level, standard multivariate models are not appropriate. The hierarchical structure of the data creates problems, because the standard assumption of independent and identically distributed observations is generally not valid". Due to the violation of the assumption of independence, conventional modelling can result in underestimation of standard errors. Researchers might reach conclusions about statistical significance and reject the null hypothesis because of small standard errors (Goldstein, 1995). In addition, even in situations where it is unlikely to make erroneous judgements, multilevel modelling provides more accurate estimates and should be used with data from natural groups, as "the existence of such data hierarchies is neither accidental nor ignorable" (Goldstein, 1995, p. 1).

Collaborative research designs entail that data are collected at different levels. They have to cope with the friction between individual-level versus group-level analysis (Flanagin, Park, & Seibold, 2004). Furthermore, cross-level interactions between variables on different levels of the hierarchy can influence outcome variables on a specific level. Because of the joint modelling of several variables at different levels, we encounter the methodological unit of analysis problem. By adopting multilevel modelling the hierarchical nesting, the interdependency, and the unit of analysis problem is handled in a more natural way, since this modelling approach is specifically geared to the statistical analysis of data with a clustered structure.

Method

Context

The study involved freshmen taking the instructional sciences course at Ghent University. These students were randomly assigned to asynchronous discussion groups of 10 students. The discussion groups were an obligatory part of the course and were organised in addition to weekly face-to-face working sessions. The discussions were expected to foster students' processing of the learning content and to promote discussion about the theoretical concepts presented in the face-to-face sessions and in the course manual. In the discussion groups, students were expected to solve authentic tasks. Taking into account the specific nature of discussing online, an introductory session was organised prior to the onset of the discussions, focusing on clarifying the aim of the discussions, the specific planning of different discussion themes, the different roles, the technical issues of the CSCL environment, and the evaluation criteria. All introductory information could be retrieved online. To ensure that students became familiar with the technical features of the online asynchronous discussion approach, a trial discussion session was organised during two weeks.

After the trial discussion, each group of students participated in four consecutive discussion themes. Each theme was organised during a three-week period. During this period, students collaborated independent of time and location. Participation in the discussions was obligatory and represented 25% of the final score. Students were required to contribute at least four messages per discussion theme. The four themes corresponded to four chapters in the course manual, namely behaviourism, cognitivism, constructivism, and evaluation. The authentic tasks in the discussion groups were identical for all groups.

Research design

Roles were introduced as a scripting tool during the first two discussions. Role assignment was cut back after the second discussion theme, since it was expected that students would have interiorised the function of the roles. This transition from explicit role support to no role support is based on the assumption that fading of support should be an integral part of scaffolding, as outlined by Brown, Collis, and Duguid (1989).

At the start of the first discussion theme, five students were allocated the role of starter, moderator, theoretician, source searcher, and summariser respectively. These roles were assigned randomly and passed on to other students within the same group at the start of the second discussion theme. As stated before, none of the students were given roles during the last two discussion themes. At a general level, all students were encouraged to moderate, to summarise, and to add new discussion points, theory, and information. But students with a specific role were asked to do this in an explicit and regular way.

Data set and analysis instruments

The discussion transcripts of the 4 themes of 14 groups were randomly selected for content analysis. These transcripts were coded independently by four trained coders. The complete message was chosen as the unit of analysis. Complete messages are considered as the unit defined by the original author of the contributions, as suggested by Rourke, Anderson, Garrison, and Archer (2001).

Each contribution to a discussion reflects a specific level of social construction of knowledge. In order to determine these levels, the interaction analysis model of Gunawardena et al. (1997) was applied. The codes and descriptions of this model can be consulted in Table 4.3. Each message receives one code. This variable will serve as our dependent variable, indicating the degree of collaborative knowledge construction. When a message comprises elements of two different levels of knowledge construction, the highest level was assigned. For example, when a student shared information in order to argument why he or she disagrees with another student, this was coded as level 2 (disagreement) and not as level 1 (sharing new information).

Next to this content analysis scheme, an additional analysis model was developed to identify message characteristics along five different dimensions: moderating, summarising, adding new discussion points, adding theory, and adding external information. Indicators of different levels within these dimensions are presented in Table 4.1.

As opposed to the model of Gunawardena et al. (1997), the analysis scheme identifying message characteristics (ASIMeC) is specifically related to the different roles. Each unit of analysis is assigned a code along these dimensions. The scheme was developed to provide more information about the actual role adoption in the discussion groups. As to the dimension “adding external information” for example, the ASIMeC differentiates between “mentioning external sources” without linking the source to the ongoing discussion and "actively using and discussing new external sources".

Table 4.1
Analysis scheme identifying message characteristics (ASIMeC)

Dimension	Characteristic (code)	Description
Theory	No theory	Not referring to theoretical concepts
	Mentioning theory	Mentioning theoretical concepts
	Discussing theory	Actively using and discussing theoretical concepts
Source	No sources	Not referring to external sources
	Mentioning sources	Mentioning external sources
	Discussing sources	Actively using and discussing external sources
Summary	No summary	Not summarising information from other messages
	Minor summary	Summarising information from a number of messages
	Extensive summary	Summarising information of a substantial part of the discussion
Moderating	No moderating	No moderation tasks performed
	Organisational moderating	Organisational moderation tasks performed (e.g. planning)
	Content moderating	Moderation task as regards content performed (e.g. compare different statements, weigh up different messages)
	Organisational and content moderating	Combination of both moderation tasks
New points	No new points	No new points added to the discussion
	New points introduced	New points added to the discussion

Hypotheses

A first hypothesis focuses on the analysis of the transcripts of the first two discussions and explores the impact of the different roles on students' level of knowledge construction through social negotiation. More specifically, the level of knowledge construction of students adopting a role is compared with the level of knowledge construction of students without roles. It is hypothesised that students performing the role of starter, moderator, theoretician, source searcher, or summariser post messages reflecting higher levels of knowledge construction.

The second hypothesis focuses on the analysis of the four discussion themes and clusters two subhypotheses. First, we test whether a gradual increase in level of knowledge construction can be observed, since a learning effect could be expected in the course of the consecutive discussions. Secondly, this hypothesis concentrates on the relation between message characteristics and the level of knowledge construction. Messages reflecting characteristics such as summarising, moderating, introducing new discussion points, and debating theory and various sources are expected to reflect higher levels of knowledge construction as compared to contributions without these characteristics.

Statistical analysis

The data collected within the framework of the present study have a clear hierarchical structure. Every student belongs to one group. Furthermore, each message is written by one student. Therefore, multilevel modelling was applied. To test the first hypothesis, a three-level model was built. Messages are clustered within students that are nested within discussion groups. Taking into account that multilevel modelling is especially useful to analyse repeated measures (Snijders & Bosker, 1999), a specific type of hierarchical nesting was defined to test the second hypothesis: measurement occasions (in our case the four themes) nested within subjects (Hox, 1998). This results in a hierarchical structure in which messages are hierarchically nested within measurement occasions that are clustered within students who are in turn assigned to groups.

In view of testing both hypotheses, we start by calculating a random intercept null model. This model only contains an estimation of the intercept for the dependent variable, so there are no independent variables or predictors involved. In this null model, the total variance of students' level of knowledge construction is decomposed into between-group, between-students, and between-message variance. Next, explanatory variables are added to the models. Roles serve as a predictor for testing the first hypothesis. For the second hypothesis, both the measurement occasions (themes) and the dimensions of the ASIMeC serve as predictors. All models are discussed in detail in the results section.

The statistical package R 1.8.1. was used for the calculation of the interrater reliability coefficient Krippendorff's alpha. The descriptive results were calculated with SPSS 11.0.1. MLwiN 2.01. was used to perform the multilevel analysis. The multilevel models were estimated with the restrictive iterative generalised least squares (RIGLS) procedure. All analyses assume a 95% confidence interval.

Coding strategy and reliability

Four independent coders were trained during approximately 3 hours to perform the coding activity. They were introduced to the content analysis models, the underlying theoretical basis, and a number of examples to illustrate each coding scheme. After the training, transcripts were coded together for another 4 hours and the coding process was discussed and elaborated. Next, the transcripts were coded independently.

A number of transcripts was selected for calculating interrater reliability coefficients of the ASIMeC and the model of Gunawardena et al. (1997) (approximately 7% and 15% respectively). Table 4.2 presents the Krippendorff's alpha (α) interrater reliability coefficients. The values for Krippendorff's alpha were all situated within the classification 'fair to good agreement beyond chance'.

Table 4.2
Overview of the Krippendorff's alpha reliability coefficients

Variable	α
Level of knowledge construction (n=510)	0.53
Source (n=236)	0.75
Theory (n=236)	0.74
Summary (n=236)	0.62
Moderating (n=236)	0.59
New points (n=236)	0.63

Results

Descriptive results

In total 3345 messages were analysed (approximately 40,943 lines of text) with the interaction analysis model of Gunawardena et al. (1997). Table 4.3 presents an overview of the descriptive results.

Table 4.3
Overview of the codes based on the interaction analysis scheme of Gunawardena et al. (1997)

Level	Description	Frequency	Percent
1	Sharing and comparing of information	2132	63.7
2	Exploration of dissonance	658	19.7
3	Negotiation of meaning	420	12.6
4	Testing synthesis	95	2.8
5	Agreement statements and applications	40	1.2

Of these messages, approximately 2859 messages were analysed along the five dimensions of the ASIMeC. Table 4.4 gives an overview of these descriptive results.

Table 4.4
Overview of the codes based on the ASIMeC

Dimension	Characteristic (code)	Frequency	Percent
Theory	No theory	828	29.0
	Theory mentioned	1357	47.5
	Theory discussed	671	23.5
Source	No sources	2526	88.4
	Source mentioned	168	5.9
	Source discussed	165	5.8
Summary	No summary	2697	94.3
	Minor summary	50	1.7
	Extensive summary	112	3.9
Moderating	No moderating	2264	79.2
	Organisational moderating	78	2.7
	Content moderating	506	17.7
	Organisational and content moderating	9	.3
New points	No new points	1816	63.5
	New points introduced	1042	36.5

Results for hypothesis 1

The null model shows that respectively 2.63%, 2.84%, and 94.53% of the total variance in students' level of knowledge construction is linked to differences between groups, between students within groups, and between students' messages. The group-level variance is not significantly different from zero ($\chi^2 = 3.415$, df = 1, p = .065), whereas the within-group between-student variance ($\chi^2 = 4.204$, df = 1, p = .040) and the variance between messages of students ($\chi^2 = 769.758$, df = 1, p < .001) are significantly different from zero.

In the final random intercepts model the five roles were contrasted with the reference category (no role). The estimates for this model are presented in Table 4.5. The intercept of 1.377 represents the mean level of knowledge construction for messages from students without roles. The mean level of knowledge construction reflected in messages from students with the role of starter, moderator, theoretician, and source searcher does not differ significantly from this mean. However, students with the role of summariser post messages with a significantly higher mean level of knowledge construction (mean = 1.377 + 0.321 = 1.698, $\chi^2 = 32.376$, df = 1, p < .001).

Table 4.5
Model estimates for the three-level analyses of levels of knowledge construction in students' messages

Parameter	Null model	Final Model
Fixed		
Intercept	1.416 (0.035)	1.377 (0.041)
Starter		-0.053 (0.058)
Moderator		0.057 (0.057)
Theoretician		0.051 (0.055)
Source searcher		-0.034 (0.056)
Summariser		0.321^{***} (0.056)
Random		
Level 3 – group		
σ^2_{v0}	0.012 (0.007) [1]	0.013 (0.007)
Level 2 – student		
σ^2_{u0}	0.013^{*} (0.006) [2]	0.010 (0.006)
Level 1 – message		
σ^2_{e0}	0.432^{***} (0.016) [3]	0.426^{***} (0.015)

Values between brackets are standard errors
[1] 2.63%, [2] 2.84%, and [3] 94.53% of total variance
$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Results for hypothesis 2

Firstly, a four-level random intercepts null model was estimated, with messages (level 1) hierarchically nested within the themes (measurement occasions, level 2) that are clustered within students (level 3) assigned to groups (level 4). This model is presented as model A in Table 4.6.

As can be seen in the random part of this model, the variances the on group, theme, and messages level are significantly different from zero: 2% of the total variance in students' levels of knowledge construction is situated at the group level (χ^2 = 4.274, df = 1, p = .039), 7% is situated at the theme level (measurements occasions) (χ^2 = 25.951, df = 1, p < .001), and 91% of the variance arises from differences between messages within measurement occasions (χ^2 = 1440.268, df = 1, p < .001). No part of the total variance can be assigned to the level of the individual students.

Secondly, a compound symmetry model (model B) was estimated. This is a random intercept model with no explanatory variables except for the measurement occasions (Snijders & Bosker, 1999). This model allows us to explore whether a learning effect occurs throughout the successive themes. The differences between the themes are explicitly modelled by contrasting theme 2, theme 3, and theme 4 with the reference category (theme 1). This model achieves a better fit than the four-level null model, for the difference in deviance of both models – which can be used as a test statistic having a chi-squared distribution, with the difference in number of parameters as degrees of freedom (Snijders & Bosker, 1999) – is highly significant (χ^2 = 145.036, df = 3, p < .001).

The intercept of 1.505 is to be considered as the overall mean level of knowledge construction in theme 1 across all messages, students, and groups. As presented in Table 4.6 (model B), the mean level of knowledge construction in theme 4 does not differ significantly from this intercept (mean = 1.505 + 0.033 = 1.538, χ^2 = 0.605, df = 1, p = .437). However, messages in theme 2 reflect a significantly lower level of knowledge construction (mean = 1.505 - 0.169 = 1.336, χ^2 = 15.738, df = 1, p < .001), while messages in theme 3 reflect a significantly higher level of knowledge construction (mean = 1.505 + 0.393 = 1.898, χ^2 = 94.939, df = 1, p < .001).

The contradictory findings that messages in theme 2 reflect a significantly lower and messages in theme 3 reflect a significantly higher level of knowledge construction, were briefly explored by taking task complexity into account. To verify the impact of the different discussion themes' complexity, all participating students were asked to rate the difficulty of each assignment. Task complexity increased significantly from the first to the three subsequent themes, and the second assignment was identified as the most complex. These self-reported complexity rates were included in the analysis model, revealing no significant differences in levels of knowledge construction between the consecutive themes, except for a significantly higher level in the third discussion theme. Although these results are interesting, they are not discussed in detail, as this post hoc analysis was not the scope of this study.

In a third model (model C), the five dimensions of the ASIMeC are added as extra explanatory variables. This results in a significantly better fit of the model ($\chi^2 = 1464.001$, df = 10, $p < .001$). The intercept of 1.321 in this model represents the mean level of knowledge construction for messages in theme 1 that do not include theory, sources, summaries, moderation issues, or new points. Parallel to the compound symmetry model (model B), the mean level of knowledge construction of messages in theme 4 does not differ significantly from this intercept (mean = 1.321 + 0.060 = 1.381, $\chi^2 = 1.679$, df = 1, $p = .195$), messages in theme 2 reflect a significantly lower level of knowledge construction (mean = 1.321 - 0.176 = 1.145, $\chi^2 = 14.189$, df = 1, $p < .001$), and messages in theme 3 reflect a significantly higher level of knowledge construction (mean = 1.321 + 0.433 = 1.754, $\chi^2 = 95.256$, df = 1, $p < .001$).

Concerning theory, both mentioning and discussing theory leads to a significantly higher mean level of knowledge construction (mean = 1.321 + 0.223 = 1.544, $\chi^2 = 33.950$, df = 1, $p < .001$ and mean = 1.321 + 0.238 = 1.559, $\chi^2 = 24.764$, df = 1, $p < .001$ respectively). The same goes for the variable summary: both minor summaries and extended summaries lead to a significantly higher mean level of knowledge construction (mean = 1.321 + 0.336 = 1.657, $\chi^2 = 7.566$, df = 1, $p = .006$ and mean = 1.321 + 0.864 = 2.185, $\chi^2 = 108.537$, df = 1, $p < .001$ respectively).

With regard to sources, the results are somewhat different: messages in which students mention but do not discuss new sources reflect a significantly lower mean level of knowledge construction, whereas messages including this discussion of the external sources do not reflect a significant different level of knowledge construction (mean = 1.321 - 0.273 = 1.048, $\chi^2 = 16.510$, df = 1, $p < .001$ and mean = 1.321 + 0.061 = 1.382, $\chi^2 = 0.779$, df = 1, $p = .377$ respectively).

Next, as to moderating, the mean level of knowledge construction is significantly lower for messages containing organisational moderation (mean = 1.321 - 0.399 = 0.922, $\chi^2 = 16.378$, df = 1, $p < .001$), significantly higher for messages comprising content moderation (mean = 1.321 + 0.161 = 1.482, $\chi^2 = 14.803$, df = 1, $p < .001$), and not significantly deviant for messages containing both organisational and content moderating (mean = 1.321 - 0.463 = 0.858, $\chi^2 = 2.724$, df = 1, $p = .099$).

Table 4.6
Model estimates for the four-level analyses of levels of knowledge construction

Parameter	Model A	Model B	Model C
Fixed			
Intercept	1.573 (0.040)	1.505 (0.048)	1.321 (0.058)
Theme 2 (cognitivism)		-0.169^{***} (0.043)	-0.176^{***} (0.047)
Theme 3 (constructivism)		0.393^{***} (0.040)	0.433^{***} (0.044)
Theme 4 (evaluation)		0.033 (0.043)	0.060 (0.047)
Theory mentioned			0.223^{***} (0.038)
Theory discussed			0.238^{***} (0.048)
Source mentioned			-0.273^{***} (0.067)
Source discussed			0.061 (0.069)
Minor summary			0.336^{**} (0.122)
Extensive summary			0.864^{***} (0.083)
Organisational moderating			-0.399^{***} (0.099)
Content moderating			0.161^{***} (0.042)
Organisational and content moderating			-0.463 (0.281)
New points			-0.074^{*} (0.037)
Random			
Level 4 – group			
σ^2_{f0}	0.017^{*} (0.008)	0.020^{*} (0.009)	0.020^{*} (0.010)
Level 3 – student			
σ^2_{v0}	0.000 (0.000)	0.008 (0.005)	0.000 (0.000)
Level 2 – theme			
σ^2_{u0}	0.057^{***} (0.011)	0.000 (0.000)	0.007 (0.008)
Level 1 – message			
σ^2_{e0}	0.733^{***} (0.019)	0.739^{***} (0.018)	0.688^{***} (0.019)
Model fit			
Deviance	8675.480	8530.444	7066.443
χ^2		145.036	1464.001
df		3	10
p		<.001	<.001
Reference		Model A	Model B

Values between brackets are standard errors
$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Additionally, messages introducing new points reflect a significantly lower mean level of knowledge construction (mean = 1.321 - 0.074 = 1.274, χ^2 = 4.038, df = 1, p = .044).

Discussion

A first conclusion that can be drawn from the results for hypothesis 1 is that multilevel modelling is an appropriate technique to analyse content analysis data, as the between-students and between-messages variance is significantly different from zero. The large proportion of variance situated at the level of the messages indicates that a student's messages generally reflect a whole range of different levels of knowledge construction, while only rather small differences between students and between groups can be observed.

Secondly, with respect to the impact of role assignment on the level of knowledge construction in students' messages, it can be concluded that only the role of summariser has a significantly positive effect. The other roles do not result in significantly higher levels of knowledge construction. This finding confirms previous research (Schellens et al., 2005) that studied the influence of four different roles (theoretician, source searcher, moderator, and summariser) and revealed that only students who perform the role of the summariser submit messages that reflect significantly higher levels of knowledge construction.

In this respect, it can be concluded that although the introduction of roles seems to increase students' awareness of group interaction and collaboration (Strijbos et al., 2004), this does not necessarily lead to an increase in students' knowledge construction. The positive effect of the summariser can be attributed to the fact that this student is expected to post interim summaries during the discussions, and this requires him/her to identify similarities or differences between the messages, to develop a general overview, to consider all parties and opinions, etc. These extra activities clearly push higher levels of knowledge construction.

However, with the exception of the role of the starter, also the other roles might require this type of higher level activities. Yet, considering the analysis results, this does not seem to be the case. The differential impact of the roles might be due to the fact that the task of the summariser is more explicit, more transparent, and more concrete for the students. In this respect, further research is needed to clarify this differential impact and to get a better understanding of role interpretation, adoption, and execution. Furthermore, next to focusing on the contribution of students performing roles, it might also be interesting to concentrate on other students' contributions, especially those following on role-related messages.

As to the second hypothesis, the results again reveal the importance of multilevel modelling, since the between-groups, between-themes, and between-messages variance is significantly different from zero. Again, the largest proportion of variance is situated at the message level, pointing towards large variability in levels of knowledge construction between student messages. Furthermore, as a learning effect could occur when students get acquainted with the CSCL-environment and master the necessary discussion skills, a gradual increase of students' level of knowledge construction throughout the different discussion themes was expected. However, the results do not completely support this assumption. The findings more specifically reveal that with reference to the first discussion theme, contributions reflect significantly lower levels of knowledge construction in theme 2, significantly higher levels in theme 3, and no significantly deviant levels of knowledge construction in theme 4. This absence of a clearly positive development in students' knowledge construction throughout successive discussion themes seems to imply that every new discussion theme forces students to start knowledge construction from scratch, implying students to develop their knowledge along the different levels of knowledge construction. In this respect, it can be argued that the level of knowledge construction attained by students does not only depend on the increase in experience and discussion skills. Furthermore, given the decrease in knowledge construction in theme 2, and the increase in theme 3, it is unlikely that these effects can be attributed to the fact that roles were no longer assigned to the students. Other factors also appear to be important. In this respect, Schellens, Van Keer, Valcke, and De Wever (in press) refer to the significance of task characteristics. More specifically, the impact of task complexity appears to be important: when tasks are too complex, students' levels of knowledge construction are also significantly lower. On the other hand, when the assignments are overly straightforward, it is expected that students are hardly challenged and that the quality of the contributions drops. Based on the finding that, except for a significantly higher level in the third discussion, no significant differences in levels of knowledge construction are revealed when adding complexity to the model, it can be argued that the significant decrease in levels of knowledge construction in the second discussion theme can be attributed to a perceived high level of complexity in this assignment. This finding points at the importance of well-considered task design to foster knowledge construction.

In addition to the hypothesis of a growing trend in knowledge construction throughout the successive discussion themes, higher levels of knowledge construction were also expected for contributions mentioning and discussing theory, mentioning or discussing new sources, including minor and extensive summaries, containing organisational and/or content moderating, and introducing new points. The results corroborate this hypothesis for both mentioning and discussing theory, posting minor and extensive summaries, and introducing contributions including content moderating.

In combination with the frequent occurrence of theory, the significant effects of mentioning and discussing theory confirm that discussing theoretical concepts is probably an essential factor influencing knowledge construction.

Regarding summaries, both contributing minor and extensive summaries results in higher levels of knowledge construction.

As to moderating, contributions including organisational moderating reflect significantly lower levels of knowledge construction, whereas contributions including content moderating reflect significantly higher levels of knowledge construction. These results can be attributed to the fact that the former contributions focus on planning and organisation of the discussions and, as such, do not actually influence knowledge construction. In contrast, messages including content related moderation invoke knowledge construction activities. Nevertheless, organisational moderating might be a prerequisite for knowledge construction as it is important to guide the discussion process.

With respect to discussing new sources, no significant positive impact on knowledge construction is observed. On the contrary, merely mentioning sources, without explicitly discussing them and linking them to the ongoing discussions, even leads to significantly lower levels of knowledge construction. This is in line with the aforementioned research of Schellens et al. (2005).

Finally, contributions comprising new points result in lower levels of knowledge construction. However, introducing new points to the discussion might still be an important and critical condition in view of the later phases in a discussion. These contributions are in a way indispensable in order to elicit contributions at a higher level of knowledge construction, as an influx of new elements is useful to prevent discussions from drying up. Future research should therefore also focus on studying the structure in the discussions over time in order to be able to unravel the impact of message characteristics on knowledge construction over time.

Conclusion

Critical questions about the choice of statistical analysis techniques to study quantitative content analysis data have only recently been raised in the CSCL literature. Within this context, the present article focuses on the potential of adopting multilevel modelling methodologies. One of the main reasons for applying multilevel analysis is the fact that the use of unilevel analysis methods on multilevel data can have baleful consequences. Since multilevel modelling handles the hierarchical nesting, the interdependency, and the unit of analysis problem in a natural way, it is an ideal technique for analysing the interaction in collaborative learning environments in general, or content analysis data from CSCL-environments in particular. Especially for research in ecologically valid settings studying natural groups, multilevel modelling is a worthwhile alternative for traditional analysis techniques. Although a demonstration of the full power of multilevel modelling was beyond the scope of this article, the process, output, and interpretation of the specific analyses of this study have been described in detail. The results reveal that applying multilevel models on content analysis data can be used to gain an in depth understanding of the nature of collaborative learning processes.

References

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18,* 32-42.

Chiu, M. M., & Khoo, L. (2005). A New Method for Analyzing Sequential Processes: Dynamic Multilevel Analysis. *Small Group Research, 36,* 600-631.

Cohen, E. G. (1994). *Designing Groupwork. Strategies for the Heterogeneous Classroom.* (2nd ed.) New York: Teachers College Press.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46,* 6-28.

Flanagin, A. J., Park, H. S., & Seibold, D. R. (2004). Group performance and collaborative technology: A longitudinal and multilevel analysis of information quality, contribution equity, and members' satisfaction in computer-mediated groups. *Communication Monographs, 71,* 352-372.

Goldstein, H. (1995). *Multilevel statistical models*. (2nd ed.) London: Edward Arnold.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17,* 397-431.

Hara, N., Bonk, C. J., & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science, 28,* 115-152.

Hox, J. J. (1994). Hierarchical regression models for interviewer and respondent effects. *Sociological Methods and Research, 22,* 300-318.

Hox, J. J. (1998). Multilevel modeling: When and why. In R. Balderjahn, R. Mathar, & M. Schader (Eds.), *Classification, data analysis, and data highways* (pp. 147-154). New York: Springer-Verlag.

Hox, J. J., & Maas, C. J. M. (2002). Sample sizes for multilevel modeling. In J.Blasius, J. J. Hox, E. De Leeuw, & P. Schmidt (Eds.), *Social Science Methodology in the New Millennium. Proceedings of the Fifth International Conference on Logic and Methodology. Second expanded edition.* Retrieved September 1, 2006, from http://www.fss.uu.nl/ms/jh/publist/simnorm1.pdf

Marra, R. M., Moore, J. L., & Klimczak, A. K. (2004). Content analysis of online discussion forums: A comparative analysis of protocols. *Educational Technology Research and Development, 52,* 23-40.

Meyer, K. A. (2004). Evaluating online discussions: Four different frames of analysis. *Journal of Asynchronous Learning Networks, 8*. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v8n2/pdf/v8n2_meyer.pdf

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42,* 243-265.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Methodological Issues in the Content Analysis of computer conference transcripts. *International Journal of Artificial Intelligence in Education, 12,* 8-22.

Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior, 21,* 957-975.

Schellens, T., Van Keer, H., & Valcke, M. (2005). The impact of role assignment on knowledge construction in asynchronous discussion groups: A multilevel analysis. *Small Group Research, 36,* 704-745.

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (in press). Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group, and task characteristics. *Behaviour & Information Technology*.

Shotsberger, P. G. (1997). Emerging Roles for Instructors and Learners in the Web-Based Instruction Classroom. In B.H.Khan (Ed.), *Web-based Instruction* (pp. 101-106). New Jersey: Educational Technology Publications.

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis*. London: Sage.

Strijbos, J. W., Martens, R. L., Jochems, W., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35,* 195-229.

Tagg, A. C. (1994). Leadership from Within: Student Moderation of Computer Conferences. *The American Journal of Distance Education, 8,* 40-50.

Chapter 5[*]

Structuring asynchronous discussion groups by introducing roles: Do students act up to the assigned roles?

Abstract

This article fits in with the search for the optimisation of asynchronous text-based discussions. Roles were introduced as a scripting tool in asynchronous discussion groups in order to provide structure. The aim of this article is to examine whether this structuring intervention is implemented successfully. More specifically, we study to what extent the assigned roles of source searcher, theoretician, summariser, moderator, and starter are actually performed during the discussions. The results confirm that all students perform the roles assigned to them. Although source searchers, theoreticians, summarisers, and students without roles in the role condition focused less on some activities related to other roles, students generally did not neglect other activities while discussing. It can be concluded that the introduction of roles is a successful structuring intervention.

Introduction

In the age of lower hardware costs and broadband internet technology, online learning is becoming more and more popular. Networked computers and software for both synchronous and asynchronous communication are very suitable for supporting collaborative learning approaches. Within the field of computer-supported collaborative learning (CSCL), researchers as well as practitioners are engaged in a continuous search for optimising the instructional approaches in online learning environments. This article concentrates on the optimisation of one specific online learning environment, namely asynchronous text-based discussions. The study is situated in the context of a first year instructional sciences course, where asynchronous discussion groups of 10 students are introduced in addition to weekly face-to-face working sessions. The discussion groups are organised to foster students' processing of the learning content and, by confronting them with authentic tasks, to promote discussion about the different concepts presented in the face-to-face sessions and the course manual. In order to promote high-level interaction, enhanced collaboration, and consequently knowledge construction through social negotiation, roles are assigned to students. Providing structure by

---

[*] Based on: De Wever, B., Schellens, T., Van Keer, H., & Valcke, M. (2006). *Structuring asynchronous discussion groups by introducing roles: Do students act up to the assigned roles?* Manuscript submitted for publication to *Small Group Research.*

assigning roles is a well-known instructional approach. However, a prerequisite for studying the impact of this intervention on knowledge construction is examining whether the structuring intervention was implemented successfully. In this respect, the main goal of this article is to study to what extent the assigned roles are actually performed during the discussions.

This article starts off by describing scripting in general and by illustrating roles as a scripting tool in particular. Both their application in face-to-face settings and CSCL-environments are discussed. After this literature review, we elaborate on the specific context of the present study and on the spectrum of roles that was selected. Further, the focus of the study on validating students' actual role performance is substantiated. Next, the method and results of the study are presented in detail. This article ends with a discussion in which specific conclusions, practical implications, and directions for further research are formulated.

Scripts

Simply grouping individual students does not necessarily bring about effective interaction or collaborative learning (Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). Therefore, collaborative learning environments are usually equipped with a certain amount of structure: specific goals, task types, task prescripts, or pre-structuring. Pre-structuring or scripting learning environments is found to improve collaboration (Pfister & Mühlpfordt, 2002). A script (the term is actually borrowed from the theatre world) specifies the roles and the nature and timing of the activities of the participants (O'Donnell & Dansereau, 1992). In this respect, a script can be considered as a more or less rigid scheme according to which the collaboration proceeds (Pfister & Mühlpfordt, 2002).

The concept 'script' can be regarded as a collective term, covering a whole range of operationalisations. Scripts can be imposed by the instructor – either personally or through a computer program (Weinberger, Fischer, & Mandl, 2002) – or can be self-generated by the participants (O'Donnell & Dansereau, 1992). Furthermore, the level of detail of scripts can vary. General scripts – or macro scripts – solely provide a global structure. An example of a general script is "a discussion group, moderated by a teacher who tries to structure the discussion along a sequence of specific phases, e.g., brainstorming, critique, and summary" (Pfister & Mühlpfordt, 2002, p. 1). More specific scripts – which we call micro scripts – impose a highly detailed structure. They prescribe in detail what actions should be undertaken and in which order. Such a script for example requires students to identify the type of each contribution or predetermines a specific sequence of contributions (Pfister & Mühlpfordt, 2002; Weinberger et al., 2005).

Within the field of face-to-face collaborative learning, a number of well known scripts were developed: student team learning, jigsaw, learning together, and group investigation (for an overview see Slavin, 1989). Recently, the idea of implementing scripts to guide collaborative learning is also adopted within computer-supported settings. The interest in using scripts to specify, sequence, and assign collaborative learning activities (Kollar, Fischer, & Hesse, 2003) is growing in view of improving the design of CSCL-environments (Weinberger et al., 2005).

Roles as scripting tool

One specific type of scripting that is used to structure and improve collaborative discourse, is the assignment of different roles to group members. The introduction of roles in small groups is anything but a recent development. Long before the advent of the computer in education, roles have been assigned in collaborative groups in face-to-face settings within a variety of learning contexts from primary to higher education. One example of scripts involving roles is the cooperation script of O'Donnell and Dansereau (1992). In this script, two students read a section of a text. One is assigned the role of recaller (or summariser) and has to recall the main topics, whereas the other student is assigned the role of listener (detector or commentator) and should detect errors and omissions. He or she should also comment on the summary. After elaborating on the information in the first section, another section is read and both students switch roles. These summariser and listener roles are often implemented in face-to-face dyads studying texts (Lambiotte, Dansereau, & O'Donnell, 1987; O'Donnell, Dansereau, Hall, & Rocklin, 1987; O'Donnell & Dansereau, 1992; Buchs, Butera, & Mugny, 2004).

Instructional approaches to collaborative learning focus on assigning roles to students in order to support coordination and promote effective interaction patterns. A number of positive effects are attributed to roles. Groups where roles are assigned can work efficiently, smoothly, and productively (Cohen, 1994) and "the practical matter of having critical roles filled in meetings has direct implications for improving task performance and satisfaction" (Zigurs & Kozar, 1994, p. 277). The use of roles can alleviate problems of nonparticipation or domination of the interaction by one group member (Cohen, 1994). In the literature, a whole range of different roles are discriminated. A distinction can be made between studies exploring the spontaneously emerging roles in groups and studies which a priori assign roles to students.

In their exploratory study in computer-supported groups, Zigurs and Kozar (1994) aimed at presenting an overview of the different roles students can perform during collaboration. In this respect, the roles were not used as a scripting tool. Roles were not a priori assigned to students in order to stimulate interaction, but their occurrence was studied a posteriori through questionnaires. This approach is similar to the one of Mudrack and Farrell (1995). The results of these studies imply that different roles can be attributed to the same student, or one role to different students. Zigurs and Kozar (1994) based their role classification on Benne and Sheats' (1948) classification (for a full overview we refer to Mudrack & Farrell, 1995) and incorporated other roles within their classification. The authors classify the different roles that group members can take on in two categories: task-related roles and group-building roles. They put forward 7 task-related roles: proceduralist (procedure person, moderator, agenda-keeper), recorder (record-keeper), evaluator (devil's advocate, critic), explainer (elaborator, coordinator, orienter, summariser, amplifier), information/opinion seeker (questioner), information/opinion giver, and idea generator. The 5 group-building roles are: follower (listener, information receiver), motivator (energiser, encourager), gatekeeper (participation monitor/expediter), mediator (harmoniser, compromiser, conflict handler) and tension-releaser (jokester). Notwithstanding that roles were not used as a scripting tool in these studies, Strijbos, Martens, Jochems, and Broers (2004) argue that the role descriptions they provide can inspire and guide the design of roles for instructional purposes. In this respect, a number of the roles identified by Zigurs and Kozar (1994) recur underneath in the description of different roles implemented as a scripting tool.

Other role classifications focus on the instructional purposes of roles and a priori assign roles to students. In this view, roles serve as a scripting tool in order to enhance the interaction and collaboration among students. Cohen (1994) illustrates a number of roles in face-to-face discussions and distinguishes between "how"-roles and "what"-roles. The former roles relate to how the work is done. According to Cohen (1994) these roles can be used to delegate tasks that the teacher usually performs, such as keeping the group on task, organising and cleaning-up, and summarising what has been learned. Examples of "how"-roles are: resource person, materials manager, clean-up person, facilitator, reporter, recorder, spokesperson, synthesiser or summariser, safety officer, and checker (Cohen, 1994). The "what"-roles focus on what should be done and relate to a specific task. They are used in settings where a division of labour exists. These roles are more context-specific and can be used in situations where each person plays a different and complementary role. Examples of "what"-roles in a specific context are: camera person, director, story writer, and actor (Cohen, 1994). Strijbos et al. (2004) make a similar distinction: roles can either be based on individual responsibilities regarding group coordination (process-based roles) or on differences in individual expertise (content-based roles).

Roles in online discussion groups

Although the use of roles is not the most prominent approach to structure communication and collaboration in asynchronous discussion groups (Strijbos & Martens, 2001), a number of practical examples can be found in the literature. In a course called ‘quasi landevaluation and variability for explorative land use studies’, Veerman and Veldhuis-Diermanse (2001) introduced “particular perspectives” (regional planner, local politician, tourism, citrus farmer) to analyse a problem. These “particular perspectives” can be regarded as content-based roles and resemble the roles (economics, web, schools, health & wellness, and lead editor) introduced by Rose (2002) in an online asynchronous learning environment where the task consisted of the creation of an html-based technology assessment report on the health and wellness implication of computer use by children.

Process-based roles are applied in an online setting described by Aviv (2000). Learners are assigned four roles to encourage and facilitate each other’s efforts to reach the learning goals: helper, feedback provider, resource manager, and process reflector. In another example, Strijbos et al. (2004) introduce four process-based roles to support the work organisation and communication between team members, namely project planner, communicator, editor, or data collector. Hara, Bonk, and Angeli (2000) introduced two process-based roles in their asynchronous computer conferences within a graduate level course. The starter was asked to initiate the discussion by asking questions related to specific readings and the wrapper summarised the discussion on the readings for the week. Zhu (1996) also used this starter-wrapper technique in electronic discussions. Tagg (1994) developed a similar approach for exercises with the aim of relating theoretical material to own experiences, involving two process-based roles: a topic leader who was responsible for submitting an initial introductory exercise contribution and a topic reviewer responsible for summarising the topic at the end. The topic leader furthermore appeared to perform a vital contextualising function in moderating conferences (Tagg, 1994). The role of moderator in computer conferencing terms involves guiding the discussions and stimulating participation and is generally highly valued (Mason, 1991). Gray (2004) investigated informal learning in online communities and her findings suggest that “the presence of an online moderator helped the community evolve from a forum for sharing information to a community of practice where knowledge was constructed through shared learning". In this respect, it can be concluded that in CSCL-environments, the role of online moderator is critical for enhancing learning (Gray, 2004).

Aim of the present study

As mentioned above, a number of studies concentrate on introducing roles in online discussion groups. More specifically, these studies aim to examine the effect of introducing roles on for example students' participation rates, their interaction patterns, the group efficiency, or the level of knowledge construction reflected in the discussion (Hara, Bonk, & Angeli, 2000; Schellens, Van Keer, & Valcke, 2005; Strijbos et al., 2004; Zhu, 1996). However, in most studies no attention is paid to collecting data on whether the roles assigned to students are implemented accurately and completely. Yet, Cohen (1994) notices that students are not always performing the assigned roles. Therefore, studies focusing on validating the realisation of the specific role assignments are needed.

Verifying to which extent students perform their roles is interesting from a practical point of view, since this information can be used to make more informed decisions on roles that are both feasible and valuable to introduce in CSCL environments in different contexts. Moreover, it is also important to shed a light on role performance from a theoretical and empirical point of view. As roles are introduced as an instructional approach to structure and to optimise online discussions, the question whether students actually act up to the roles assigned to them merits particular attention before studying the impact of the implementation of roles on the ongoing knowledge construction processes in discussion groups. Attention should primarily go out to whether the intervention of assigning roles was successful, i.e. did students perform the roles they were assigned? And if so, did they exclusively stick to these roles, or did they engage in other discussion activities as well?

Taking into account the online setting and the study level of the students, in the present study the performance of 5 different process-based roles is studied: starter, summariser, moderator, theoretician, and source searcher. The inclusion of the starter and summariser was founded on the literature regarding the starter-wrapper technique (Hara et al., 2000; Zhu, 1996), while the moderator was incorporated based on the findings of Gray (2004) indicating the role of an online moderator as critical for enhancing learning. Further, Strijbos et al. (2004) argue that when cooperative learning pedagogies, and more specifically roles, are used in higher education or online learning environments, they should be adapted to the specific context, as students in these settings vary considerably in prior knowledge, experience, and collaboration skills. Taking into account that the discussion groups are organised in order to stimulate debate on the theoretical concepts presented in the face-to-face sessions and course manual, the starter, summariser, and moderator role were supplemented with the role of source searcher and theoretician.

The role of the *source searcher* comprises of seeking external information on the discussion topics in order to stimulate other students to go beyond the scope of the course material. The role of source searcher is partly based on the ‘information giver’ described by Zigurs and Kozar (1994), the ‘resource person’ described by Cohen (1994), and a specific activity assigned to the role of ‘weekly participant’ by Zhu (1996), namely bringing related issues or newspaper articles to everyone’s attention. Students performing the role of *theoretician* are required to introduce theoretical information from the weekly face-to-face session or the course material and to ensure that all relevant theoretical concepts are used in the discussion. This role is closely related to the specific goal of the online discussions in the present research setting, namely becoming familiar with the different theoretical concepts through discussing and solving tasks. The *summariser* is expected to post interim summaries during the discussion, focusing on identifying dissonance and harmony between the messages and making provisional conclusions. Moreover, summarisers should post a final summary and conclusion at the end of the discussion. The role of the *moderator* consists of monitoring the discussions, asking critical questions, and inquiring for others’ opinions. This involves pointing out questions and concerns that have yet to be answered (Zhu, 1996). Furthermore, one of the main functions of the moderator is encouraging participation (Gray, 2004). The *starter* is required to start off the discussions by posting a number of contributions where other students can build upon. Furthermore, their job consists of adding new points during the discussions and giving new impulses every time the discussion slacks off. It is important to notice that all students were generally encouraged to moderate, to summarise, and to add new discussion points, theory, and information. However, students with a specific role were asked to do this in an explicit and regular way.

Taking into account the need of validating the realisation of specific role assignments in online discussion groups, the main goal of the present study is to explore to what extent students perform the assigned roles of source searcher, theoretician, summariser, moderator, and starter. More specifically, we hypothesise that (1) students assigned the role of source searcher will mention and discuss significantly more sources, (2) students assigned the role of theoretician will mention and discuss significantly more theoretical elements, (3) summarisers will engage significantly more in summarising and recapitulating parts of the discussion, (4) students assigned the role of moderator will post significantly more contributions comprising organisational or content moderating, and (5) the contributions of the starter will include more new points instigating the discussion. In order to purge the analysis, gender and educational degree are controlled for.

Method

Participants and context of the study

The participants in the present study were students enrolled in the freshman course in instructional sciences (N=200). The majority of the participants were female students; only 18 male students were involved in the study. Further, a small subgroup of 17 students already had a degree in higher education. Students were divided into discussion groups of 10 persons. Each discussion group participated in four consecutive discussion themes. The four themes corresponded to four chapters of the course manual, namely behaviourism, cognitivism, constructivism, and evaluation. Each theme was organised during a three-week period; in the course of this period, students collaborated independent of time and location. Participation in the discussions was obligatory and represented 25% of the final exam score. Students were required to contribute at least four times per discussion theme. As mentioned before, the discussion groups are organised to foster students' processing of the learning content and, by confronting them with authentic tasks, to promote discussion about the different concepts presented in the face-to-face sessions and the course manual. One of the discussion assignments for example required students to develop a checklist of essential criteria to decide whether learning environments are based on constructivistic principles. Furthermore, students were asked to actively use this checklist in order to determine the nature of a given learning environment. In addition, students were required to search for other learning environments to apply their checklist on. After the actual application of the checklist, the students were asked to revise their instrument. The authentic tasks in the discussion groups were identical for all groups.

Design and data collection

A cross-over design was applied: every discussion group participated in two discussion themes with and in two discussion themes without role support. To control for time effects, the role-supported discussion themes were either the first or the last two discussion themes. In the first role-supported discussion theme, five randomly selected students were assigned one of the five roles, while the remaining students were not assigned a role. The roles were rotated at the start of the next discussion theme. Consequently, in the second role-supported discussion, the roles were assigned to the students without role assignment in the first role-supported discussion. The alternation of roles implies that each student was assigned a role once. Students were asked to perform their roles in addition to their regular discussion input.

The roles were introduced and explained in a face-to-face session. Furthermore, all information on the discussion groups in general and on the role descriptions in particular was presented on a website, so all students could retrieve the essential information online. In this way, we tried to meet the following guidelines for assigning roles formulated by Cohen (1994, p. 96): (1) make your assignment of the job to a specific member of each group public knowledge, (2) specify exactly what the person playing the role is supposed to do, and (3) make sure everyone knows what the role player is supposed to do.

The data collected comprise the transcripts of 20 discussion groups of 10 students. All 4 themes were analysed. This corresponds to 80 discussions, approximately 4770 messages, and approximately 60,000 lines of text.

Quantitative content analysis

Quantitative content analysis was applied to explore students' actual role performance. Neuendorf (2002, p. 10) defines content analysis as "a summarizing, quantitative analysis of messages that relies on the scientific method and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented". The aim of content analysis is to go beyond analyses based on only counting the number of messages and to reveal information that is not situated at the surface of the transcripts.

In order to analyse the role-related activities in students' contributions, we developed an analysis model to identify message characteristics on five different dimensions: sources, theory, summaries, moderation, and new points. These dimensions are related to the introduced roles. Although all students are essentially encouraged to perform these activities, the different roles were especially introduced to stimulate students to pay extra attention to the execution of this kind of activities. Indicators of different levels within these dimensions are presented in Table 5.1. In our analysis, each message receives one code for each dimension.

Coding strategy and reliability

Five independent coders were trained to perform the coding activity. After the training, they coded some transcripts together in order to discuss and elaborate on the coding process. Next, the transcripts were coded independently. 154 messages were randomly selected and coded by all the coders in order to calculate the interrater reliability of the ASIMeC. The Krippendorff's alpha (α) interrater reliability coefficients for the dimensions source, theory, summaries, moderation, and new points (respectively .73, .76, .66, .58, and .53) are all situated between .40 and .80, which corresponds to 'fair to good agreement beyond chance' (De Wever, Schellens, Valcke, & Van Keer, 2006; Krippendorff, 1980; Neuendorf, 2002).

Table 5.1
Analysis scheme identifying message characteristics (ASIMeC)

Dimension	Characteristic (code)	Description
Source	No sources	Not referring to external sources
	Mentioning sources	Mentioning external sources
	Discussing sources	Actively using and discussing external sources
Theory	No theory	Not referring to theoretical concepts
	Mentioning theory	Mentioning theoretical concepts
	Discussing theory	Actively using and discussing theoretical concepts
Summary	No summary	Not summarising information from other messages
	Minor summary	Summarising information from a number of messages
	Extensive summary	Summarising information from a substantial part of the discussion
Moderating	No moderating	No moderation tasks performed
	Organisational moderating	Organisational moderation tasks performed (e.g. planning)
	Content moderating	Moderation task as regards content performed (e.g. compare different statements, weigh up different messages)
	Organisational and content moderating	Combination of both moderation tasks
New points	No new points	No new points added to the discussion
	New points introduced	New points added to the discussion

Statistical analysis

The five dimensions of the ASIMeC serve as dependent variables for our analysis. The first three dimensions (source, theory, and summaries) are treated as ordinal. The moderation dimension is treated as nominal, since organisational and content moderating cannot be ranked. The new points dimension is dichotomous. We refer to Table 5.1 for a complete overview of the five dependent variables (dimensions).

The roles assigned to the students serve as the independent variable in our study. In addition, we control for the effect of gender (male versus female) and degree in education (degree in higher education versus degree in secondary education). No interaction between these variables was assumed. The independent variable role type comprises of 7 categories: (1) source searcher, (2) theoretician, (3) summariser, (4) moderator, (5) starter, (6) no role, and (7) no role condition. Students in the last two categories are not assigned a role. However, we want to make a distinction between students without roles in a condition where roles are present (category 6: no role) on the one hand and students in the no role condition (category 7) on the other hand.

The first three dimensions (source, theory, and summaries) are analysed through ordinal regression. Multinomial and binary logistic regression procedures were respectively executed to study the moderation and new points dimension. Female students, students with a degree in secondary education, and students in the no role condition were selected as reference category for the regressions. The overall effect of the role type predictor is examined with likelihood ratio tests (LRT) and the specific parameter estimates are presented. In this respect, the tables report the estimated parameters (est), the standard error (SE), the Wald statistic (Wald), the p-values (p) of the Wald test, the odds ratio (OR = exp (est)), the inverse odds ratio (OR^{-1} = exp (-est)) in case the odds ratio is smaller than 1, and the 95% confidence interval (CI) for the odds ratio, comprising a lower bound (LB_L) and an upper bound (UB_L). In order to correct for multiple tests, we used Bonferroni adjusted significance values. As for role type 6 categories are contrasted to the reference category, a Bonferroni adjusted alpha level of .0083 (= .05 / 6) is used. When reported, both the original as the Bonferroni corrected alpha levels are reported (e.g. $p < .05 / 6 = .0083$ or $p < .001 / 6 = .00017$).

Results

Descriptive results

47.9% of all contributions were posted by students in the no role condition. 22.0% were posted by students without a role in the role condition, whereas respectively 6.1%, 5.7%, 6.4%, 6.0%, and 5.9% of the messages were posted by students assigned the role of source searcher, theoretician, summariser, moderator, or starter.

Table 5.2
Overview of the distribution among the categories of the dimensions of the ASIMeC for students assigned one of the roles (1-5), without role in the role condition (6), and in the no role condition (7)

Dimension	Category	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Total
Source	No sources	**64.4**%	91.5%	95.4%	90.8%	92.1%	90.9%	90.7%	89.4%
	Mentioning sources	**11.4**%	3.9%	1.6%	4.8%	4.3%	3.5%	4.2%	4.4%
	Discussing sources	**24.2**%	4.6%	2.9%	4.4%	3.6%	5.7%	5.2%	6.2%
Theory	No theory	34.9%	**24.6**%	30.4%	34.3%	30.9%	30.3%	34.3%	32.3%
	Mentioning theory	41.2%	**37.5**%	51.0%	42.8%	42.1%	42.0%	40.7%	41.3%
	Discussing theory	23.9%	**37.9**%	18.6%	22.9%	27.0%	27.7%	25.0%	26.4%
Summary	No summary	98.3%	98.2%	**67.1**%	93.4%	97.8%	98.1%	95.6%	94.7%
	Minor summary	1.0%	0.7%	**2.9**%	2.2%	1.4%	1.4%	1.8%	1.6%
	Extensive summary	0.7%	1.1%	**30.0**%	4.4%	0.7%	0.5%	2.6%	3.7%
Moderating	No moderating	86.5%	81.9%	83.1%	**64.9**%	72.7%	86.1%	81.9%	81.6%
	Organisa-tional	0.7%	0.7%	3.9%	**5.9**%	4.7%	1.4%	3.1%	2.8%
	Content	12.8%	17.4%	13.0%	**27.3**%	20.5%	12.2%	14.6%	15.1%
	Org. & content	0.0%	0.0%	0.0%	**1.8**%	2.2%	0.3%	0.5%	0.5%
New points	No new points	57.1%	57.7%	76.9%	58.7%	**52.5**%	59.2%	63.2%	61.0%
	New points introduced	42.9%	42.3%	23.1%	41.3%	**47.5**%	40.8%	36.8%	39.0%

(1) source searcher (2) theoretician (3) summariser (4) moderator (5) starter (6) no role (7) no role condition

10.3% of the contributions were posted by students with a degree in higher education and 7.7% were posted by male students. Furthermore, Table 5.2 presents an overview of the distribution among the categories of the five dimensions of the ASIMeC for students assigned the role of (1) source searcher, (2) theoretician, (3) summariser, (4) moderator, (5) starter, (6) students without role assignment in the role condition, and (7) students in the no role condition. In the following sections, we discuss the results for each dimension in more detail.

Mentioning and discussing sources

The descriptive results show that 89.4% of the contributions do not mention or discuss sources. In 4.4% of the contributions sources are mentioned, while in 6.2% of the postings sources are discussed. No significant effect of gender was found. However, there is a significant effect of degree: the specific parameters in Table 5.3 show that the odds of mentioning versus not mentioning sources and the odds of discussing versus mentioning sources are about 1.67 times higher for students with a degree in higher education compared to students with a degree in secondary education (est = 0.510, SE = 0.144, $p < .001$).

Table 5.3
Ordinal regression estimates for mentioning and discussing sources

	est.	SE	Wald	df	p	OR	OR^{-1}	LB_L	UB_L
Gender									
Male	0.061	0.187	0.105	1	0.746	1.062		0.737	1.532
Female	(ref. cat.)								
Degree									
Higher educ.	0.510	0.144	12.471	1	0.000	1.665		1.255	2.209
Secondary educ.	(ref. cat.)								
Role type									
Source searcher	1.694	0.144	138.766	1	0.000	5.439		4.103	7.209
Theoretician	-0.014	0.227	0.004	1	0.950	0.986	1.014	0.632	1.537
Summariser	-0.837	0.293	8.167	1	0.004	0.433	2.308	0.244	0.769
Moderator	-0.041	0.224	0.033	1	0.855	0.960	1.042	0.619	1.490
Starter	-0.278	0.245	1.292	1	0.256	0.757	1.321	0.468	1.224
No roles	-0.028	0.131	0.047	1	0.828	0.972	1.029	0.751	1.257
Without roles	(ref. cat.)								

Furthermore, the results corroborate hypothesis 1. The likelihood ratio test shows an overall effect of role type ($\chi^2 = 152.371$, df = 6, $p < .001$). The odds of mentioning versus not mentioning and the odds of discussing versus mentioning sources are about 5.44 times higher for students assigned the role of source searcher compared to students in the no role condition (est = 1.694, SE = 0.144, $p < .001/6 = 0.00017$). The results also show that the odds of mentioning versus not mentioning sources and the odds of discussing versus mentioning sources are about 2.31 times lower for students assigned the role of summariser compared to students in the no role condition (est = -0.837, SE = 0.293, $p < .05/6 = 0.0083$). No significant differences were revealed for the three other roles and for the students without roles in a role condition compared to the reference category (see Table 5.3).

Mentioning and discussing theory

32.3% of the contributions do not mention or discuss theory. In 41.3% of the messages theoretical concepts are mentioned and in 26.4% they are actively discussed. The effect of gender is not significant. On the other hand, the effect of degree is significant. The odds of mentioning versus not mentioning theory and the odds of discussing versus mentioning theory are about 1.29 times lower for students with a degree in higher education compared to students with a degree in secondary education (est = -0.255, SE = 0.091, $p < .01$).

Table 5.4
Ordinal regression estimates for mentioning and discussing theory

	est.	SE	Wald	df	p	OR	OR^{-1}	LB_L	UB_L
Gender									
Male	-0.138	0.104	1.754	1	0.185	0.871	1.148	0.710	1.068
Female	(ref. cat.)								
Degree									
Higher educ.	-0.255	0.091	7.816	1	0.005	0.775	1.290	0.649	0.927
Secondary educ.	(ref. cat.)								
Role type									
Source searcher	-0.114	0.118	0.925	1	0.336	0.893	1.120	0.708	1.125
Theoretician	0.554	0.122	20.462	1	0.000	1.740		1.369	2.212
Summariser	-0.014	0.115	0.014	1	0.905	0.986	1.014	0.787	1.236
Moderator	-0.057	0.120	0.225	1	0.636	0.945	1.059	0.747	1.195
Starter	0.116	0.120	0.937	1	0.333	1.123		0.888	1.420
No roles	0.157	0.071	4.944	1	0.026	1.170		1.019	1.344
Without roles	(ref. cat.)								

The expected positive effect of theoretician (hypothesis 2) is confirmed by the data: there is an effect of role type (LRT: $\chi^2 = 26.942$, df = 6, $p < .001$) and the odds of mentioning versus not mentioning theory and of discussing versus mentioning theory are about 1.74 times higher for contributions from theoreticians compared to contributions from students in the no role condition (est = 0.554, SE = 0.122, $p < .001/6 = 0.00017$). All other roles have no significant effect at the .0083 (= .05 / 6) level (see Table 5.4).

Summarising

About 94.7% of the messages do not contain summaries, 1.6% comprise minor summaries, and 3.7% of the messages include extensive summaries. Table 5.5 shows no significant effect for gender and degree.

The predictor role type is significant (LRT: $\chi^2 = 282.022$, df = 6, $p < .001$). More specifically, the effect of assigning a summariser role is highly significant (est = 2.442, SE = 0.161, $p < .001/6 = 0.00017$): compared to contributions in the no role condition, the odds of minor versus no summaries and the odds of extensive versus minor summaries are about 11.50 times higher for contributions posted by a summariser. In addition, Table 5.5 shows that the odds of minor versus no summaries and the odds of extensive versus minor summaries are about 2.36 times lower for contributions of students without roles in a role condition compared to students in the no role condition (est = -0.859, SE = 0.255, $p < .01/6 = 0.0017$).

Table 5.5
Ordinal regression estimates for minor and extensive summaries

	est.	SE	Wald	df	p	OR	OR^{-1}	LB_L	UB_L
Gender									
Male	-0.143	0.258	0.310	1	0.578	0.866	1.154	0.523	1.435
Female	(ref. cat.)								
Degree									
Higher educ.	0.175	0.208	0.702	1	0.402	1.191		0.792	1.791
Secondary educ.	(ref. cat.)								
Role type									
Source searcher	-0.916	0.465	3.885	1	0.049	0.400	2.499	0.161	0.995
Theoretician	-0.833	0.464	3.222	1	0.073	0.435	2.300	0.175	1.080
Summariser	2.442	0.161	231.258	1	0.000	11.499		8.394	15.753
Moderator	0.469	0.267	3.074	1	0.080	1.598		0.946	2.698
Starter	-0.704	0.428	2.711	1	0.100	0.494	2.022	0.214	1.144
No roles	-0.859	0.255	11.345	1	0.001	0.423	2.362	0.257	0.698
Without roles	(ref. cat.)								

Moderating

Contributions including content moderating activities are more prevalent (15.1%) than contributions comprising organisational moderating (2.8%) or contributions containing both forms of moderating (0.5%). The nominal regression estimates for these three categories (compared with the reference category: no moderating (81.6%)) are presented in Table 5.6.

Again, no effect of gender is found. The overall effect of degree is positive (LRT: $\chi^2 = 29.790$, df = 3, $p < .001$): the odds of organisational moderating and content moderating are respectively about 3.02 and 1.53 times higher for students with a degree in higher education compared to students with a degree in secondary education (respectively est = 1.104, SE = 0.220, $p < .001$ and est = 0.424, SE = 0.127, $p = .001$). The overall effect of role type is also significant (LRT: $\chi^2 = 108.907$, df = 18, $p < .001$). We can see that the results confirm hypothesis 4: messages of moderators are about 2.60 times more likely to include organisational moderating (est = 0.957, SE = 0.294, $p < .01/6 = 0.0017$), about 2.37 times more likely to include content moderating (est = 0.861, SE = 0.153, $p < .001/6 = .00017$), and about 5.55 times more likely to contain both forms of moderating (est = 1.713, SE = 0.559, $p < .05/6 = 0.0083$) compared to messages of students in the no role condition. In addition to this result, the results in Table 5.6 also show significant effects not assumed in hypothesis 4: students without roles in a role condition are 2.27 times less likely to perform organisational moderating activities (est = -0.817, SE = 0.297, $p < .05/6 = 0.0083$) and starters are 1.61 times more likely to perform content moderating activities and 5.31 times more likely to perform both moderating activities (est = 0.474, SE = 0.165, $p < .05/6 = 0.0083$ and est = 1.669, SE = 0.523, $p < .01/6 = 0.0017$ respectively). All estimates are presented in Table 5.6. A few parameters are not estimated due to zero frequencies.

Table 5.6
Nominal regression estimates for organisational, content, and organisational & content moderating (reference category: no moderating)

	est.	SE	Wald	df	p	OR	OR^{-1}	LB_L	UB_L
Gender									
Male									
[org]	-0.207	0.346	0.358	1	0.549	0.813	1.230	0.412	1.602
[cont]	0.103	0.151	0.471	1	0.493	1.109		0.825	1.490
[o&c]	-0.846	1.043	0.657	1	0.418	0.429	2.330	0.056	3.318
Female	(ref. cat.)								
Degree									
Higher educ.									
[org]	1.104	0.220	25.255	1	0.000	3.018		1.962	4.642
[cont]	0.424	0.127	11.140	1	0.001	1.528		1.191	1.960
[o&c]	0.420	0.626	0.451	1	0.502	1.523		0.446	5.196
Secondary educ. (ref. cat.)									
Role type									
Source searcher									
[org]	-1.452	0.722	4.046	1	0.044	0.234	4.271	0.057	0.964
[cont]	-0.146	0.189	0.598	1	0.439	0.864	1.158	0.596	1.252
[o&c]	n.c.								
Theoretician									
[org]	-1.320	0.722	3.344	1	0.067	0.267	3.745	0.065	1.099
[cont]	0.274	0.172	2.550	1	0.110	1.315		0.940	1.841
[o&c]	n.c.								
Summariser									
[org]	0.245	0.323	0.577	1	0.448	1.278		0.679	2.404
[cont]	-0.081	0.182	0.200	1	0.654	0.922	1.085	0.646	1.316
[o&c]	n.c.								
Moderator									
[org]	0.957	0.294	10.579	1	0.001	2.604		1.463	4.636
[cont]	0.861	0.153	31.699	1	0.000	2.366		1.753	3.193
[o&c]	1.713	0.559	9.391	1	0.002	5.547		1.854	16.594
Starter									
[org]	0.576	0.314	3.350	1	0.067	1.778		0.960	3.294
[cont]	0.474	0.165	8.253	1	0.004	1.606		1.163	2.220
[o&c]	1.669	0.523	10.184	1	0.001	5.306		1.904	14.786
No roles									
[org]	-0.817	0.297	7.557	1	0.006	0.442	2.265	0.247	0.791
[cont]	-0.259	0.116	5.010	1	0.025	0.772	1.296	0.615	0.968
[o&c]	-0.477	0.660	0.524	1	0.469	0.620	1.612	0.170	2.261
Without roles	(ref. cat.)								

[org] = organisational moderating; [cont] = conent moderating; [o&c] = organisational and content moderating; n.c. = not calculated

Adding new points

39.0% of the contributions include new points. Concerning new points we found no effect of gender. As to the impact of students' degree, a significant effect was found: the odds of introducing new points are about 1.56 times smaller for students with a degree in higher education compared to students with a degree in secondary education (est = -0.442, SE = 0.107, p < .001).

Table 5.7
Binary logistic regression estimates for new points

	est.	SE	Wald	df	p	OR	OR^{-1}	LB_L	UB_L
Gender									
Male	0.123	0.115	1.128	1	0.288	1.130		0.902	1.417
Female	(ref. cat.)								
Degree									
Higher educ.	-0.442	0.107	17.079	1	0.000	0.643	1.556	0.521	0.793
Secondary educ.	(ref. cat.)								
Role type									
Source searcher	0.215	0.129	2.774	1	0.096	1.240		0.963	1.597
Theoretician	0.256	0.133	3.705	1	0.054	1.292		0.995	1.677
Summariser	-0.650	0.144	20.299	1	0.000	0.522	1.915	0.394	0.693
Moderator	0.136	0.132	1.064	1	0.302	1.146		0.885	1.484
Starter	0.420	0.130	10.379	1	0.001	1.522		1.179	1.965
No roles	0.148	0.078	3.613	1	0.057	1.160		0.995	1.352
Without roles	(ref. cat.)								

Furthermore, the predictor role type is significant (LRT: $\chi^2 = 46.450$, df = 6, p < .001). As hypothesised, students assigned the role of starter add significantly more (about 1.52 times more, see Table 5.7) new points in their contributions (est = 0.420, SE = 0.130, p < .01/6 = .0017). Moreover, students assigned the role of summariser add significantly less (about 1.92 times less) new points in their contributions (est = -0.650, SE = 0.144, p < .001/6 = .00017).

Table 5.8 presents an overview of the results. Non-significant effects are represented by '=', significant effects are represented by '+'when positive, and by '-' when negative.

Table 5.8
Overview of the results concerning role type

	Source	Theory	Summary	Moderation	New points
Source searcher	+++	=	=	= / = / n.c.	=
Theoretician	=	+++	=	= / = / n.c.	=
Summariser	-	=	+++	= / = / n.c.	---
Moderator	=	=	=	++ / +++ / +	=
Starter	=	=	=	= / + / ++	+++
No role	=	=	--	- / = / =	=
No role condition	Reference category	Reference category	Reference category	Reference category	Reference category

Moderating column: Organisational / content / both forms of moderating
n.c.: not calculated
+++ and --- < .001/6 = .00017, ++ and -- < .01/6 = .0017, + and - < .05/6 = 0.0083

Discussion

Within the field of CSCL research, the interest in applying scripts to foster high-quality interaction and collaborative learning is growing. One specific type of scripting is the assignment of roles to group members. In this respect, research primarily focuses on studying the impact of role assignment on a number of process or outcome variables. Verifying the actual implementation of the scripting intervention, however, only receives limited attention. Taking into account that studying the actual realisation of the roles should precede effectiveness studies, the main goal of the present study was to reveal to what extent students act up to the role they were assigned in asynchronous discussion groups. More specifically, the performance of source searchers, theoreticians, summarisers, moderators, and starters was explored.

An analysis scheme identifying message characteristics (ASIMeC) was developed to explore the role-related activities in students' contributions. Logistic regression was applied to study the impact of the different roles on the five dimensions of the ASIMeC. In addition, we controlled for the effect of two background variables: students' gender and degree in education. In this respect, the results indicate that for all dimensions of the ASIMeC, gender did not have a significant effect. Degree in education is of significant importance in the models for four dimensions: source, theory, moderation, and new points. More specifically, students with a degree in higher education add and discuss significantly more sources, refer significantly less to and comment significantly less on theoretical concepts, moderate significantly more, and add significantly less new points compared to students with a degree in secondary education. This might be due to the fact that students with a degree in higher education are more experienced in moderating discussions and reveal a higher degree of self-regulative behaviour. They are more accustomed to refer to additional information and sources and therefore focus more on these dimensions and less on adding new points or theory. However, this hypothesis should be verified by further research.

With respect to the aim of validating the introduction of role assignments, the overall results indicate that the structuring intervention was successful: all students performed the activities related to their roles fairly well. Table 5.8 clearly illustrates highly significant positive effects on the main diagonal, confirming the different hypotheses. Compared to students in the no role condition, source searchers introduce and discuss significantly more discussion-related external sources, theoreticians focus significantly more on referring to and commenting upon theoretical concepts, summarisers engage significantly more in summarising the ongoing discussion, moderators concentrate significantly more on both organisational and content moderating, and starters introduce significantly more new ideas to the discussion. As the contexts of CSCL studies introducing role assignments are very diverse and most studies do not focus on the extent of role performance, it is troublesome to compare the present results with the findings of previous research. However, the study of Zhu (1996) discusses role performance and goes into the actions of the summariser. Contrary to the present results, where summarisers actually do engage in summarising parts of the discussion and in making provisional conclusions, Zhu (1996) reported that the summariser role did not demonstrate its expected value to synthesise the groups' understanding of the readings and that the summarisers read the discussion notes and reflected on them, but "often offered few insights or summaries" (Zhu, 1996, p. 831).

In addition to the confirmation of the hypotheses, Table 5.8 also indicates a number of additional effects that were not included in the hypotheses. Below, we discuss these extra findings. More specifically, a clarification for every non-zero in the off-diagonal area is looked for, as these effects were not assumed in advance. Pluses in the off-diagonal area indicate positive effects. This means that students pay extra attention to activities that are not part of their own role, but fit in the role description of other students. Minuses in the off-diagonal area indicate negative effects, meaning that students overlook other activities than the ones formulated in their own role description. One might worry that stimulating students to focus on one specific role would result in less attention to the activities related to other roles.

However, this would imply that all off-diagonal cells in Table 5.8 would be minus signs. As can be observed, this is generally not the case.

Taking into account the plus and minus signs in the off-diagonal area (see Table 5.8), three different trends can be distinguished. The first trend is indicated by pluses on the main diagonal and by zeros in the off-diagonal area. This refers to students sticking to the role-related behaviour without paying less or more attention to the non role-related activities. The second tendency is indicated by pluses on the main diagonal and both zeros and pluses in the off-diagonal area. This demonstrates a focus on role-related behaviour without paying less attention to the other activities but with extra attention on some other activities. The third trend is characterised by pluses on the main diagonal and the occurrence of zeros and minuses in the off-diagonal area. This indicates a focus on role-related behaviour on the one hand and less attention being paid to certain other activities on the other hand.

The specific roles fit in with one of these trends. *Source searchers, theoreticians, and moderators* are the perfect example of students paying extra attention to their role without neglecting other discussion activities. They clearly fit in with the first trend: they all focused more on the activities assigned to them by their role, without losing sight of the four other dimensions.

Starters fit in with the second trend. In addition to the role-related focus on adding new points and introducing new impulses to the discussion, starters also concentrate significantly more on content moderation issues. In this respect, it can be assumed that students assigned the role of starter not only add new points to the discussion, but they also apply this information as input for content moderation issues. While performing this kind of activities, starters shift to the field of the moderator. This finding is in line with the study of Tagg (1994), who noticed that topic leaders (a role more or less equivalent to starters) inclined to perform “a vital contextualizing function in moderating conferences”. As a consequence, it can be argued that the operationalisation of the role of starter in the present study is to some extent too closely related to the role of moderator. The role of starter might be more relevant and more distinguished from the moderator role when starters actually have to introduce completely new discussion topics or select a discussion theme by themselves, based on the course material or readings (e.g. Hara et al., 2000; Zhu, 1998). In the context of the present study, however, the different discussion themes were already launched by the instructor in the discussion task. Taking into account the role overlap and the fact that no moderator is involved in studies based on the starter-wrapper technique (Hara et al., 2000; Zhu, 1996), we might consider eliminating the starter role and assigning a few of its activities (e.g.

giving new impulses when the discussions slack off) to the moderator. An additional reason why the elimination of the starter role might be worth considering is that it can be very frustrating for the nine other students to wait for the starter to kick off the different parts of discussions, especially when the discussion task is already made available by the instructor.

While no significant negative effects were found for source searchers, theoreticians, moderators, and starters, this was not the case for students without roles in the role condition and summarisers. They focus on their own role but pay less attention to the activities related to other roles and thus fit in with the third trend. In addition to a significantly higher amount of summaries, the contributions of the *summariser* comprise significantly fewer sources and new points. This negative effect is however not completely unexpected, since summarising activities are contradictory to adding new points or relevant sources to the discussion. Although all students were asked to perform all activities, summarisers might lose track of these activities since the summarising role may be quite demanding and focuses on the exact opposite goals, namely synthesising contributions instead of adding new points or sources.

Students without roles in the role condition form a particular group. They find themselves in a particular situation, as they see other students performing assigned roles. At first one may expect them to behave like students in the no role condition. Our observations however indicate that this is not the case. Students without a role in the role condition post fewer contributions containing summaries and organisational moderation issues.

An explanation for this finding may be that organisational moderation and summarising can be clearly defined. They comprise specific and identifiable activities and are therefore more avoided by the students not performing a role, since students do not want to poach on someone’s preserves. When students are placed in a role condition, they appear to avoid contributions that contain typical utterances that can be claimed by the specific roles. Moreover, this might be reinforced by the fact that students do not feel the need to post a certain type of contributions when there are already sufficient contributions of this kind present in the discussion. For instance, if there already are a lot of interim summaries posted by the summariser, there is no need for more summaries to be posted by students not assigned a role. Further research, for instance combining specific questionnaires and stimulated recall interviews, is necessary to explore students’ underlying motives guiding their role behaviour in detail.

Conclusion

In short, it can be concluded that the scripting approach presented is fruitful. The assignment of roles is very useful to stimulate students to perform certain activities. The results show that all students perform the roles assigned to them. In addition, they generally do not neglect the activities related to the other roles while discussing. Since it is confirmed that the introduction of roles is a successful structuring intervention, further research can focus on the impact of assigning roles on knowledge construction processes through social negotiation. A practical implication of this study is that assigning roles can be considered as a recommended scripting approach and can be used further on to structure asynchronous discussion groups.

References

Aviv, R. (2000). Educational performance of ALN via content analysis. *Journal of Asynchronous Learning Networks*, *4*, 53-72. Retrieved September 1, 2006, from http://www.sloan-c.org/publications/jaln/v4n2/v4n2_aviv.asp

Benne, K. D., & Sheats, P. (1948). Functional roles of group members. *Journal of Social Issues, 4*, 41-49.

Buchs, C., Butera, F., & Mugny, G. (2004). Resource interdependence, student interactions and performance in cooperative learning. *Educational Psychology, 24*, 291-314.

Cohen, E. G. (1994). *Designing groupwork. Strategies for the heterogeneous classroom* (2nd ed.). New York: Teachers College Press.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education*, 46, 6-28.

Gray, B. (2004). Informal learning in an online community of practice. *Journal of Distance Education*, 19, 20-35.

Hara, N., Bonk, C. J., & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science*, 28, 115-152.

Kollar, I., Fischer, F., & Hesse, F. W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning, CSCL 2003 - Community events, communication, and interaction* (pp. 59-61). Bergen: Intermedia.

Krippendorff, K. (1980). *Content analysis: An introduction to its methodology.* Thousand Oaks, CA: Sage.

Lambiotte, J. G., Dansereau, D. F., & O'Donnell, A. M. (1987). Manipulating cooperative scripts for teaching and learning. *Journal of Educational Psychology, 79,* 424-430.

Mason, R. (1991). Moderating educational computer conferencing. *Deosnews, 1*. Retrieved September 1, 2006, from http://www.emoderators.com/papers/mason.html

Mudrack, P. E., & Farrell, G. M. (1995). An examination of functional role behavior and its consequences for individuals in group settings. *Small Group Research*, 26, 542-571.

Neuendorf, K. A. (2002). *The content analysis guidebook.* Thousand Oaks, CA: Sage.

O'Donnell, A. M., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups: The theoretical anatomy of group learning* (pp. 120-141). New York: Cambridge University Press.

O'Donnell, A. M., Dansereau, D. F., Hall, R. R., & Rocklin, T. R. (1987). Cognitive, social/affective, and metacognitive outcomes of scripted cooperative learning. *Journal of Educational Psychology, 79,* 431-437.

Pfister, H. R., & Mühlpfordt, M. (2002). Supporting discourse in a synchronous learning environment: The learning protocol approach. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of CSCL 2002.* Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://newmedia.colorado.edu/cscl/178.pdf

Rose, M. A. (2002). *Cognitive dialogue, interaction patterns, and perceptions of graduate students in an online conferencing environment under collaborative and cooperative structures.* Unpublished doctoral dissertation, Indiana University, Bloomington, IN. Retrieved September 1, 2006, from http://www.bsu.edu/web/arose/Vita/MARose.pdf

Schellens, T., Van Keer, H., & Valcke, M. (2005). The impact of role assignment on knowledge construction in asynchronous discussion groups: A multilevel analysis. *Small Group Research, 36,* 704-745.

Slavin, R. E. (1989). Cooperative learning and student achievement. In R. E. Slavin (Ed.), School and classroom organization (pp. 129-156). Mahwah, NJ: Lawrence Erlbaum.

Strijbos, J. W., & Martens, R. L. (2001). Coördinatieprocessen tijdens computer ondersteund samenwerkend leren [Coordination processes during computer-supported collaborative learning]. In P. Kirschner (Ed.), *Factoren die collaboratief leren beïnvloeden: Onderwijs research dagen 2001* (pp. 1-17). Heerlen: Onderwijstechnologisch Expertisecentrum, OTEC, Open Universiteit Nederland.

Strijbos, J. W., Martens, R. L., Jochems, W., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35,* 195-229.

Tagg, A. C. (1994). Leadership from within: Student moderation of computer conferences. *The American Journal of Distance Education, 8,* 40-50.

Veerman, A., & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In *Euro CSCL 2001* (pp. 625-632). Maastricht: McLuhan institute, University of Maastricht. Retrieved September 1, 2006, from http://www.ll.unimaas.nl/euro-cscl/Papers/166.doc

Weinberger, A., Fischer, F., & Mandl, H. (2002). Fostering individual transfer and knowledge convergence in text-based computer-mediated communication. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community: Proceedings of CSCL 2002*. Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://home.emp.paed.uni-muenchen.de/~weinberg/download/153.pdf

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2005). Facilitating collaborative knowledge construction in computer-mediated learning environments with cooperation scripts. In R. Bromme, F. W. Hesse, & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication* (pp. 15-38). Boston: Kluwer.

Zhu, E. (1996). Meaning Negotiation, Knowledge Construction, and Mentoring in a Distance Learning Course. In *Proceedings of Selected Research and Development Presentations at the 1996 National Convention of the Association for Educational Communications and Technolgy.* (pp. 821-844). Indianapolis, IN. Retrieved September 1, 2006 from http://www.eric.ed.gov/sitemap/ html_0900000b8014818b.html

Zhu, E. (1998). Learning and mentoring: Electronic discussion in a distance-learning course. In C. J. Bonk & K. S. King (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship and discourse* (pp. 233-259). Mahwah, NJ: Lawrence Erlbaum.

Zigurs, I., & Kozar, K. A. (1994). An exploratory study of roles in computer-supported groups. *MIS Quarterly, 18*, 277-297.

Chapter 6[*]

Structuring asynchronous discussion groups: The impact of role assignment and self-assessment on students' levels of knowledge construction through social negotiation

Abstract

This article focuses on the instructional approaches in online asynchronous discussion groups implemented in a first year university course in instructional sciences. More particularly, it examines the impact of the introduction of roles and the added value of self-assessment on students' level of knowledge construction in these online asynchronous discussions.

The transcripts of 20 discussion groups were used as the research data for this study. The transcripts of all messages, submitted during the 12 week discussion period, comprising 4 discussion themes of 3 weeks each, were analysed. Taking into account the hierarchical nested nature of the research data, repeated measures multilevel modelling was adopted to analyse the data of the content analysis performed.

The results point at a significant positive impact of assigning roles to students. However, this positive impact depends on the moment of the introduction the roles. Higher levels of social knowledge construction were found in discussion groups where roles were introduced right at the start of the discussions and faded out towards the end. The results further indicate that self-assessment has no significant added value.

Introduction

In the early days of the information technology age, computers were rather positioned as personal tools and their potential to foster interpersonal communication was less well anticipated (Crook, 2002). In contrast, current approaches towards computers and the Internet acknowledge this interpersonal significance. Recent online learning and instruction approaches highlight the importance of learner interaction in view of knowledge construction. This has resulted in a growing implementation of computer-supported collaborative learning (CSCL) approaches, including asynchronous discussion groups. In the literature, a large research body that explores the educational potential of online discussion environments can be found (e.g. De Laat & Lally, 2004; De Wever, Van Winckel,

[*] Based on: De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2006). *Structuring asynchronous discussion groups: The impact of role support and self-assessment on students' levels of knowledge construction through social negotiation.* Manuscript submitted for publication to *Journal of Computer Assisted Learning.*

& Valcke, in press; Järvelä & Häkkinen, 2002; McKenzie & Murphy, 2000; Schellens & Valcke, 2005; Schellens, Van Keer, & Valcke, 2005; Schrire, 2004; Schrire, 2006; Zhu, 1998).

The research reported in this article builds on the state-of-the art in the CSCL-literature and focuses on the further optimisation of the instructional approaches to stimulate knowledge construction through social negotiation in asynchronous e-discussions. Two particular optimisation approaches will be studied. The study is situated in the context of a first year instructional sciences course, where asynchronous discussion groups of 10 students are organised in addition to weekly face-to-face working sessions. The discussion groups are organised to foster students' processing of the learning content and, by confronting them with authentic tasks, to promote discussion about the different concepts presented in the face-to-face sessions and the course manual. First, we focus on the evaluation of role assignment. Roles were assigned to students when collaborating in the online asynchronous discussions in order to promote knowledge construction through social negotiation. Previous research presented empirical evidence that providing structure by assigning roles is an effective approach (De Wever, Schellens, Van Keer, & Valcke, 2006b). Second, this specific structuring approach is combined with the introduction of formative self-assessment in order to enhance reflection. The main aim of this study is to evaluate the impact of role assignment on students' knowledge construction and to study the surplus value of introducing self-assessment on the knowledge construction processes within the discussion groups.

In the next paragraphs we first examine roles as a structuring tool in online discussions. Next, we focus on the assessment of collaborative learning in discussion groups and in this context we discuss formative self-assessment in order to enhance student reflection. The article continues with the method, the results, and a discussion of these results. The article finishes by presenting conclusions, practical implications, and directions for further research.

Roles as structuring tool

Putting individual students together does not necessarily bring about effective interaction or collaborative learning (Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). Instructional design, building on collaborative learning environments, therefore focuses on embedding a certain amount of structure, such as adding specific goals, defining task types, presenting task prescripts, or pre-structuring (scripting) (De Wever et al., 2006b). The goal of introducing structure is to support interaction processes and actual collaborative learning within CSCL-environments.

Some empirical evidence underscores that pre-structuring or scripting learning environments improves collaboration (Pfister & Mühlpfordt, 2002) and produces strong positive learning effects (Baker & Lund, 1997).

At a conceptual level, the concept of *scripting* is used as an umbrella concept to incorporate a variety of approaches to add structure to CSCL-environments. The interest in using scripts is clearly growing in view of improving the design of CSCL-environments (Kollar, Fischer, & Hesse, 2003; Weinberger et al., 2005). A script is considered as a more or less rigid scheme according to which the collaboration proceeds (Pfister & Mühlpfordt, 2002). It can influence both the way in which students collaborate (communication scripts) and the way they tackle the task (task scripts). The explicit presentation of scripts can be continuous, just-in-time or can be faded. The latter approach is expected to help students to adopt and integrate relevant discussion behaviour at the start of the discussion in such a way that they gain sufficient confidence, competence, and control to function in a more autonomous way during a later discussion phase (See also Brown, Collins, & Duguid, 1989).

In a previous article (De Wever et al., 2006b) we discussed structuring in general and explored different types of scripting. Varying levels of detail were discussed and a distinction was presented between macro scripts that provide a global structure and micro scripts that impose a highly detailed structure. Next, the study examined role assignment as a specific type of scripting. Five roles were presented to students: the role of starter, moderator, theoretician, source searcher, and summariser. The empirical study did not focus on the impact of the role assignment on specific dependent variables. The study rather tested to what extent students did actually adopt the roles being assigned to them. Given the clear empirical results that confirm role adoption, the present study can in a valid way assume that possible treatment effects can be related to differential role assignment and adoption. We discuss the different roles in more detail in the design section of this article.

Assessment of collaborative learning in discussion groups

Since assessment is an important drive of the learning process (Hunt, Hughes, & Rowe, 2002) and students report that their study is dominated by the way they perceive the assessment demands (Gibbs & Simpson, 2004), assessment of student behaviour in CSCL-environments merits attention. Despite recent innovations in assessment approaches, "much of our assessment still focuses on testing knowledge and comprehension and ignores the challenge of developing and assessing judgements" (Bryan & Clegg, 2006, p. 3). However, changes in educational approach often require new forms of assessment (Dochy, Heylen, & Van de Mosselaer, 2002). In this respect, it is important to calibrate both the collaborative learning process and the assessment procedure. By tuning assessment practices to the nature and the goals of a CSCL-environment, we can prevent the assessment procedure from undermining the goals of collaborative learning and the engagement of students in collaborative settings (Boud, Cohen, & Sampson, 1999).

In addition to stressing well-adapted summative assessment, the literature also discusses the importance of adopting formative assessment procedures. Jenkins (2004) argues that when students are engaged in online discussions, it is necessary to develop formative assessment procedures that recognise the e-oriented skills being acquired. Furthermore, he claims that "alternative means of formative assessment (compared with traditional 'text-based' comments on assignments) … need to be considered" (Jenkins, 2004, p. 70). In addition, McLoughlin and Luca (2002) argue that CSCL-environments enable students to become more self-directed, and that "the shift to student self-direction and autonomy means that students need to take more responsibility for their own learning" (McLoughlin & Luca, 2002, p. 577). This suggestion introduces self-assessment as a formative and alternative assessment approach.

Alternative assessment practices, such as peer, self, and co-assessment have gained attention within this pursuit of learner responsibility and formative assessment. These types of assessment assume that students themselves have a necessary role in taking responsibility for assessing their own work. This is congruent with the key objectives of peer learning, in which students are considered as responsible for their own learning and as active participants in instructional activities (Boud, 1995; Falchikov, 2001; McDonald & Boud, 2003). Furthermore, Peat and Franklin (2002, p. 516) believe that "support, such as online self-assessment opportunities, can provide students with more flexibility in their learning". In this context, the present study adopts formative self-assessment as a way to facilitate processes underlying effective collaboration.

Formative self-assessment to enhance reflection

Self-assessment requires learners to make judgements about their own learning and is considered as a tool providing feedback to students about both learning and educational standards (Boud & Falchikov, 1989; Boud, 1995). It requires students to consider the characteristics of competent work in a given area or situation, and to apply these criteria to their own work (Boud, 1999). Self-assessment helps students to internalise academic standards (Gibbs, 2006). As such, self-assessment encourages independent and self-directed learning. In collaborative contexts, this implies that self-assessment fosters reflection on the quality of personal contributions and the input of others, and to develop awareness of effective and qualitative contributions to the discussions (Sluijsmans, Dochy, & Moerkerke, 1999; Freeman & McKenzie, 2002). Students need to monitor the actual condition of their discussion, learning process, and human relations, in order to improve their learning community and to plan their upcoming study so that they should make their learning substantial (Mochizuki, Fujitani, Isshiki, Yamauchi, & Kato, 2003).

While performing their own regular and structured self-assessment, learners develop a questioning and reflective approach (Robinson & Udall, 2006). Self-assessment encourages students to become critical and perceptive, stimulates reflection, and is thereby contributing to the learning processes and to lifelong learning (Larres, Ballantine, & Whittington, 2003). Empirical evidence stresses that self-assessment has an effect on cognition, affection, and conation and can encourage deep approaches to learning (McDonald & Boud, 2003). Research also reveals a considerable impact of self-assessment on students' content-related learning, quality of problem solving, and self-reflection (Sluijsmans et al., 1999).

In this respect, self-assessment was introduced in the present study as a reflection tool and a tool for learning. It was implemented primarily as a way to help students to improve their learning, as it focuses students' attention on the metacognitive aspects of their learning and teaches them to be more effective at monitoring their own performance (Longhurst & Norton, 1997), and not as a substitute for the instructor's evaluation. Following the claim that self-assessment is clearly an important part of supporting students to improve their own learning (Longhurst & Norton, 1997), it is hypothesised that self-assessment of the individual contributions in a CSCL-environment will elicit readjustment of discourse in forthcoming collaborative activities. The idea is that by asking students to reflect upon and to rate the quality of their performance, students will identify weaknesses and strengths and might amend or redirect their contributions in forthcoming discussions (Hunt et al., 2002).

Method

Research questions

The first research question studies the implementation of self-assessment to guide students' reflections on the discussion process. More specifically, it focuses on whether or not students are capable of judging their own social knowledge construction processes. Since self-assessment has a considerable impact on self-reflection (Sluijsmans et al., 1999) and reflecting on one's own knowledge construction processes might influence the quality of the knowledge construction processes of subsequent discussions, we want to check to what extent students are able to assess their own knowledge construction processes accurately. This question precedes the study of the impact of the research conditions on the knowledge construction processes.

The second research question focuses on (1) determining whether role assignment has an impact on the knowledge construction processes in the discussion groups, (2) whether the moment of introduction of the role assignment is an important factor, and (3) whether self-assessment has a surplus value to stimulate students' knowledge construction through social negotiation.

Research setting

Context

The present study was conducted in the context of a first year course in instructional sciences in the bachelor in Educational Sciences of Ghent University. The instructional design of this course combined face-to-face sessions with an online learning environment (Schellens & Valcke, 2000). All first year students enrolled (N = 273) participated in the discussion groups.

The discussion groups were organised in parallel to the weekly face-to-face sessions to promote the timely study of the theoretical concepts. It was expected that students would develop a stronger knowledge base when applying the theoretical concepts during discussions and while they were involved in social negotiations and debate. After a one-week trial discussion, the formal study plan required students to discuss four successive authentic tasks. Each discussion took three weeks. The authentic discussion tasks were identical for all groups and were related to corresponding chapters in the handbook (behaviourism, cognitivism, constructivism, and evaluation). Within the three-week periods, students collaborated online, independently of time and location.

Students were divided at random into discussion groups of 10 persons. Participation in the online discussion groups was a formal component of the course and represented 25% of the final exam score. Students were required to contribute at least four times per discussion theme.

Roles

In specific research conditions, particular students of a group were assigned one of the following five roles. The *starter* was required to start off the discussion, to add new points for other students to build upon, and to give new impulses when discussions slacked off. The role of the *moderator* consisted of monitoring the discussion, asking critical questions, and probing others' opinion. Students in the role of *theoretician* were required to introduce theoretical information and to ensure that all relevant theoretical concepts were used in the discussion. The role of the *source searcher* comprised of seeking external information about the discussion topics in order to stimulate other students to go beyond the scope of the available handbook. The *summariser* was expected to post interim summaries during the discussion and a final synopsis at the end, focusing on identifying dissonance and harmony between the messages and drawing conclusions. In general, all students were allowed to perform all these activities. However, students with a specific role were asked to pay explicit attention to the activities related to their role on a very regular basis.

Self-assessment

In the present study, self-assessment was introduced as a way of formative assessment in order to enhance reflection and to stimulate self-directed learning (Larres et al., 2003). The students were asked to evaluate themselves in relation to the knowledge construction processes in their messages. They were informed by the staff members about the fact that this self-assessment would not affect the formal score for this course and about the criteria for the summative assessment. The self-assessment was based on an online questionnaire in which students had to rate their knowledge construction through social negotiation after each discussion assignment.

Data collection

The discussion transcripts of 20 discussion groups were selected for this study and the transcripts of the entire 12 week discussion period were analysed, comprising 4 discussion themes of 3 weeks each. This resulted in the analysis of 4818 messages or approximately 60453 lines.

Design

Discussion groups were assigned to one of three research conditions. In condition 1, students started discussing without role assignment in theme 1 and 2; role assignment was introduced when discussing theme 3 and 4. In condition 2, roles were assigned right from the start in theme 1 and 2 but no longer stressed during theme 3 and 4. The third condition was equal to the second condition, except that students in the third condition were in addition requested to fill out a self-assessment questionnaire at the end of each discussion theme.

The specific cross-over design of the present study was helpful to answer research question 2, since it allows us to explore the differences between role-supported and non-role-supported discussions. Furthermore, the comparison of the first two research conditions enables us to study whether or not the timing of role assignment is an important mediating factor influencing students' knowledge construction through social negotiation. Comparing the second and the third condition allows us to explore whether or not self-assessment has a surplus value in stimulating knowledge construction through social negotiation. Table 6.1 gives an overview of the different research conditions.

Table 6.1
Overview of research conditions

	Condition 1	Condition 2	Condition 3
Theme 1	No Role Assignment	Role Assignment	Role Assignment + SA
Theme 2	No Role Assignment	Role Assignment	Role Assignment + SA
Theme 3	Role Assignment	No Role Assignment	No Role Assignment + SA
Theme 4	Role Assignment	No Role Assignment	No Role Assignment + SA

SA = Self-assessment

In each condition, roles were introduced in either the first or the last two discussion themes. In the first theme where role assignment was applied, five randomly selected students were given one of the five roles. In the second discussion theme with role assignment, the roles were assigned to the students who did not take up a role in the first discussion theme. The rotation of roles guaranteed that each student adopted a specific role at least once. Students were asked to perform their roles in addition to submitting regular discussion input. Taking into account the different discussion assignments, the study was constructed according to a repeated-measures design.

Instruments

In order to determine the level of knowledge construction through social negotiation, quantitative content analysis was applied. Neuendorf (2002, p. 10) defines content analysis as “a summarizing, quantitative analysis of messages that relies on the scientific method and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented”.

The interaction analysis model of Gunawardena, Lowe, and Anderson (1997) was applied to analyse the transcripts. This model examines the social construction of knowledge in computer conferencing and distinguishes five different levels of knowledge construction activities: (1) sharing and comparing information, (2) identifying areas of disagreement, (3) negotiating meaning and co-construction of knowledge, (4) evaluation and modification of new schemas that result from co-construction, and (5) reaching and stating agreement and application of co-constructed knowledge (See Table 6.2). A detailed discussion of this model can be found in De Wever, Schellens, Valcke, and Van Keer (2006a). This specific analysis scheme was selected considering its social constructivist theoretical base and the fact that it is one of the few content analysis models that has been applied in a number of empirical studies (Marra, Moore, & Klimczak, 2004; De Wever et al., 2006a; Schellens & Valcke, 2005; Schellens et al., 2005)

As suggested by Rourke, Anderson, Garrison, and Archer (2001), messages were selected as units of analysis since complete messages are an objective unit and are considered as the unit defined by the original author of the contributions.

Table 6.2
Levels of knowledge construction in the interaction analysis scheme of Gunawardena et al. (1997)

Level	Description
1	Sharing and comparing of information
2	Exploration of dissonance
3	Negotiation of meaning
4	Testing synthesis
5	Agreement statements and applications

By analogy with the content analysis scheme applied to analyse the transcripts of the discussion groups, the self-assessment questionnaire was founded on the instrument of Gunawardena et al. (1997). The questions probe into students’ perceptions of their achieved levels of knowledge construction through social negotiation. More particularly, students were asked to rate how often their own contributions to the discussion fit into each of the five levels of knowledge construction. An example of the self-assessment items was “My contributions aimed at sharing and comparing of information”.

By presenting the self-assessment questionnaire after each discussion, students were required to step back and evaluate the levels of knowledge construction reflected in their contributions. They were encouraged to reflect on the extent to which their messages were effective contributions to the ongoing discussion. In this way, students were required to monitor their discussion behaviour. They were motivated to verify which knowledge construction processes they invoked. In case they noticed their messages did not cover the whole spectrum of knowledge construction processes, this could lead them into adjusting their future discussion behaviour in order to optimise future debates.

Coding strategy and reliability

Five independent coders were trained during approximately 7 hours to carry out the coding activity. After working with coding examples for each level of knowledge construction in the analysis model (Gunawardena et al, 1997), they coded some transcripts together in order to discuss and elaborate on the coding process. Next, the transcripts were coded independently. A number of transcripts were randomly selected for calculating interrater reliability coefficients. The Krippendorff’s alpha interrater reliability coefficient ($\alpha = .52$, $n = 198$) was situated between .40 and .80, which corresponds to ‘fair to good agreement beyond chance’ (De Wever et al., 2006a; Neuendorf, 2002; Banerjee, Capozzoli, McSweeney, & Sinha, 1999).

Statistical analysis

Taking into account the hierarchical nesting of students in discussion groups and the successive nature of the four themes, repeated-measures multilevel modelling was applied in order to answer the research questions. Multilevel models are developed to analyse data that have a hierarchical or clustered structure (Hox, 1998) and are especially useful to analyse repeated measures (Snijders & Bosker, 1999). In the present study, measurement occasions (the four discussion themes) are nested within subjects (Hox, 1998). We refer to De Wever, Van Keer, Schellens, & Valcke (2006) for an in-depth discussion on this analysis technique.

The statistical package R 1.8.1. was used for the calculation of the interrater reliability. MLwiN 2.01. was used to perform the multilevel analysis. The multilevel models were estimated with the iterative generalised least squares (IGLS) procedure. All analyses assume a 95% confidence interval.

Results

Research question 1:
Students' ability to evaluate their own social knowledge construction processes

In order to explore whether students are able to assess their own level of knowledge construction through social negotiation, we focus on the match between students' self-assessment and the content analysis of their messages. Following Longhurst and Norton (1997) a convergence measure was computed per discussion theme by calculating the difference between the self-reported occurrence of utterances reflecting each level of knowledge construction (LKC_{SA}) and the observed occurrence of messages for each level of knowledge construction (LKC_{OBS}) as coded by the coders during the content analysis.

For each level of knowledge construction, a difference score was calculated (LKC_{DIF} 1 to 5). Negative difference scores indicate that students underestimate their level of knowledge construction, while positive scores point at overestimation. For each LKC_{DIF}, a three-level model was set up, in which the four successive discussion themes and self-assessment assignments (level 1) were nested within students (level 2), who were grouped themselves in discussion groups (level 3). First, random intercept null models were estimated. In a null model, the total variance of students' LKC_{DIF} is decomposed into between-group, between-students, and between-theme variance. Next, compound symmetry models were estimated for each LKC_{DIF}. These are random intercept models with no explanatory variables except for the measurement occasions (Snijders & Bosker, 1999). They allow us to study the differences between the successive themes, by contrasting theme 2, theme 3, and theme 4 with the reference category (theme 1).

The random intercepts null models (null) and the compound symmetry models (CSM) for all five levels of knowledge construction can be found in appendix A. The null models indicate that variance in the difference score between discussion groups is low (0 % - 6 %), the variance between students within groups is medium (20 % - 30 %, except for LKC_{DIF} 4: 12 %), and the variance between themes within students is high (64 % or more). Furthermore, they indicate that students underestimate themselves at the first level of knowledge construction (LKC_{DIF} 1 = -1.103, *SE* = 0.128) and overestimate themselves at the four subsequent levels (LKC_{DIF} 2 = 1.314, *SE* = 0.086; LKC_{DIF} 3 = 1.344, *SE* = 0.101; LKC_{DIF} 4 = 2.280, *SE* = 0.084; LKC_{DIF} 5 = 1.714, *SE* = 0.067).

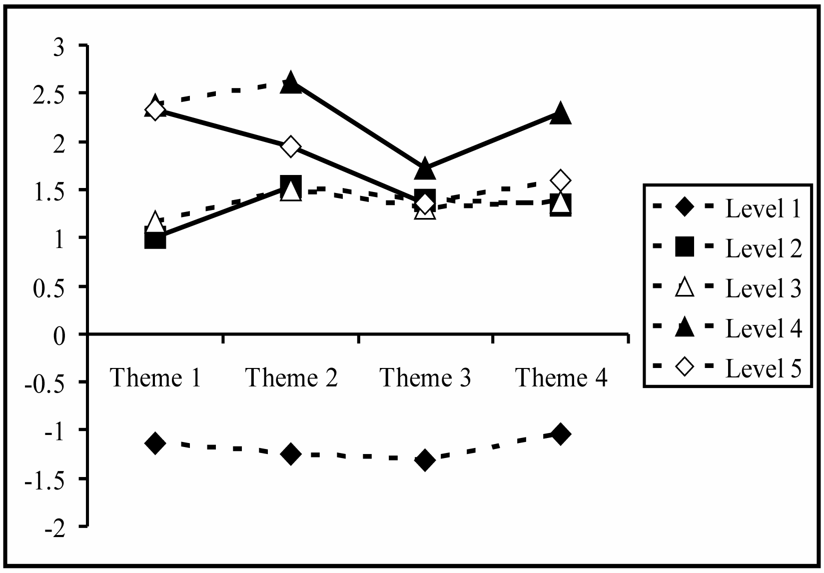

Figure 6.1. Graphical representation of the convergence measures (LKC_{DIF}) for each level of knowledge construction and each theme.

Figure 6.1 gives an overview of the difference scores with regard to the different levels of knowledge construction throughout the four themes (see also CSM models in appendix A). Dotted lines represent unsignificant differences, whereas full lines represent significant differences between consecutive discussion themes. Figure 6.1 clearly indicates that students underestimate themselves concerning the occurrence of the first level of knowledge construction reflected in their contributions and overrate themselves with respect to the following levels (2 till 5) in all themes. For the second level, students overestimate themselves significantly more in the second theme (compared to the first theme). With regard to the third level, no significant differences were encountered between the four themes. Concerning the fourth level, a significant decrease in overestimation is noticed in theme 3 compared to theme 2 and a significant increase in overestimation in theme 4 compared to theme 3. Finally, in the fifth level a significant decrease in overestimation is observed between theme 2 and 1 and between theme 3 and 2.

Research question 2:
Impact of the research conditions on levels of knowledge construction reflected in the online discussions

The second research question focuses on the impact of the three different research conditions on the levels of knowledge construction reflected in student messages (LKC_{OBS}). For this research question, a four-level model was estimated, with messages (level 1) hierarchically nested within measurement occasions (level 2) that are clustered within students (level 3) who are in turn assigned to groups (level 4). The analysis models were built following a stepwise procedure. Comparable to the first research question, a random intercept null model and a compound symmetry model were estimated first. Next, additional analyses were performed in which the different research conditions were included as predictors to the model. All models are presented in Table 6.3.

The random part of the four level null model (model 0) for LKC_{OBS} shows that the variances on group, theme, and messages level are significantly different from zero: 4.89% of the total variance in LKC_{OBS} in students' messages is situated at the group level (χ^2 = 8.129, df = 1, p = .004), 5.76% is situated at the theme level (measurements occasions) (χ^2 = 29.501, df = 1, p < .001), and 89.35% of the variance arises from differences between messages within measurement occasions (χ^2 = 2060.958, df = 1, p < .001). No part of the total variance can be assigned to the level of the individual students.

Next, a compound symmetry model (model 1) is compared with the null model, using the difference in deviance of both models as a test statistic having a chi-squared distribution with the difference in number of parameters as degrees of freedom (Snijders & Bosker, 1999). The compound symmetry model achieves a better fit than the null model (χ^2 = 146.410, df = 3, p < .001). Compared to theme 1, the LKC_{OBS} in theme 4 is not significantly different (χ^2 = 1.265, df = 1, p = .261). However, messages in theme 2 reflect a significantly lower LKC_{OBS} (χ^2 = 13.188, df = 1, p < .001), while messages in theme 3 reflect a significantly higher LKC_{OBS} (χ^2 = 78.783, df = 1, p < .001).

In model 2 the differences between the three conditions across all themes are revealed by adding the explanatory variable 'research condition' to the fixed part of the model. This categorical variable is represented by two dummies: 'condition 2' refers to the role/no-role condition in which groups were assigned roles in theme 1 and 2 and 'condition 3' refers to the role/no-role+SA condition with similar role assignment in theme 1 and 2 and with the additional support of reflection through self-assessment. Both conditions are contrasted against the reference category representing the no-role/role condition (condition 1) in which role assignment was introduced in theme 3 and 4.

Model 2 has a significantly better fit (χ^2 = 18.000, *df* = 2, *p* < .001) and indicates that messages in both condition 2 and 3 reflect significantly higher LKC_{OBS} compared to messages in condition 1 (χ^2 = 27.521, *df* = 1, *p* < .001. and χ^2 = 14.463, *df* = 1, *p* < .001 respectively). No significant difference between condition 2 and 3 was revealed (χ^2 = 2.290, *df* = 1, *p* = .130).

In model 3 the difference between the conditions is explored more deeply by taking the interaction effects between the conditions and the themes into account. In this respect the differential progress in LKC_{OBS} in the different research conditions is studied. This model has a significantly better fit (χ^2 = 59.060, *df* = 6, *p* < .001). The difference between the three research conditions is depicted in Figure 6.2. The trend indicating that students' contributions in general reflect higher LKC_{OBS} in conditions 2 and 3 compared to condition 1 (as revealed by model 2) is significant for the first theme: the LKC_{OBS} is significantly higher in both condition 2 (role/no-role) and condition 3 (role/no-role+SA) compared to the first condition (no-role/role) (respectively χ^2 = 11.725, *df* = 1, *p* = .001 and χ^2 = 5.767, *df* = 1, *p* = .016). No significant differences were found between condition 2 and 3 in theme 1 (χ^2 = 1.128, *df* = 1, *p* = .228).

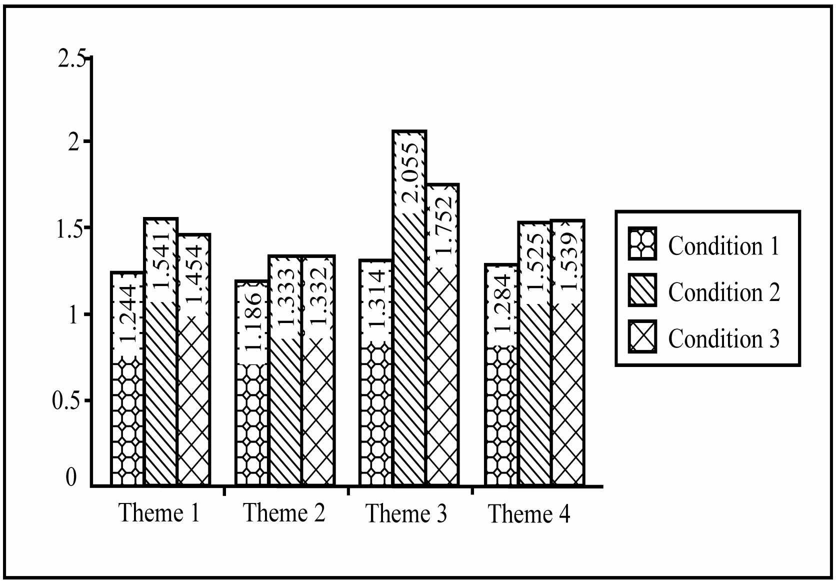

Figure 6.2. Graphical overview of the mean LKC_{OBS} per condition and per theme (based on model 3 in Table 6.3).

Table 6.3
Multilevel parameter estimates of LKC_{OBS}

Parameter	Model 0 (null)	Model 1 (CSM)	Model 2	Model 3
Fixed				
Intercept	1.479 (0.044)	1.418 (0.050)	1.190 (0.057)	1.244 (0.065)
Theme 2 (cognitivism)		-0.132^{***} (0.036)	-0.131^{***} (0.036)	-0.058 (0.066)
Theme 3 (constructivism)		0.306^{***} (0.034)	0.308^{***} (0.034)	0.070 (0.061)
Theme 4 (evaluation)		0.040 (0.036)	0.043 (0.036)	0.040 (0.061)
Condition 2			0.376^{***} (0.072)	0.297^{***} (0.087)
Condition 3			0.272^{***} (0.072)	0.210^{*} (0.088)
Theme 2 * Condition 2				-0.150 (0.088)
Theme 2 * Condition 3				-0.064 (0.088)
Theme 3 * Condition 2				0.444^{***} (0.081)
Theme 3 * Condition 3				0.228^{**} (0.081)
Theme 4 * Condition 2				-0.056 (0.084)
Theme 4 * Condition 3				0.045 (0.084)
Random				
Level 4 – group				
$\sigma^2 f0$	0.034^{**} (0.012)	0.037^{**} (0.013)	0.013^{*} (0.005)	0.013^{*} (0.005)
Level 3 – student				
$\sigma^2 v0$	0.000 (0.000)	0.000 (0.004)	0.001 (0.004)	0.004 (0.004)
Level 2 – theme				
$\sigma^2 u0$	0.040^{***} (0.007)	0.017^{*} (0.007)	0.017^{*} (0.007)	0.006 (0.006)
Level 1 – message				
$\sigma^2 e0$	0.621^{***} (0.014)	0.618^{***} (0.014)	0.618^{***} (0.014)	0.617^{***} (0.013)
Model fit				
Deviance	11536.050	11389.740	11371.740	11312.680
χ^2		146.41	18	59.06
df		3	2	6
p		< .001	< .001	< .001
Reference		Model 0	Model 1	Model 2

Values between brackets are standard errors
* $p < .05$ ** $p < .01$ *** $p < .001$

The trend of higher LKC_{OBS} in the last two research conditions is also significant in the third theme: the LKC_{OBS} is significantly higher in condition 2 (role/no-role) and condition 3 (role/no-role+SA) compared to the first condition (no-role/role) (respectively $\chi^2 = 29.824$, $df = 1$, $p < .001$ and $\chi^2 = 7.853$, $df = 1$, $p = .005$). In addition, the LKC_{OBS} is significantly higher in condition 2 compared to condition 3 ($\chi^2 = 7.954$, $df = 1$, $p = .005$). The differences between the conditions are not significant for themes 2 and 4. As to the differences between role and no role based discussions, the results of model 3 indicate that for the initial discussion theme the discussion groups with role assignment reach higher levels of knowledge construction, whereas the opposite is true for theme 3. In condition 2 and 3 no role assignment was present in this third discussion theme and yet these discussion groups reach higher levels of knowledge construction.

Discussion

Taking into account the growing interest in online discussions in e-learning environments, studies focusing on the specific conditions that foster deep-level learning are of importance. This article studied an attempt to optimise online asynchronous discussions in CSCL. In order to promote knowledge construction through social negotiation, roles were assigned to students. Furthermore, one research condition was combined with self-assessment in order to promote reflection.

Research question 1

The first question focused on the ability of freshmen to evaluate their level of knowledge construction in an accurate and critical way. In this respect, the analyses focused on the correspondence between self-ratings and the level of knowledge construction as coded by independent coders.

The results clearly indicate that students underestimate the extent to which they engage in sharing and comparing information during the ongoing discussion. On the other hand, they overestimate the occurrence of postings reflecting the four subsequent levels of knowledge construction. This means that students post more contributions focusing on sharing and comparing information and fewer contributions focusing on identifying disagreement, negotiating meaning, evaluating co-constructed meaning, and agreeing on and applying the co-constructed knowledge than they actually think they do. These results are in line with Robinson and Udall’s statement (2006, p. 98) that “students are often unable to make realistic judgements about their own learning”.

The findings in the present study that first-year students are not always capable of judging themselves accurately with respect to the level of knowledge construction in their contributions might be due to lack of experience. This corresponds to the findings of Larres, Ballantine, and Whittington (2003), who studied the difference between objective and self-appraisal computer literacy tests and argued that at entry level students “would require much more experience in self-evaluation before it to become effective” (Larres et al., 2003, p. 109). However, the divergence in self-assessment and objective measures can not be an argument to by-pass self-assessment procedures, since solely focussing on the degree of agreement neglects the undoubted learning benefits of the application of self-assessment (Falchikov & Boud, 1989). Moreover, since practice makes perfect, providing greater exposure to self-evaluation might enhance students’ capability to self-assess and reflect upon their knowledge construction processes.

Additionally, the current findings can also entail that more support should be given to the students to develop their self-assessment skills; for example by making students aware of the fact that their self-assessed ratings will be validated with ratings from other sources (e.g. cross-checking with other measures or verification with peer or instructor assessment) and by providing comparative information about peers as suggested by Larres et al. (2003). In addition, students could be informed of the divergence in self-assessed ratings and independent ratings. In this respect, feedback from their peers or interim teacher feedback might also be a significant factor improving students’ self-assessment skills and accurateness (Gibbs & Simpson, 2004). Finally, explicit development of assessment skills can be called for, as suggested by McLoughlin and Luca (2002) and Black, Harrison, Lee, Marshall, and Wiliam (2004) who argue that students might need assistance in achieving the skills that come with more autonomy and responsibility.

Falchikov and Boud (1989) point at two other possible explanations for the lack of students’ accuracy in self-assessment. First, they claim that “studies within the broad area of science appear to produce more accurate self-assessment than do those from other areas of study” (Falchikov & Boud, 1989, p. 425). In addition to the fact that there seems to be more variation in studies conducted within the social science knowledge domain, they claim that the level of the course of which the assessment is a part of, is an important influential factor as well. It more particularly appears that students in advanced courses are better at assessing themselves accurately. According to Falchikov and Boud (1989) this has more to do with the expertise in a particular field than with the seniority of the students.

Based on the findings with respect to the first research question, it can be argued that future practice and research should aim at making students’ self-assessment more accurate by exposing them to self-assessment more frequently, by offering an introductory training, by making students aware of the fact that their self-assessment will be monitored, and by providing them with comparative information and feedback.

Research question 2

The second research question focused on determining (1) whether role assignment has an impact on the knowledge construction processes in the discussion groups, (2) whether the moment of introducing the role assignment is an important factor, and (3) whether self-assessment has a surplus value stimulating students' social knowledge construction.

When we focus on the results with regard to the introduction of role assignment, significant differences were found in theme 1 and 3 between the *condition with roles in the two final discussion themes* and the *conditions with roles during the two initial themes*. In both theme 1 and 3, the latter conditions outperform the former one with respect to the levels of knowledge construction. As to the impact of the presence of roles, this implies that in the very first theme students in discussion groups with roles reach higher levels of knowledge construction as compared to students discussing in groups without role assignment. In the third theme the opposite can be concluded. Concerning the importance of the moment in time of the role introduction, it can be noticed that in both the first and the third theme, groups with initial role assignment outperform groups receiving role assignment at the end. With respect to theme 3, it is important to mention that groups starting with role assignments outperform the other groups even when the original role assignment had faded out.

These results lead us to the conclusion that the moment of time of the role introduction can have an important impact on the dependent variable since groups in which roles were introduced at the start and faded later on never reflected significantly lower levels of knowledge construction and even reflected significantly higher levels of knowledge construction in two themes. The observation that groups with initial role assignment outperform the others in theme 3 might point at the fact that students have interiorised the role-related activities. In this respect, Weinberger et al. (2005) argue that "fading of the cooperation script could improve internalization processes". However, since the trend is not pursued in the fourth theme, further research is needed to confirm this finding. Further research might also focus on gradually decreasing the role assignment, since Hoadley and Enyedy (1999, p. 250) argue that "we know from studies of learning technology that gradually fading of scaffolding from a tool, or tools with a gradually sloped learning curve are more effective than sudden drops in scaffolding, or tools with a staircase shaped learning curve".

With regard to the impact of self-assessment on students' knowledge construction, the comparison of the role/no role and role/no role+SA condition indicates only a significant difference in levels of knowledge construction between the conditions in the third discussion theme. In this theme, the research condition without self-assessment significantly outperforms its equivalent including self-assessment. Throughout the other discussion assignments, no significant differences were found. From these findings, the conclusion can be drawn that the introduction of recurrent self-assessment procedures does not have a significant surplus value on knowledge construction processes in the asynchronous discussions.

The fact that self-assessment does not have a significant positive impact on the levels of knowledge construction in subsequent discussion themes, may be due to the fact that the first-year students in our study were not yet able to assess their knowledge construction processes in an accurate way. Self-assessment was implemented in the present study as a reflection tool aiming at eliciting readjustment of students' discourse behaviour. However, since the results indicate that students generally overestimate the occurrence of contributions reflecting higher levels of knowledge construction, it can be argued that the reflex to readjust did not took place because students did not see the need to alter the types and content of their postings. As argued above, the knowledge domain, the level of the course, and students' lack of experience with self-assessment might account for the lack of accurate self-ratings. However, Falchikov and Boud (1989, p. 427) argue that "self-assessment can be a valuable learning activity, even in the absence of significant agreement between student and teacher, and can provide potent feedback to the student about both learning and educational and professional standards". In accordance with this view, self-assessment could have a positive impact, even when the degree of agreement between self and objective ratings is low. However, this was not the case in the present study. Nevertheless, self-assessment remains a medium with potential to stimulate reflection. Therefore, further research focusing on optimising the self-assessment procedures and studying its effects on knowledge construction processes in online discussions is needed. In this respect, especially the introduction of training students in self-assessment merits particular attention since McDonald and Boud (2003, p. 217) already illustrated that "self-assessment training had a significant impact on the performance of those who had been exposed to it".

In any case, further research is wanting since it can be argued that the process of incorporating self-assessment to enhance the quality of the discourse in online discussion groups is still in its infancy. Murphy and Jerome (2005) note that “little has been written on students’ self-assessment of participation in online discussion”. In this respect, they suggest the use of self-analysis as a tool for students to assess their performance and identify ways of improving their future learning. This self-analysis comprises of a detailed examination of the number of messages, their distribution over the modules, and their length, supplemented with an analysis of the content of the contributions in relation to claims and grounds and a critical assessment to demonstrate knowledge construction by presenting quotes. Murphy and Jerome (2005) deem that self-analysis can provide students with an opportunity to actively reflect on how they advanced their own learning. Such a detailed self-analysis might have a more direct impact on knowledge construction in discussion groups. However, further research is needed to confirm this hypothesis. In addition, future studies should also focus more on the long term effects, since students may need more time and experience in self-assessment in order to improve their participation in the discussion groups.

The differences between the conditions are not significant in all themes, which point to the fact that other factors may be important. Previous research referred in this respect to task characteristics. It appears that the levels of social knowledge construction are lower if tasks are too complex. On the other hand, when the assignments are overly straightforward, the quality of the contribution may also drop down, since students are hardly challenged (De Wever et al., 2006; Schellens, Van Keer, Valcke, & De Wever, in press). In addition, taking into account that this study took place in a natural setting, we cannot rule out that external factors influence the level of social knowledge construction reached in the discussions. Future research could follow some discussion groups at close range, relating knowledge construction to detailed information obtained from the students.

Limitations of this study and directions for future research

Since the present study aims to study collaborative learning in CSCL-environments by manipulating variables that influence collaborative activities (see O'Donnell & Dansereau, 1992), we focus on the social knowledge construction processes in the discussions. Studying processes is important, “especially if educators want to know which learning activities and methods are contributing to collaborative knowledge building” (Dennen & Paulus, 2006, p. 1). In online discussions, it is therefore necessary to look at what is actually going on during students' discourse (Schellens et al., in press). Consequently, the present research studies a process-related dependent variable that is an indicator of knowledge construction in the online discussions (Dennen & Paulus, 2006). Further research should focus on unravelling the specific relationship between knowledge construction processes and the actual acquisition of knowledge, for instance by presenting knowledge acquisition tests after each discussion theme.

Furthermore, this study took place in an authentic educational setting. This implies that we could not control all variables affecting instructional processes and outcomes. This is a limitation compared with experimental studies. However, it also presents advantages, since this complex and ecologically valid setting provides a more stringent test of the successful implementation of roles and self-assessment as compared to studies in controlled laboratory settings. In this respect, we argue that the interventions implemented in this study are feasible and that the results can be generalised to our research context, which is the study of knowledge construction processes and the related outcomes in online asynchronous discussion groups with first year university students. Further research, implemented in other knowledge domains and with students of different educational levels, is however needed in order to make more general statements about the impact of roles and self-assessment.

Conclusion

The main aim of this study was to examine the effect of assigning roles on students' knowledge construction and to study the surplus value of introducing reflection through self-assessment on the knowledge construction processes within the discussion groups.

With respect to the introduction of roles, it can be concluded that introducing roles is a valuable structuring tool, especially if roles are introduced at the start of the discussions and faded out at a later stage. In this respect, it appears that role assignment is particularly helpful to get students started. The ultimate goal is that this structuring tool eventually can be faded out or taken away when students have interiorised the skills related to the different roles and are competent enough to discuss in a more natural way, which is without the additional support and structure of role assignment. In this respect, we agree with Brown et al. (1989), who state that fading of support should be an integral part of scaffolding. The findings of the present study suggest that students were already sufficiently competent to move forward without the additional structure offered by explicit role assignment after discussing for six weeks.

As to the implementation of self-assessment, it can be concluded that a larger investment in support for the students should be made in order to increase freshmen's ability to assess their knowledge construction processes in asynchronous discussions accurately. This can be achieved by exposing them more frequently to self-assessment experiences, by implementing a self-assessment training, by pointing at the validation of their self-assessment and providing comparative information, by providing intermediate feedback by instructors or by peers, or by introducing peer assessment. As to the impact of self-assessment, this study failed to show a significant surplus value of self-assessment on the levels of knowledge construction reflected in students' discourse in asynchronous discussion groups. However, further research and practice is recommended since the students in this study were not experienced in assessing their knowledge construction processes, and research on incorporating self-assessment to enhance the quality of the discourse in online discussion groups is still in its infancy (Murphy & Jerome, 2005).

References

Baker, M., & Lund, K. (1997). Promoting reflective interactions in a CSCL environment. *Journal of Computer Assisted Learning, 13,* 175-193.

Banerjee, M., Capozzoli, M., McSweeney, L., & Sinha, D. (1999). Beyond kappa: A review of interrater agreement measures. *The Canadian Journal of Statistics, 27,* 3-23.

Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2004). Working inside the black box: Assessment for learning in the classroom. *Phi Delta Kappan, 86,* 9-21.

Boud, D. (1995). *Enhancing learning through self assessment*. London: Kogan Page.

Boud, D. (1999). Avoiding the traps: seeking good practice in the use of self assessment and reflection in professional courses. *Social Work Education, 18,* 121-132.

Boud, D., Cohen, R., & Sampson, J. (1999). Peer Learning and Assessment. *Assessment & Evaluation in Higher Education, 24,* 413-426.

Boud, D., & Falchikov, N. (1989). Quantitative studies of self-assessment in higher education: A critical analysis of findings. *Higher Education, 18,* 529-549.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18,* 32-42.

Bryan, C., & Clegg, K. (2006). Innovative assessment in higher education: introduction. In C. Bryan & K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 1-7). London: Routledge.

Crook, C. (2002). Deferring to resources: collaborations around traditional vs computer-based notes. *Journal of Computer Assisted Learning, 18,* 64-76.

De Laat, M., & Lally, V. (2004). It's not so easy: Researching the complexity of emergent participant roles and awareness in asynchronous networked learning discussions. *Journal of Computer Assisted Learning, 20,* 165-171.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006a). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46,* 6-28.

De Wever, B., Schellens, T., Van Keer, H., & Valcke, M. (2006b). *Structuring asynchronous discussion groups by introducing roles: Do students act up to the assigned roles?* Manuscript submitted for publication.

De Wever, B., Van Keer, H., Schellens, T., & Valcke, M. (2006). *Applying multilevel modelling on content analysis data: Methodological issues in the study of the impact of role assignment in asynchronous discussion groups*. Manuscript submitted for publication.

De Wever, B., Van Winckel, M., & Valcke, M. (in press). Discussing Patient Management Online: The Impact of Roles on Knowledge Construction for Students Interning at the Paediatric Ward. *Advances in Health Sciences Education*, 1-18. Retrieved September 1, 2006, from http://dx.doi.org/10.1007/s10459-006-9022-6

Dennen, V. P., & Paulus, T. M. (2006). Researching "collaborative knowledge building" in formal distance learning environments. In T. Koschman, T. W. Chan, & D. D. Suthers (Eds.), *Computer supported collaborative learning 2005: The next 10 Years!* Taipei: International Society of the Learning Sciences. Retrieved September 1, 2006, from http://css.cscl2005.org/Fullpapers.aspx

Dochy, F., Heylen, L., & Van de Mosselaer, H. (2002). *Assessment in onderwijs*. Utrecht: Lemma.

Falchikov, N. (2001). *Learning together. Peer tutoring in higher education*. London: Routledge Falmer.

Falchikov, N., & Boud, D. (1989). Student self-assessment in higher education: A meta-analysis. *Review of Educational Research*, *59*, 395-430.

Freeman, M., & McKenzie, J. (2002). SPARK, A Confidential Web-Based Template for Self and Peer Assessment of Student Teamwork: Benefits of

Evaluating across Different Subjects. *British Journal of Educational Technology*, *33*, 551-569.

Gibbs, G. (2006). How assessment frames student learning. In C. Bryan & K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 23-36). London: Routledge.

Gibbs, G., & Simpson, C. (2004). Conditions under which assessment supports students' learning. *Learning and Teaching in Higher Education, 1,* 3-31.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17,* 397-431.

Hoadley, C., & Enyedy, N. (1999). Between information and communication: Middle spaces in computer media for learning. In C. Hoadley & J. Roschelle (Eds.), *Proceedings of the Computer Support for Collaborative Learning (CSCL) 1999 Conference* (pp. 242-251). Mahwah NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://www.tophe.net/papers/Hoadley-Enyedy-1999.pdf

Hox, J. J. (1998). Multilevel modeling: When and why. In R. Balderjahn, R. Mathar, & M. Schader (Eds.), *Classification, data analysis, and data highways* (pp. 147-154). New York: Springer-Verlag.

Hunt, N., Hughes, J., & Rowe, G. (2002). Formative Automated Computer Testing (FACT). *British Journal of Educational Technology, 33,* 525-535.

Järvelä, S., & Häkkinen, P. (2002). Web-based cases in teaching and learning: The quality of discussions and a stage of perspective taking in asynchronous communication. *Interactive Learning Environments, 10,* 1-22.

Jenkins, M. (2004). Unfulfilled promise: formative assessment using computer-aided assessment. *Learning and Teaching in Higher Education, 1,* 67-80.

Kollar, I., Fischer, F., & Hesse, F. W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning, CSCL 2003 - Community events, communication, and interaction* (pp. 59-61). Bergen: Intermedia.

Larres, P. M., Ballantine, J. A., & Whittington, M. (2003). Evaluating the validity of self-assessment: Mearsuring computer literacty among entry-level undergraduates within accounting degree programmes at two UK universities. *Accounting Education, 12,* 97-112.

Longhurst, N., & Norton, L. S. (1997). Self-assessment in coursework essays. *Studies In Educational Evaluation, 23,* 319-330.

Marra, R. M., Moore, J. L., & Klimczak, A. K. (2004). Content analysis of online discussion forums: A comparative analysis of protocols. *Educational Technology Research and Development, 52,* 23-40.

McDonald, B., & Boud, D. (2003). The impact of self-assessment on achievement: the effects of self-assessment training on performance in external examinations. *Assessment in Education, 10,* 209-220.

McKenzie, W., & Murphy, D. (2000). "I hope this goes somewhere": Evaluation of an online discussion group. *Australian Journal of Educational Technology, 16,* 139-257.

McLoughlin, C., & Luca, J. (2002). A learner-centred approach to developing team skills through web-based learning and assessment. *British Journal of Educational Technology, 33,* 571-582.

Mochizuki, T., Fujitani, S., Isshiki, Y., Yamauchi, Y., & Kato, H. (2003). Assessment of Collaborative Learning for Students: Making the State of Discussion Visible for their Reflection by Text Mining of Electronic Forums. In G. Richards (Ed.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2003* (pp. 285-288). Chesapeake, VA: AACE.

Murphy, E., & Jerome, T. (2005). Assessing students' contributions to online asynchronous discussions in university-level courses. *Electronic Journal of Instructional Science and Technology, 8*. Retrieved September 1, 2006, from http://www.usq.edu.au/electpub/e-jist/docs/vol8_no1/commentary/stu_contrib_ansynch.htm

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, CA: Sage Publications.

O'Donnell, A. M., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In R. Hertz-Lazarowitz & N. Miller (Eds.), *Interaction in cooperative groups. The theoretical anatomy of group learning* (pp. 120-141). New York: Cambridge University Press.

Peat, M., & Franklin, S. (2002). Supporting student learning: the use of computer-based formative assessment modules. *British Journal of Educational Technology, 33,* 515-523.

Pfister, H. R., & Mühlpfordt, M. (2002). Supporting discourse in a synchronous learning environment: The learning protocol approach. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of CSCL 2002.* Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://newmedia.colorado.edu/cscl/178.pdf

Robinson, A., & Udall, M. (2006). Using formative assessment to improve student learning through critical reflection. In C. Bryan & K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 92-99). London: Routledge.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Methodological Issues in the Content Analysis of computer conference transcripts. *International Journal of Artificial Intelligence in Education, 12,* 8-22.

Schellens, T., & Valcke, M. (2000). Re-engineering conventional university education: Implications for students' learning styles. *Distance Education, 21,* 361-384.

Schellens, T., & Valcke, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior, 21,* 957-975.

Schellens, T., Van Keer, H., & Valcke, M. (2005). The impact of role assignment on knowledge construction in asynchronous discussion groups: A multilevel analysis. *Small Group Research, 36,* 704-745.

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (2006a). *Comparing knowledge construction in two cohorts of asynchronous discussion groups with and without scripting.* Manuscript submitted for publication.

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (in press). Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group, and task characteristics. *Behaviour & Information Technology*.

Schrire, S. (2004). Interaction and cognition in asynchronous computer conferencing. *Instructional Science, 32,* 475-502.

Schrire, S. (2006). Knowledge building in asynchronous discussion groups: Going beyond quantitative analysis. *Computers & Education, 46,* 49-70.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1999). Creating a Learning Environment by Using Self-, Peer- and Co-Assessment. *Learning Environments Research, 1,* 293-319.

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis*. London: Sage.

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2005). Facilitating collaborative knowledge construction in computer-mediated learning environments with cooperation scripts. In R. Bromme, F. W. Hesse, & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication* (pp. 15-38). Boston: Kluwer.

Zhu, E. (1998). Learning and Mentoring: Electronic Discussion in a Distance-Learning Course. In C. J. Bonk & K. S. King (Eds.), *Electronic Collaborators.*

Learner-centered technologies for literacy, apprenticeship and discourse (pp. 233-259). Mahwah, NJ: Lawrence Erlbaum.

Appendix A. Parameter estimates for the null models and compound symmetry models for the convergence measures for each level of knowledge construction (LKC_{DIF})

Parameter	Null (LKC_{DIF} 1)	Null (LKC_{DIF} 2)	Null (LKC_{DIF} 3)	Null (LKC_{DIF} 4)	Null (LKC_{DIF} 5)
Fixed					
Intercept	-1.103 (0.128)	1.314 (0.086)	1.344 (0.101)	2.280 (0.084)	1.714 (0.067)
Random					
Level 3 – group					
$\sigma^2 v0$	0.122 (0.101) 5.67 %	0.013 (0.044) 0.87 %	0.076 (0.062) 5.38 %	0.053 (0.043) 5.06 %	0.000 (0.000) 0 %
Level 2 – student					
$\sigma^2 u0$	0.644^{***} (0.187) 29.91 %	0.370^{**} (0.130) 24.82 %	0.303^{**} (0.115) 21.44 %	0.127 (0.078) 12.12 %	0.252^{**} (0.085) 24.92 %
Level 1 – theme					
$\sigma^2 e0$	1.387^{***} (0.154) 64.42 %	1.108^{***} (0.122) 74.31%	1.034^{***} (0.113) 73.18 %	0.868^{***} (0.093) 82.82 %	0.759^{***} (0.083) 75.07 %
Model fit					
Deviance	1080.109	969.748	955.492	869.910	855.241

Parameter	CSM (LKC_{DIF} 1)	CSM (LKC_{DIF} 2)	CSM (LKC_{DIF} 3)	CSM (LKC_{DIF} 4)	CSM (LKC_{DIF} 5)
Fixed					
Intercept	-1.134 (0.213)	1.010 (0.159)	1.156 (0.172)	2.371 (0.148)	2.332 (0.121)
Theme 2 (cognitivism)	-0.113 (0.233)	0.513^{*} (0.205)	0.345 (0.199)	0.239 (0.175)	-0.391 (0.150)
Theme 3 (constructivism)	-0.180 (0.226)	0.378 (0.199)	0.152 (0.196)	-0.654^{***} (0.172)	-0.975^{***} (0.148)
Theme 4 (evaluation)	0.091 (0.208)	0.330 (0.173)	0.207 (0.176)	-0.068 (0.152)	-0.741^{***} (0.130)
Random					
Level 3 – group					
$\sigma^2 v0$	0.160 (0.113)	0.013 (0.044)	0.078 (0.063)	0.063 (0.045)	0.002 (0.028)
Level 2 – student					
$\sigma^2 u0$	0.642^{***} (0.186)	0.402^{**} (0.131)	0.315^{**} (0.116)	0.135 (0.073)	0.345^{***} (0.088)
Level 1 – theme					
$\sigma^2 e0$	1.365^{***} (0.152)	1.056^{***} (0.117)	1.012^{***} (0.111)	0.777^{***} (0.084)	0.574^{***} (0.065)
Model fit					
Deviance	1078.332	962.792	952.406	844.000	809.786

Values between brackets are standard errors

* $p < .05$ ** $p < .01$ *** $p < .001$

Chapter 7

General discussion and conclusion

The research presented in this dissertation focuses on the impact of structuring tools on knowledge construction in asynchronous discussion groups in higher education. More specifically, the impact of assigning roles to students was studied in computer-supported collaborative learning (CSCL) settings in both medical school and educational sciences. In this chapter we present an integrated overview of the results of the different studies. We start off by outlining the theoretical background and practice of asynchronous discussion groups. Next, we discuss the specific structuring approach that was implemented in the present dissertation and that aimed at fostering knowledge construction, namely the assignment of roles. We describe the roles assigned in both settings, and the additional support of self-assessment in one of these settings. In a next step, we formulate the two preliminary questions and the eight main research questions that were presented in the introduction of this dissertation, after which we provide an answer to each question. Further, we discuss the results brought forward in the different chapters. Finally, we conclude this chapter with limitations of the studies, directions for future research, and practical implications.

Theory and practice of asynchronous discussion groups

The advent of CSCL in higher education is a logical result of the increasing educational use of information and communication technologies (ICT). ICT-based applications become more and more prevalent in higher education, not only because of the lower costs of hard and software, but also because they allow the adoption of new teaching and learning techniques. “ICT has the potential of providing means for enhancing the variety or quality of group-based learning” and “ICT may provide … discussion tools to support the learning process…” (Hammond & Bennet, 2002, p. 55). This dissertation fits in with this growing trend to adopt ICT-based learning environments to improve group-based learning. More specifically, online asynchronous discussion groups were implemented in two settings. These discussion groups did not replace the traditional face-to-face instruction but were rather used in addition. Therefore, these CSCL applications can be seen as a form of blended learning.

The implementation of asynchronous discussion groups is based on the notion that social dialogue is important to trigger knowledge construction. The importance of dialogue is in turn founded on principles of the social constructivist theory.

Social constructivists consider individual learning as socially mediated. As such, learning is collaborative in nature and group settings can foster learning via questioning, criticising, and evaluative discourse (Schrire, 2004). The basic assumption of social constructivism is that knowledge is not transferred, but co-constructed by individuals who interact within an authentic and social context. This construction of knowledge is especially triggered by dialogue (Pena-Shaff & Nicholls, 2004).

Dialogue and collaboration are two social constructivist principles on which collaborative learning is based. Collaborative learning can be considered as “a situation in which two or more people learn or attempt to learn something together” (Dillenbourg, 1999, p. 1). This definition is rather broad and encompasses a lot of group learning strategies, some of which are often referred to as cooperative learning. However, in the introduction to this dissertation, we made clear that we opted to label the learning situations under investigation as collaborative learning (instead of cooperative learning), thereby drawing attention to the fact that authentic and ill-structured tasks are presented and to the fact that students are required to go through all learning processes together instead of dividing the workload and go through subtasks individually.

Computer-supported collaborative learning can be identified as the “electronic form of collaborative learning”, since it focuses on learning situations in which individuals learn with and from each other, while these learning processes are in one way or another supported by technology. In this way, CSCL environments can be considered as social constructivist learning environments that form the present and the future of learning (Kirschner, 2001).

The CSCL environments under investigation in this dissertation are asynchronous discussion groups. There are some general advantages of the implementation of CSCL in higher education. ICT gives students the opportunity to get acquainted with essential technologies in order to keep up with the rapid growth of knowledge (Hagdrup et al., 1999). The technology can be used to integrate certain curriculum components (e.g. work placements) within the context of an entire curriculum (Hagdrup et al., 1999; Stromso, Grottum, & Hofgaard Lycke, 2004). In addition, there are a number of advantages that are related to the asynchronous nature of online discussions. First, asynchronous discussion groups are independent of time and location, and therefore increase accessibility, opportunities for interaction, and educational flexibility (Bernard & Lundgren-Cayrol, 2001; Hew & Cheung, 2003). Furthermore, they provide students with extra time to reflect, think, and search for additional information before contributing to the discussion (De Wever, Schellens, Valcke, & Van Keer, 2006;

Pena-Shaff & Nicholls, 2004). Last but not least, they leave a footprint of the discussions, in the sense that all exchanges of information between students are stored in the discussion transcripts (Cecez-Kecmanovic & Webb, 2000; De Wever et al., 2006; Mason, 1992; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005).

Asynchronous discussion groups are furthermore seen as ideal tools to support the co-construction of learning (Gilbert & Dabbagh, 2005). In these learning environments, students can work together, achieve shared understanding, and collaboratively solve problems (Cecez-Kecmanovic & Webb, 2000). Discussing online is an excellent activity for co-constructing knowledge, since explaining, elaborating, and defending one's position to others "forces learners to integrate and elaborate knowledge in ways that facilitate higher-order learning" (Rourke & Anderson, 2002, p. 3).

However, grouping students in asynchronous discussion groups does not necessarily lead to effective interaction and the co-construction of knowledge (Dillenbourg, 2002; Vonderwell, 2003; Weinberger et al., 2005). Collaborative knowledge construction in asynchronous discussion groups may need additional support (Weinberger et al., 2005). Therefore, asynchronous discussion groups are often equipped with a certain amount of structure. They can be structured by means of introducing specific goals, task types, task prescripts, or forms of scripting. Structuring or scripting learning environments is found to improve collaboration (Pfister & Mühlpfordt, 2002) and can be seen as a form of scaffolding for students to get started in authentic activities. The interest in using scripts to specify, sequence, and assign collaborative learning activities (Kollar, Fischer, & Hesse, 2003) is growing in view of improving the design of CSCL-environments (Weinberger et al., 2005).

Supporting knowledge construction: Focus of this dissertation

In the research reported in this dissertation one specific type of structuring is studied: the assignment of roles. Roles are assigned to students in the asynchronous discussion groups in order to support the process of social knowledge construction. Instructional approaches to collaborative learning focus on assigning roles to students in order to support coordination and promote effective interaction patterns. A number of positive effects are attributed to roles. Groups where roles are assigned can work efficiently, smoothly, and productively (Cohen, 1994) and "the practical matter of having critical roles filled in meetings has direct implications for improving task performance and satisfaction" (Zigurs & Kozar, 1994, p. 277). Furthermore, the use of roles can alleviate problems of non-participation or domination of the interaction by one group member (Cohen, 1994) and is an important factor in determining the quality of knowledge construction in a community (Aviv, Erlich, & Ravid, 2003).

In addition, in one setting the impact of the additional support of introducing self-assessment on knowledge construction is studied. Research reveals considerable impact of self-assessment on students' content-related learning, quality of problem solving, and self-reflection (Sluijsmans, Dochy, & Moerkerke, 1999). While performing their own regular and structured self-assessment, learners develop a questioning and reflective approach (Robinson & Udall, 2006). This can stimulate students to identify suitable amendments to their actions in forthcoming discussions (Hunt, Hughes, & Rowe, 2002). In this respect, self-assessment was introduced in the present study as a reflection tool and a tool to support knowledge construction.

The impact of the introduction of roles on knowledge construction is studied in two different settings. Both are higher educational contexts, but they differ with regard to the knowledge domain and the age and study experience of the students. The first setting in which asynchronous discussion groups were implemented was situated in the knowledge domain of medical sciences and involved sixth-year medical students discussing during a clinical rotation in paediatrics. The discussion groups involved 5 students and two different roles were introduced: a moderator and a developer of alternatives for patient management.

The second setting was situated in the knowledge domain of educational sciences and involved groups of 10 freshmen discussing theoretical concepts dealt with in the instructional sciences course. Five different roles were introduced in order to promote high-level interaction, enhanced collaboration, and consequently knowledge construction through social negotiation: starter, summariser, moderator, theoretician, and source searcher. In addition, self-assessment was introduced in this setting as a way of formative assessment in order to enhance reflection (Larres, Ballantine, & Whittington, 2003). The students were asked to evaluate themselves in relation to the knowledge construction processes in their messages.

Overview of the research questions and the results

Taking into account the main aim of this dissertation, namely to study the impact of supporting knowledge construction in asynchronous discussion groups in higher education by means of role assignment and self-assessment, two preliminary and eight research questions were formulated:

(PQ 1) How to measure students' knowledge construction in asynchronous discussion groups?
(PQ 2) How to analyse knowledge construction measures of students collaborating in asynchronous discussion groups?
(RQ 1) Does the introduction of roles have a significant impact on students' knowledge construction in the medical school setting?
(RQ 2) Is there a significant differential impact for the roles in the medical school setting?
(RQ 3) Do freshmen act up to the assigned roles in the educational sciences setting?
(RQ 4) Does the introduction of roles have a significant impact on the knowledge construction in the educational sciences setting?
(RQ 5) Is there a significant differential impact for certain roles in the educational sciences setting?
(RQ 6) What message characteristics have an impact on knowledge construction in the educational sciences setting?
(RQ 7) Are freshmen in the educational sciences setting able to assess their own social knowledge construction processes accurately?
(RQ 8) Does the introduction of self-assessment have a significant additional impact on students' knowledge construction on top of the effect of role assignment in the educational sciences setting?

Below, we successively provide an answer to each question.

Preliminary question 1: How to measure students' knowledge construction in asynchronous discussion groups?

The first preliminary question was related to how knowledge construction in asynchronous discussion groups can be measured. Chapter 2 deals with quantitative content analysis, a technique to study transcripts of asynchronous discussions, and provides an overview of fifteen content analysis instruments. For each analysis instrument, the theoretical background, the choice for a unit of analysis, and the reliability of the instruments is discussed. Based on this review, we opted to use the interaction analysis model of Gunawardena, Lowe, and Anderson (1997). This model distinguishes five different levels of knowledge construction activities: (1) sharing and comparing information, (2) identifying areas of disagreement, (3) negotiating meaning and co-construction of knowledge, (4) evaluation and modification of new schemas that result from co-construction, and (5) reaching and stating agreement and application of co-constructed knowledge.

The choice for this analysis scheme was also based on the fact that this instrument focuses on knowledge construction through social negotiation. Furthermore, it is based on a social constructivist theoretical background and it is one of the few content analysis models with a sound empirical research base (Marra, Moore, & Klimczak, 2004). The analysis scheme of Gunawardena, Lowe, and Anderson (1997) was used to measure the level of knowledge construction in both settings. It was applied throughout all studies in which knowledge construction was measured (see chapters 3, 4, and 6).

Preliminary question 2: How to analyse knowledge construction measures of students collaborating in asynchronous discussion groups?

The next preliminary question focused on the analysis of knowledge construction measures of students collaborating in discussion groups. Since knowledge construction in collaborative situations is marred by variables both at the level of the individual learner and the group, an appropriate technique is necessary to analyse the quantitative data. Chapter 4 goes more deeply into the methodological challenges to take into account the mutual influences between groups and the individuals who make up that group. We suggested adopting multilevel modelling techniques to analyse the data resulting from the quantitative content analysis procedure. The study reported in chapter 4 focuses on the process, output, and interpretation of multilevel analyses on quantitative content analysis data derived from asynchronous discussion group transcripts.

In hierarchically structured settings, the assumption of independency for using the traditional analysis techniques is violated. With regard to the studies presented in this dissertation, this implies that data from students within a discussion group cannot be considered as completely independent because of the shared group history (Hox, 1994). Due to the violation of the assumption of independence, conventional modelling can result in underestimation of standard errors. In addition, even in situations where it is unlikely to make erroneous judgements, multilevel modelling provides more accurate estimates and should be used with data from natural groups, as “the existence of such data hierarchies is neither accidental nor ignorable” (Goldstein, 1995, p. 1).

Multilevel modelling handles the hierarchical nesting, interdependency, and unit of analysis problem and is presented as a more optimal technique to study content analysis data from CSCL-environments. Based on this choice for multilevel modelling, this analysis technique was applied in all chapters focusing on the analysis of knowledge construction in the discussion groups (see chapters 3, 4, and 6).

Research question 1: Does the introduction of roles have a significant impact on students' knowledge construction in the medical school setting?

In the medical school setting, two different roles were introduced: a moderator and a developer of alternatives for patient management. The specific research question in chapter 3 examines whether there are differences between groups (1) with a student or an instructor as moderator and (2) with or without a developer of alternatives. A content analysis based on the model of Gunawardena, Lowe, and Anderson (1997) (see preliminary question 1) was performed to explore the different levels of social construction of knowledge and multilevel logit analyses (see preliminary question 2) were applied. The results show a significant difference in knowledge construction through social negotiation between conditions with a student moderator and conditions where the instructor is moderating, but only when a developer of alternatives is involved. No significant difference was revealed between student-moderated and instructor-moderated groups when no developer of alternatives was present. It is concluded that students' contributions are more likely to reflect a high level of knowledge construction in the condition where both the moderator and developer role are assigned to students.

Research question 2: Is there a significant differential impact for the roles in the medical school setting?

This research question focused on the contributions of students performing the role of moderator or developer of alternatives in the asynchronous discussion groups in the medical school setting. The results show that messages from students assigned the role of moderator reflected significantly higher levels of knowledge construction as compared to students without a role. No significant differences were found for the messages from students performing the role of developer of alternatives as compared to students without a role.

Research question 3: Do freshmen act up to the assigned roles in the educational sciences setting?

Chapter 5 focuses on the validation of the assumptions about role adoption by students in the educational sciences setting. Since Cohen (1994) argues that students are not always performing the assigned roles and since freshmen were involved in this setting, we verified to what extent students adopt and perform their roles. The question whether freshmen actually act up to the roles merits attention before studying the impact of roles on the knowledge construction processes in discussion groups.

In this respect, chapter 5 studies to what extent the assigned roles of source searcher, theoretician, summariser, moderator, and starter were actually adopted and performed by the students. The results confirm that all students perform the roles assigned to them. Although source searchers, theoreticians, summarisers, and students without roles in the role condition focused to a lesser extent on some activities related to other roles, students generally did not neglect activities related to other roles. From this chapter, it can be concluded that the introduction of roles was a successful intervention to structure the discussions.

Research question 4: Does the introduction of roles have a significant impact on the knowledge construction in the educational sciences setting?

Research question 4 concentrated on the impact of the introduction of the five roles (source searcher, theoretician, summariser, moderator, and starter) in the educational sciences setting. The research questions in chapter 6 focused on determining whether role assignment has an impact on the knowledge construction processes in the discussion groups and whether the moment of introduction of the role assignment is an important factor. By analogy with the study in the medical school setting (see research question 1), a content analysis based on the model of Gunawardena, Lowe, and Anderson (1997) (see preliminary question 1) was performed to explore the different levels of social construction of knowledge. Repeated-measures multilevel modelling (see preliminary question 2) was applied to take into account the hierarchical nesting of students in discussion groups and the successive nature of the four themes.

The results show that in order to enhance the levels of knowledge construction reflected in students' contributions, the moment of introduction of the role assignment is important. Groups with initial role assignment outperform groups where roles were only assigned from the third theme on. In the third theme, groups with initial role assignment outperform the other groups even when the role assignment was cut back and roles were no longer assigned. Therefore it is concluded that role assignment should be introduced right from the start, but can be faded out towards the end of the online discussions.

Research question 5: Is there a significant differential impact for certain roles in the educational sciences setting?

This research question focused on comparing the knowledge construction reflected in contributions of students adopting one of the five roles with the knowledge construction in contributions of students without a role in discussion groups with role assignment. Multilevel analyses were performed to answer this question in chapter 4.

The results show that the role of summariser has a significantly positive effect on the levels of knowledge construction reflected in students' messages. The assignment of other roles (source searcher, theoretician, moderator, and starter) did not result in significantly different levels of knowledge construction.

Research question 6: What message characteristics have an impact on knowledge construction in the educational sciences setting?

This research question investigated the relationship between a number of message characteristics and the knowledge construction in students' contributions. In chapter 4, different message characteristics related to the five roles, such as summarising, moderating, introducing new discussion points, and debating theory and various sources, were identified in order to explore whether messages reflecting certain characteristics have a differential impact on knowledge construction.

Multilevel analyses were performed. The results show that contributions focusing on theory, content moderating, or summaries result in significantly higher levels of knowledge construction.

Research question 7: Are freshmen in the educational sciences setting able to assess their own social knowledge construction processes accurately?

Comparable to research question 3, we checked to what extent students were able to assess their own knowledge construction processes accurately before studying the actual impact of the introduction of self-assessment on the knowledge construction processes. In chapter 6, we focused on the ability of freshmen to evaluate the levels of knowledge construction reflected in their contributions in an accurate and critical way. The analyses focused on the correspondence between students' self-ratings and the coded level of knowledge construction of their messages.

The results revealed a general trend throughout all discussion themes: on the one hand, students underestimate the extent to which they engage in sharing and comparing information during the ongoing discussion. On the other hand, they overestimate the occurrence of postings that reflect identifying disagreement, negotiating meaning, evaluating co-constructed meaning, and agreeing on and applying the co-constructed knowledge.

Research question 8: Does the introduction of self-assessment have a significant additional impact on students' knowledge construction on top of the effect of role assignment in the educational sciences setting?

In addition to the assignment of roles, self-assessment was introduced in the educational sciences setting in order to enhance students' reflection. In chapter 6 the added value of the introduction of self-assessment was explored. More specifically, the research question dealt with the issue whether or not reflection through self-assessment has a significant surplus value (in addition to the introduction of roles) to stimulate knowledge construction through social negotiation. This research question was examined in the same way as research question 4. The conclusion can be drawn that the introduction of recurrent self-assessment procedures does not have a significantly positive impact on or surplus value for knowledge construction processes in asynchronous discussions.

General discussion

In this section, we discuss the most important results summarised above and we link the different results.

In chapter 2, a review of content analysis schemes was presented. We selected the analysis scheme of Gunawardena, Lowe, and Anderson (1997) to analyse the level of knowledge construction in our studies. As mentioned above (see preliminary question 1), this analysis scheme was applied in chapter 3, 4, and 6. In chapter 2, we furthermore argue that the selection of a previously reported scheme instead of developing a new scheme is favourable in order to increase the validation of existing analysis schemes in empirical studies (De Wever et al., 2006; Stacey & Gerbic, 2003). Moreover, an additional advantage of supporting the accumulating validity of an existing procedure is the possibility to use and contribute to a growing catalogue of normative data (Rourke & Anderson, 2003). In this respect, the studies reported above help to validate the analysis scheme of Gunawardena et al. (1997). Throughout the different chapters it more specifically appeared that content analysis by means of the analysis model of Gunawardena et al. (1997) can be regarded as a convenient, manageable, and reliable technique to map and study knowledge construction processes in asynchronous discussion groups.

Chapter 3 presents the results of the study in the medical school setting. The results show a significant difference in social knowledge construction between conditions with a student moderator and conditions with the instructor as moderator. Students seem to reach higher levels of knowledge construction when a student is moderating. However, this is only the case when a developer of alternatives is involved. In discussion groups where this developer role was not assigned, there are no significant differences encountered between student-moderated and instructor-moderated groups (see also research question 1). In chapter 3, we argued that when staff tutors are involved, students may feel less free to speculate about the problem-at-hand and to explain subject-matters to each other (Moust & Schmidt, 1994). This might especially be the case for the developer of alternatives in the present study. However, no differences were found in the level of knowledge construction between messages from students with the role of developer in the instructor-moderated and the student-moderated condition. It appears that the presence of a developer of alternatives is essential to increase the knowledge construction in student-moderated groups. Yet, the contributions of the developer of alternatives do not reflect higher levels of knowledge construction as compared to messages of students without role assignment (see research question 2). This paradox is elaborated later in this chapter.

Chapter 4 deals with methodological issues when analysing content analysis data of students collaborating in discussion groups. Multilevel modelling is put forward as an appropriate analysis technique and was as such applied in chapter 3, 4, and 6 (see also preliminary question 2). In addition, chapter 4 provides us with answers to two other questions with regard to the introduction of roles in the educational sciences setting. First, in discussion groups were the five roles are assigned, only the contributions from the summarisers reflect significantly higher levels of knowledge construction as compared to contributions of students without a role (see research question 5). Second, contributions focusing on theory, content moderating, or summaries result in significantly higher levels of knowledge construction (see research question 6). With regard to the first finding, the positive effect of the summariser is attributed to the fact that this student has a role that explicitly requires higher level activities. However, it is argued that with the exception of the role of the starter, also the other roles might require this type of higher level activities. Concerning the second finding, it is argued that even activities that do not have a significant effect on knowledge construction may be necessary for keeping the discussions alive, since adding new elements and external information is useful to prevent discussions from drying up. These two findings, namely that only summarisers' contributions (see research question 5) and contributions focusing on theory, content moderating, or summaries (see research question 6) result in significantly higher levels of knowledge construction appear to be in contradiction, especially when the results reported in chapter 5 are taken into account (see below).

In chapter 5, we were able to verify that students adopt and perform their roles in the educational sciences setting. The results more particularly showed that students assigned a role paid particular attention to the activities related to this role (see research question 3). In this respect, it can be argued that assigning roles can be considered as a recommended scripting approach. Since the introduction of roles is a successful structuring intervention, subsequent research can be more confident when studying the impact of role assignment on dependent variables such as knowledge construction (see e.g. research question 4 and chapter 6). However, if we combine the former finding with the findings of chapter 4 (see research question 5 and 6), some discrepancies arise. If all students adopt and perform the activities related to their role in a satisfactory way – and we know from research question 6 that contributions focusing on theory, content moderating, and summaries reflect higher levels of knowledge construction – how can we explain that only contributions of students assigned the role of summariser reflect significantly higher levels of knowledge construction?

We suggest that the origin of these discrepancies is related to the reference group which we compared the contributions of students performing a role with. The analyses presented earlier in chapter 4 only compared the discussion contributions of students with and without a role in the role condition. Remember that role assignment was rotated between the students during the consecutive themes. The aim of chapter 4 was to explore the methodological issues and the differences between students with and without a role in discussion groups with role assignment in the first two themes. However, since our data set was expanded after the methodological issues had been resolved – especially in order to check for the significance of the moment of introduction of the roles in chapter 6 – we can adopt a different analysis perspective and contrast the discussion contributions of all students in the role condition (independent of the fact whether they adopt a role or not) with the discussion contributions of students in the no role condition. The results of the analyses building on this comparison are presented in Table 7.1.

Table 7.1
Model estimates for the four-level analyses of levels of knowledge construction (reference category: no role condition)

Parameter	Model 0	Model 1
Fixed		
Intercept	1.354 (0.035)	1.220 (0.055)
Starter		0.101 (0.081)
Moderator		0.213^{**} (0.081)
Theoretician		0.210^{**} (0.079)
Source searcher		0.114 (0.080)
Summariser		0.484^{***} (0.080)
No role in role condition		0.151^{*} (0.068)
Random		
Level 4 – group		
$\sigma^2 f0$	0.020^{*} (0.008)	0.013^{*} (0.006)
Level 3 – student		
$\sigma^2 v0$	0.001 (0.006)	0.000 (0.006)
Level 2 – theme		
$\sigma^2 u0$	0.016 (0.008)	0.011 (0.008)
Level 1 – message		
$\sigma^2 e0$	0.381^{***} (0.012)	0.378^{***} (0.012)
Model fit		
Deviance	4359.112	4310.662
χ^2		48.45
df		6
p		< .001
Reference		Model 0

Values between brackets are standard errors
$^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 7.1 clearly shows us that, compared to the contributions of students in the no role condition, the contributions of moderators, theoreticians, and summarisers reflect significantly higher levels of knowledge construction. This is in line with the results of research question 6 indicating that contributions focusing on theory, content moderating, and summaries reflect higher levels of knowledge construction. Furthermore, it can be noticed that contributions of students without roles in the role condition reflect significantly higher levels of knowledge construction as well. However, one to one comparisons do not reveal significant differences between students without role in the role condition and students with a role, except for the summariser. This leads to the same results as reported in relation to research question 5 and explains the discrepancies discussed above.

Chapter 6 discusses the impact of the introduction of roles, the added value of the introduction of self-assessment, and the relation between knowledge construction and final exam scores. Concerning the impact of roles, the conclusion can be drawn that the moment of the introduction of role assignment is important and that roles are especially valuable during the initial discussions and can be faded out towards the end (see research question 4). The finding that groups with initial role assignment outperform other groups even after their role support was cut back might support the hypothesis that students interiorised the role-related activities. In chapter 6 we mentioned that fading of collaboration scripts could improve such internalisation processes (Weinberger et al., 2005). In this respect, the introduction of roles can be seen as a way of scaffolding that eventually can be faded out (Brown, Collins, & Duguid, 1989). Self-assessment on the other hand, did not have a significant positive impact on social knowledge construction (see research question 8). This might be due to the fact that the first-year students in our study were not yet able to assess their knowledge construction processes very accurately (see research question 7). These results are in line with the study of Dewiyanti, Brand-Gruwel, and Jochems (2004; 2006) reporting no significant effect of reflection on knowledge construction. However, we argued in chapter 6 that self-assessment remains a medium with a strong potential to stimulate reflection (Falchikov & Boud, 1989; Larres et al., 2003) but that students may need more experience in assessing themselves on the one hand and more time in order to improve their future participation in the discussion groups on the other hand.

In general, it can also be concluded that the effects of the introduction of roles to structure asynchronous discussion groups in order to promote knowledge construction are not always clear. With regard to the findings in the medical school setting, we already pointed at the paradox that although the contributions of the developer of alternatives do not reflect higher levels of knowledge construction, the presence of this role is essential to increase the knowledge construction in student-moderated groups. Furthermore, by resolving the discrepancies noticed in the educational sciences setting, we showed that there is a significant difference in knowledge construction between students without roles in groups with and without role assignment. In addition, it appears from the results in chapter 6 that the moment of the introduction of role assignment is a critical factor and that the impact of role assignment remains even when the structuring was no longer implemented. The combination of these findings leads us towards the conclusion that also the interplay between roles is a crucial factor to take into account when studying the discussion processes in a group.

In one way or another, contributions of students with roles seem to trigger other students to post messages reflecting higher levels of knowledge construction. There can be several reasons to account for this. First, it is not unlikely that students without roles are directly influenced by the role assignment. For instance, since they are well aware of the nature and the function of the roles, they may also adopt certain components of the role behaviour. Second, students may also be influenced by the roles in an indirect way. For example, contributions of students with a role may simply stimulate other students to contribute to the knowledge construction processes. Third, roles increase students' awareness of active collaboration (Strijbos, Martens, Jochems, & Broers, 2004) and this may enhance knowledge construction. In any case, it appears that all individuals in a group take advantage of the role assignment.

The above-mentioned reasons are formulated from the perspective of an individual in a collaborative group. However, the interplay of roles can also be viewed from a group perspective. Stahl (2005, p. 79) argues in favour of this group perspective since "in the CSCL perspective, it is not so much the individual student who learns and thinks, as it is the collaborative group". Collaborative groups are more than the sum of their parts and are to be considered as an entity. In this way, each group develops its own approach to knowledge construction. This approach is not developed by an individual student, but by students who mutually influence each other. Groups develop their specific dynamics during collaborative knowledge construction. These can be affected by the introduction of roles – even when the structuring approach is cut back. A group – as a unit – can "interiorise" the roles and in this view we could argue that the group as entity has learned as well.

We can conclude this section by stating that the introduction of roles is a successful structuring approach for collaborative learning in asynchronous discussion groups. However, we should be aware of over-scripting (Dillenbourg, 2002). Formulating too rigid role descriptions that lead to unnatural collaboration should be avoided. Moreover, we should keep in mind that the main goal of collaborative learning is that students learn together. In this respect, we refer to the differences between cooperative and collaborative learning as introduced in the first chapter of this dissertation. We believe that roles should not be used with the aim of dividing tasks in order to allow students to work individually without interacting with each other. On the contrary, roles should centre on enhancing social knowledge construction through intensive collaboration.

Limitations of the studies and directions for future research

In this section, we discuss the limitations of the studies reported in this dissertation. Moreover, we suggest some directions for future research in order to corroborate the research findings or to study new research questions that arise from the results.

A first limitation is that we only studied the effects of structuring asynchronous discussion groups in two specific research settings. Although these research settings are different with respect to knowledge domain, position in the curriculum, and age and study experiences of the students, we are yet unable to pronounce upon the effects in other situations. Future research in other settings is necessary in order to generalise the present research results to different knowledge domains and different student populations.

Second, we were unable to compare the different age groups (sixth year students and first year students) since the studies were set up in a different knowledge domain and different role assignments were applied. In order to compare the impact of the roles on freshmen versus advanced-level students within one knowledge domain, future research in the same settings – but with different student populations – is required. An alternative but equally interesting research aim could be to compare groups with previous experience in (structured) online discussions with groups that participate in online discussions for the first time in order to explore the need and impact of structuring and scaffolding on social knowledge construction. Other interesting research questions related to the introduction of roles could for example focus on the impact of role assignment on the knowledge construction processes of groups and individuals if the roles are assigned to respectively high and low achievers.

Third, the research in both fields was set up in real-life educational settings involving naturalistic groups. Researching authentic settings presents benefits. It provides a more stringent test of the successful implementation of support and structuring by means of role assignment or self-assessment than research in tightly controlled laboratory settings, since the results of the latter cannot be transferred to the context of real-life situations. In this respect, we can argue that the interventions implemented in this dissertation are feasible and sustainable and that the results can be generalised to our specific research contexts, which is the study of knowledge construction processes in online asynchronous discussion groups with first year educational sciences students and sixth year medical sciences students. However, studying natural groups also has important drawbacks. It implies that setting up a strictly controlled empirical research design is not possible. Studying online discussions in ecologically valid settings challenges the ability of the researcher to control all variables in the context. In the medical school setting, a cross-over design was applied (see chapter 3). Although existing student groups were used, it is important to note that they were composed at random by the student administration. With regard to the educational sciences setting, groups were composed at random. Furthermore, groups were at random assigned to the different research conditions. Nevertheless, we were unable to keep all variables under control and to exclude influences from the overall study process of the students outside the studies and the particular courses under study.

A fourth limitation is related to the study of learning processes. In this dissertation we focused on knowledge construction processes, since studying processes is critical in CSCL-research. If we want to know what learning activities and instructional methods contribute to collaborative knowledge construction, it is necessary to look at what is actually going on in students' discourse (Dennen & Paulus, 2006; Schellens, Van Keer, Valcke, & De Wever, 2006). However, future research could also aim to unravel the relation between knowledge construction processes and the actual acquisition of knowledge in detail, for instance by introducing acquisition tests after each theme.

A fifth drawback regards the choice for quantitative content analysis as a basis to analyse the knowledge construction processes in the discussions. One of the critical methodological issues in CSCL-research is the occurrence of studies building on a small number of participants with a restricted number of messages and during short periods of time. Moreover, the descriptive nature and the lack of focus on the testing of hypotheses of such studies is often criticised (see chapter 2). In order to overcome these critiques, we opted to study asynchronous discussion groups at a larger scale. In this respect, quantitative content analysis was a relevant choice in order to be able to analyse a large amount of data in a reliable scientific way. Although this technique is favourable in order to shed a light on the main aspects of knowledge construction, some nuances and details may not have been picked up. Therefore, future research should include more detailed and qualitative discourse analysis of smaller sub samples.

A sixth remark concerns the selection of the content analysis model. Based on a thorough review of the literature, we carefully selected the content analysis model of Gunawardena et al. (1997). Although this model has been compared with other models (see chapter 2) and we are confident that this model analyses knowledge construction in a reliable way, there are a few drawbacks related to the application of this analysis scheme to measure knowledge construction. First, social knowledge construction can be operationalised in different ways. By selecting this model consistently throughout each of the individual studies, we were bound to this single operationalisation. The use of other models – implying other operationalisations – may shed a different light on knowledge construction. A second drawback is that measuring knowledge construction is never 100% accurate. Although we used multiple coders and paid specific attention to the coder training, a certain amount of indistinctness still remains. In order to overcome the above-mentioned drawbacks, future research could validate our findings by applying one or more alternative content analysis scheme(s).

Seventh, the present research of collaborative knowledge construction is limited with regard to the methodological repertoire used in the studies. In this dissertation, multilevel modelling was opted for to analyse the data of the content analysis and take into account the mutual influences between groups and the individuals who make up that group. However, in order to explore the impact of structuring on social knowledge construction more deeply, other techniques could be applied. In this respect, future research may use a combination of structural equation and multilevel modelling in order to investigate the impact of roles on knowledge construction through mediating variables, such as message characteristics. In this way, it could also be explored whether different ways of structuring have a different impact on students' activities (as measured by message characteristics) which in turn affect the social knowledge construction in the discussion groups. In addition, the effect of structuring by means of roles may be explored in a qualitative way, e.g. by interviewing students about their role adoption.

Eighth, the present studies may have shed insufficient light on the group as entity. Stahl (2005) argues that collaboration studies should be analysed more at the group level. More specifically, future research should focus in greater detail on the social composition of the groups, the collaborative activities, the technological support, and the design and structuring of the groups. In this respect, it may be enlightening to select groups with a high and a low level of social knowledge construction and study the differences in detail, for example by using sequential analysis techniques that focus on what specific discourse activities trigger other kinds of discourse activities. Future research can also study the impact of roles – or role related activities – by this technique. For example, do the replies on a message from a moderator reflect social knowledge construction? Or, are messages discussing theory followed by messages reflecting knowledge construction? This kind of research focuses in depth on unravelling how processes of learning and cognition take place at the group level.

The ninth limitation is that the present studies only focus on one type of structuring of online discussion groups, namely the introduction of roles. In addition, the surplus value of introducing self-assessment was explored in one study. However, there are alternative ways to structure interaction in asynchronous discussion groups (see also chapter 5). Future research is needed to study the interrelated effect of other ways of structuring, for example sentence openers or argumentation scripts, on the knowledge construction processes. In this respect, the next step in our research on designing effective CSCL environments is the investigation of the effect of the introduction of peer tutoring in asynchronous discussion groups. In the educational sciences setting, each group of 10 first year students receives the support of a fourth year student who is assigned a tutor role. Compared to structuring discussion groups with roles, human tutors have the advantage that they are able to regulate discussion support. The structure can be gradually increased whenever needed and gradually decreased when it is no longer necessary, which is one of the basic principles of scaffolding (Brown et al., 1989). Knowledge construction in these groups will be studied by applying the same content analysis model as used in this dissertation. In this way, we will also further validate the analysis scheme and we will be able to compare the results of the present studies with these new outcomes.

A tenth limitation is related to individual differences in combination with the introduction of roles to support the collaboration in the asynchronous discussion groups. In the studies we did not take the interplay between individual differences and the roles into account. It is possible that students are assigned a role in which they feel uncomfortable, that they would prefer another role that is assigned to another student, or that they prefer to take up a role that is not assigned. Future research could focus on the impact of allowing students to choose among a set of roles. It could for example be allowed that students select the necessary roles for completing a specific task and ignore the redundant roles. Moreover, this approach of structuring by assigning roles might lower the risk of over-scripting which was discussed above.

Our last limitation is connected to the implementation of self-assessment to support students’ knowledge construction processes. In the study, students’ self-assessment appeared to be relatively inaccurate. Furthermore, no impact of self-assessment on knowledge construction processes was found. However, no specific training in self-assessment skills was offered to the students. Therefore, future research should focus on increasing students’ ability to accurately assess their knowledge construction processes in asynchronous discussions. As argued in chapter 6, this can be achieved by exposing them to more frequent and recurrent self-assessment experiences, by implementing a training and feedback procedure, by pointing at the validation of their self-assessment and providing comparative information, or by introducing peer assessment. Next to this, Murphy and Jerome (2005) suggest the use of self-analysis as a tool for students to assess their performance and identify ways of improving their future learning. Future research should explore the effects of such a detailed self-analysis on knowledge construction in discussion groups.

Practical implications

In this section we present an overview of the general implications of our findings for the implementation of asynchronous discussion groups in a curriculum and we discuss the most important practical implications mentioned throughout the different chapters.

The main idea of collaborative knowledge construction in asynchronous discussion groups is that "learners engage in more active, reflective, and socially supported knowledge construction" (Weinberger et al., 2005, p. 10). However, organising students in asynchronous discussion groups does not guarantee collaborative learning (Vonderwell, 2003; Weinberger et al., 2005). In this respect, it is necessary to thoroughly design and structure asynchronous discussions (De Wever, Valcke, Van Winckel, & Kerkhof, 2002; Gilbert & Dabbagh, 2005; Lockhorst, Admiraal, Pilot, & Veen, 2002). Students need a well-defined framework to foster their discussion. In our studies we clearly stated what was expected from students: within a distinct time frame students had to post at least a minimum number of messages. Moreover, when students are participating in asynchronous discussions for the first time, it is necessary to provide them with technical and organisational guidelines on how to discuss in an online environment. This includes an introduction to the technology, as well as some examples of good contributions. If necessary, introductory sessions should be organised in order to ensure that students new to discussion groups become familiar with the online discussion approach and technology. Our research showed that trial discussions are an excellent way to assure that students get a good picture of the nature and dynamics of discussing online. We furthermore stress the importance of a good technical helpdesk – especially at the start of the discussions – to prevent frustration and eventually dropout of students.

The CSCL literature furthermore discusses the additional introduction of specific forms of structuring or scripting to favour the emergence of productive interactions and collaborative learning (2002). This kind of structuring or scripting is found to improve collaboration (Pfister & Mühlpfordt, 2002) and can be seen as a form of scaffolding for students to get engaged in authentic activities. Our research fits in with the recurrent question for structuring tools to bring about collaborative learning. In this respect, the results are quite promising. A practical implication of our research is that assigning roles can be considered as a successful scripting approach, since we have showed that students act up to their roles. This means that we can guide students to perform essential discussion skills that could have been neglected otherwise, such as looking for additional information or summarising. By providing students with clear role descriptions and guidelines, desirable behaviour can be fostered.

In addition, introducing roles can be helpful to enhance social knowledge construction especially at the start of the discussions. Our findings show that this is not only the case for students who were assigned a role, but also for their fellow discussants. In other words, by assigning roles to individual students the social knowledge construction can be influenced at the group level. Once students have integrated the discussion behaviour underlying the roles as part of their personal behavioural repertoire and they have gained sufficient confidence, competence, and control, they will move forward to a more autonomous phase in their collaborative learning and probably will need less structure, scaffolding, or support (Brown, Collins, & Duguid, 1989). In this context, we especially want to stress the temporary nature of the introduction of roles. As is the case with most types of structuring and scripting, the role assignment should be cut back after a while and in the end students should be able to discuss without an external form of structuring. Or, as we have written in chapter 6: "The ultimate goal is that this structuring tool eventually can be faded out or taken away when students have interiorised the skills related to the different roles and are competent enough to discuss in a more natural way, which is without the additional support and structure of role assignment".

Another practical implication of CSCL research in general, and of the studies reported here, is that group learning works. By providing the right amount of structure, students actually get engaged in collaborative learning. In this respect, educational practice should invest more in group learning. Especially if we believe that individual learning takes place by internalising knowledge that was already constructed interpersonally, we should assure that students have sufficient opportunities to engage in group discussion with peers. In this respect, structuring – and more specifically the introduction of roles – merits additional attention, since the findings show that role assignment can enhance social knowledge construction and that social knowledge construction in asynchronous discussion groups has a positive effect on individuals' knowledge acquisition.

A specific implication of role assignment is that the instructor can part with a number of tasks, such as moderating, adding knowledge sources, or looking for alternative solutions. However, this does not mean that the instructor's presence is no longer needed. In some cases, for example medical cases in which prescriptions have to be negotiated, the instructor really has to keep an expert eye on the content of the discussions.

The last practical implication has already been mentioned when discussing directions for future research. If we want to increase the accuracy – and thereby the hypothetical impact – of self-assessment, specific attention has to be paid to its implementation. As argued above, this can be done by implementing a specific training, increasing feedback, and providing comparative information.

Final conclusion

Within the field of computer-supported collaborative learning, researchers as well as practitioners are engaged in a continuous search for optimising the instructional approaches in online learning environments. The research presented in this dissertation concentrated on the optimisation of one specific online learning environment, namely asynchronous discussions groups. More particularly, the impact of role assignment on students' knowledge construction through social negotiation was the main subject of this dissertation. This chapter presented the context, questions and answers, discussion, limitations, suggestions for future research, and practical implications of the dissertation. The main conclusion is that assigning roles is a promising structuring tool to enhance social knowledge construction in asynchronous discussion groups. Although we realise that a number of questions remain unanswered, this dissertation has nevertheless presented theoretical and empirical evidence that makes it possible to feel reassured when answering basic questions about the impact of role assignment. Based on the studies in this disseration, future research and practice can move forward in the quest for more optimal instructional approaches.

References

Aviv, R., Erlich, Z., & Ravid, G. (2003). Cohesion and roles: Network analysis of CSCL communities. In V. Devedzic, J. M. Spector, D. G. Sampson, & Kinshuk (Eds.), *Proceedings of the 3rd IEEE International Conference on*

Advanced Learning Technologies (pp. 145-150). Athens: ICALT. Retrieved September 1, 2006, from http://www.ravid.org/gilad/AthensICALT2003.pdf

Bernard, R. M., & Lundgren-Cayrol, K. (2001). Computer Conferencing: An Environment for Collaborative Project-Based Learning in Distance Education. *Educational Research and Evaluation, 7,* 241-261.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher, 18,* 32-42.

Cecez-Kecmanovic, D., & Webb, C. (2000). Towards a communicative model of collaborative web-mediated learning. *Australian Journal of Educational Technology, 16,* 73-85. Retrieved September 1, 2006, from http://www.ascilite.org.au/ajet/ajet16/cecez-kecmanovic.html

Cohen, E. G. (1994). *Designing Groupwork. Strategies for the Heterogeneous Classroom.* (2nd ed.) New York: Teachers College Press.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education, 46,* 6-28.

De Wever, B., Valcke, M., Van Winckel, M., & Kerkhof, J. (2002). De invloed van “structuur” in CSCL-omgevingen: een onderzoek met on line discussiegroepen bij medische studenten [The influence of structuring CSCL-environments: A study of online discussion groups with medical students]. *Pedagogisch Tijdschrift, 27,* 105-128.

Dennen, V. P., & Paulus, T. M. (2006). Researching "collaborative knowledge building" in formal distance learning environments. In T. Koschman, T. W. Chan, & D. D. Suthers (Eds.), *Computer supported collaborative learning 2005: The next 10 Years!* Taipei: International Society of the Learning Sciences. Retrieved September 1, 2006, from http://css.cscl2005.org/ Fullpapers.aspx

Dewiyanti, S., Brand-Gruwel, S., & Jochems, W. (2004). *Learning together in a computersupported collaborative learning environment: The effect of reflection on group processes in distance education.* Manuscript submitted for publication. Retrieved September 1, 2006, from http://www.ou.nl/Docs/ Expertise/OTEC/Publicaties/sylvia%20dewiyanti/Proefschrift-versie-final_ 2005.pdf

Dewiyanti, S., Brand-Gruwel, S., & Jochems, W. (2006). Fostering students positive interaction in a CSCL-environment through reflection. *Small Group Research*. Retrieved September 1, 2006, from http://www.ou.nl/Docs/ Expertise/OTEC/Publicaties/sylvia%20dewiyanti/Proefschrift-versie-final_ 2005.pdf

Dillenbourg, P. (1999). What do you mean by 'collaborative learning'? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches* (pp. 1-15). Amsterdam: Pergamon.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL: Can we support CSCL* (pp. 61-91). Heerlen: Open Universiteit Nederland.

Falchikov, N., & Boud, D. (1989). Student self-assessment in higher education: A meta-analysis. *Review of Educational Research, 59,* 395-430.

Gilbert, P. K., & Dabbagh, N. (2005). How to structure online discussions for meaningful discourse: A case study. *British Journal of Educational Technology, 36,* 5-18.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research, 17,* 397-431.

Hagdrup, N. A., Edwards, M., Carter, Y. H., Falshaw, M., Gray, R. W., & Sheldon, M. G. (1999). Why? What? and How? IT provision for medical students in general practice. *Medical Education, 33,* 537-541.

Hammond, N., & Bennet, C. (2002). Discipline differences in role and use of ICT to support group-based learning. *Journal of Computer Assisted Learning, 18,* 55-63.

Hew, K. F., & Cheung, W. S. (2003). An exploratroy study on the use of asynchronous online discussion in hypermedia design. *E-Journal of Instructional Science and Technology, 6*. Retrieved September 1, 2006, from http://www.usq.edu.au/electpub/e-jist/docs/Vol6_No1/an_exploratory_study_on_the_use_.htm

Hox, J. J. (1994). Hierarchical regression models for interviewer and respondent effects. *Sociological Methods and Research, 22,* 300-318.

Hunt, N., Hughes, J., & Rowe, G. (2002). Formative Automated Computer Testing (FACT). *British Journal of Educational Technology, 33,* 525-535.

Kirschner, P. A. (2001). Using integrated electronic environments for collaborative teaching/learning. *Research Dialogue in Learning and Instruction, 2,* 1-9.

Kollar, I., Fischer, F., & Hesse, F. W. (2003). Cooperation scripts for computer-supported collaborative learning. In B. Wasson, R. Baggetun, U. Hoppe, & S. Ludvigsen (Eds.), *Proceedings of the International Conference on Computer Support for Collaborative Learning, CSCL 2003 - Community events, communication, and interaction* (pp. 59-61). Bergen: Intermedia.

Larres, P. M., Ballantine, J. A., & Whittington, M. (2003). Evaluating the validity of self-assessment: Mearsuring computer literacty among entry-level undergraduates within accounting degree programmes at two UK universities. *Accounting Education, 12,* 97-112.

Lockhorst, D., Admiraal, W., Pilot, A., & Veen, W. (2002). Design elements for a CSCL environment in a teacher training programme. *Education and Information Technologies, 7,* 377-384.

Marra, R. M., Moore, J. L., & Klimczak, A. K. (2004). Content analysis of online discussion forums: A comparative analysis of protocols. *Educational Technology Research and Development, 52,* 23-40.

Mason, R. (1992). Evaluating Methodologies for Computer Conferencing Applications. In A. R. Kaye (Ed.), *Collaborative Learning Through Computer Conferencing* (pp. 105-116). London: Springer-Verlag.

Moust, J. C., & Schmidt, H. G. (1994). Effects of staff and student tutors on student achievement. *Higher Education, 28,* 471-482.

Murphy, E., & Jerome, T. (2005). Assessing students' contributions to online asynchronous discussions in university-level courses. *Electronic Journal of Instructional Science and Technology, 8*. Retrieved September 1, 2006, from http://www.usq.edu.au/electpub/e-jist/docs/vol8_no1/commentary/stu_contrib_ansynch.htm

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education, 42,* 243-265.

Pfister, H. R., & Mühlpfordt, M. (2002). Supporting discourse in a synchronous learning environment: The learning protocol approach. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of CSCL 2002.* Mahwah, NJ: Lawrence Erlbaum. Retrieved September 1, 2006, from http://newmedia.colorado.edu/cscl/178.pdf

Robinson, A., & Udall, M. (2006). Using formative assessment to improve student learning through critical reflection. In C. Bryan & K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 92-99). London: Routledge.

Rourke, L., & Anderson, T. (2002). Using Peer Teams to Lead Online Discussions. *Journal of Interactive Media in Education, 1*. Retrieved September 1, 2006, from http://www-jime.open.ac.uk/2002/1

Rourke, L., & Anderson, T. (2003). *Validity in quantitative content analysis.* Retrieved September 1, 2006, from http://communitiesofinquiry.com/sub/papers.html

Schellens, T., Van Keer, H., Valcke, M., & De Wever, B. (2006). *Comparing knowledge construction in two cohorts of asynchronous discussion groups with and without scripting.* Manuscript submitted for publication.

Schrire, S. (2004). Interaction and cognition in asynchronous computer conferencing. *Instructional Science, 32,* 475-502.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1999). Creating a Learning Environment by Using Self-, Peer- and Co-Assessment. *Learning Environments Research, 1,* 293-319.

Stacey, E., & Gerbic, P. (2003). Investigating the impact of computer conferencing: Content analysis as a manageable research tool. In G. Crisp, D. Thiele, I. Scholten, S. Barker, & J. Baron (Eds.), *Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education.* Adelaide, 7-10 December 2003. Retrieved September 1, 2006, from http://www.ascilite.org.au/conferences/adelaide03/docs/pdf/495.pdf

Stahl, G. (2005). Group cognition in computer-assisted collaborative learning. *Journal of Computer Assisted Learning, 21*, 79-90.

Strijbos, J. W., Martens, R. L., Jochems, W., & Broers, N. J. (2004). The effect of functional roles on group efficiency: Using multilevel modelling and content analysis to investigate computer-supported collaboration in small groups. *Small Group Research, 35,* 195-229.

Stromso, H. I., Grottum, P., & Hofgaard Lycke, K. (2004). Changes in student approaches to learning with the introduction of computer-supported problem-based learning. *Medical Education, 38,* 390-398.

Vonderwell, S. (2003). An examination of asynchronous communication experiences and perspectives of students in an online course: A case study. *Internet and Higher Education, 6,* 77-90.

Weinberger, A., Reiserer, M., Ertl, B., Fischer, F., & Mandl, H. (2005). Facilitating collaborative knowledge construction in computer-mediated learning environments with cooperation scripts. In R. Bromme, F. W. Hesse, & H. Spada (Eds.), *Barriers and biases in computer-mediated knowledge communication* (pp. 15-38). Boston: Kluwer.

Zigurs, I., & Kozar, K. A. (1994). An exploratory study of roles in computer-supported groups. *MIS Quarterly, 18,* 277-297.

Nederlandstalige samenvatting

(Summary in Dutch)

De impact van structureringsmiddelen op kennisconstructie in asynchrone discussiegroepen

Het onderzoek dat in dit proefschrift wordt voorgesteld, focust op de studie van de impact van structureringsmiddelen op kennisconstructie in asynchrone discussiegroepen. Binnen het gebied van computer-supported collaborative learning (CSCL) (computer-ondersteund samenwerkend leren) zoeken zowel onderzoekers als praktijkmensen naar mogelijkheden om het leren in online leeromgevingen te optimaliseren. Dit proefschrift wil bijdragen aan die zoektocht en richt zich meer bepaald op het bestuderen van de impact van het toekennen van rollen aan studenten op de kennisconstructie in asynchrone discussiegroepen binnen twee onderzoekssettings.

Het eerste hoofdstuk van dit proefschrift start met een overzicht van de verschillende achterliggende theorieën en praktijken die verband houden met het leren in asynchrone discussiegroepen. Door de algemene toename van het gebruik van informatie- en communicatietechnologie (ICT) in het huidig hoger onderwijs worden ook steeds meer vormen van blended learning (gemixt leren) geïmplementeerd. Blended learning is een term die voornamelijk gebruikt wordt voor het beschrijven van leersituaties waarin ICT-ondersteunde leeromgevingen gecombineerd worden met meer traditionele vormen van leren, waaronder bijvoorbeeld contactonderwijs. Dergelijke leeromgevingen sluiten nauw aan bij het sociaal constructivisme, dat ervan uit gaat dat leren geen kwestie is van kennis transfereren, maar dat kennis actief geconstrueerd wordt door de lerende in interactie met zijn omgeving en met anderen. Dit leren vindt plaats in rijke, authentieke contexten die een zekere mate van complexiteit inhouden en waarbij problemen aan bod komen die reëel en relevant zijn.

Collaborative learning (collaboratief leren) sluit aan bij deze sociaal constructivistische principes. De asynchrone discussiegroepen die het object vormen van deze studie zijn een vorm van collaboratief leren die door ICT wordt ondersteund (CSCL). Voordelen van het discussiëren in asynchrone discussiegroepen zijn de mogelijkheden om eender waar en wanneer aan de discussies deel te nemen, het feit dat studenten extra tijd hebben om te reflecteren, na te denken en extra informatie op te zoeken vooraleer ze een bijdrage leveren, en de mogelijkheid om de bijdragen opnieuw na te lezen.

Discussiëren in dergelijke discussieomgevingen is bevorderlijk voor het samen construeren van kennis. Het is echter niet zo dat het groeperen van studenten in discussiegroepen automatisch leidt tot effectieve interactie en het samen construeren van kennis. Studenten kennis laten construeren in asynchrone discussiegroepen vereist een minimum aan ondersteuning. Daarom worden de meeste asynchrone discussiegroepen uitgerust met een zekere vorm van structuur. Die structuur kan bestaan uit de introductie van specifieke doelen, taakopdrachten, taakvoorschriften of verschillende scripts. Het structureren of scripten van online leeromgevingen bevordert de onderlinge samenwerking en kan worden gezien als een vorm van scaffolding die het samenwerken ondersteunt. Het gebruik van scripts om activiteiten met betrekking tot samenwerkend leren te specificeren, ordenen of toe te kennen wordt tegenwoordig vaak gebruikt om het ontwerp van CSCL-omgevingen te verbeteren. Het is in deze context dat het doel van dit proefschrift zich situeert.

Het hoofddoel van dit proefschrift is het bestuderen van de impact van het structureren van online discussies op de sociale kennisconstructie. Meer specifiek gaat de aandacht vooral naar het structureren van discussiegroepen door middel van het introduceren van rollen. De impact van het toekennen van rollen aan studenten tijdens het discussiëren wordt onder de loep genomen in twee onderzoekssettings. Bovendien wordt ook de impact van het introduceren van self-assessment (zelfevaluatie) op de kennisconstructie bestudeerd in één van de settings. Bij zelfevaluatie dienen studenten zichzelf te evalueren aan de hand van bepaalde criteria. Daarbij wordt de aandacht op hun eigen functioneren gevestigd, wat hun reflectie bevordert.

Hoofdstuk 1 gaat vervolgens dieper in op de twee onderzoekssettings. Een eerste setting betreft studenten in het zesde jaar van de opleiding geneeskunde die deelnemen aan asynchrone discussies als onderdeel van hun stage pediatrie. De andere setting betreft studenten uit de eerste bachelor pedagogische wetenschappen die in het kader van het vak onderwijskunde deelnemen aan de asynchrone discussies. Achtereenvolgens worden verder het gebruik van rollen in het algemeen besproken, alsook de verschillende rollen die geïmplementeerd werden bij de twee onderzoekssettings. In de medische setting werd geopteerd om twee rollen te introduceren: moderator en alternatiefzoeker. In de pedagogische setting werden vijf rollen toegekend aan de studenten: starter, moderator, theoreticus, brononderzoeker, en samenvatter.

Vervolgens worden de verschillende onderzoeksvragen die doorheen het proefschrift aan bod komen, opgesomd en besproken. Bovendien worden twee voorbereidende vragen gesteld die noodzakelijk zijn voor het onderzoeken van kennisconstructie bij studenten in discussiegroepen. De twee voorbereidende vragen en de acht onderzoeksvragen worden behandeld in de hoofdstukken 2 tot 6.

De eerste voorbereidende vraag spitst zich toe op de methode voor het meten van de kennisconstructie van de studenten in de asynchrone discussies. In het tweede hoofdstuk wordt kwantitatieve contentanalyse naar voren geschoven als een techniek om de transcripten van de asynchrone discussiegroepen te bestuderen. Het hoofdstuk geeft een overzicht van vijftien instrumenten voor contentanalyse en bespreekt de theoretische achtergrond, de keuze voor de analyse-eenheid en de betrouwbaarheid van alle modellen. Gebaseerd op deze review opteerden we ervoor om het contentanalysemodel van Gunawardena, Lowe, en Anderson te gebruiken voor de contentanalyse doorheen dit proefschrift. Het model onderscheidt vijf niveaus van sociale kennisconstructie: (1) delen en vergelijken van informatie; (2) topics waarover men het niet eens is aan het licht brengen en verkennen; (3) onderhandelen over betekenisgeving en samen opbouwen van kennis; (4) testen en aanpassen van syntheses en samen geconstrueerde kennis en (5) het bereiken van overeenstemming en toepassen van samen opgebouwde kennis.

Nadat een analyseschema geselecteerd is, dringt de vraag zich op hoe we de kwantitatieve gegevens van studenten die samenwerken in asynchrone discussiegroepen zorgvuldig kunnen analyseren. Dit is de focus van de tweede voorbereidende vraag. Doordat kennisconstructie in discussiegroepen beïnvloed wordt door variabelen op verschillende niveaus, is het analyseren van dergelijke data niet voor de hand liggend. In hiërarchisch geordende settings, waarbij bijvoorbeeld studenten tot bepaalde groepen behoren, is het gebruik van traditionele analysetechnieken vaak niet aangewezen omdat niet voldaan is aan de assumptie van onafhankelijkheid. De gegevens van studenten in groepen zijn vaak niet onafhankelijk doordat ze beïnvloed worden door gemeenschappelijke ervaringen in een groep. In hoofdstuk 4 wordt dieper ingegaan op de methodologische uitdagingen om rekening te houden met het feit dat individuele studenten worden beïnvloed door de groep en dat de groep beïnvloed wordt door de individuele studenten. Multilevel analyses worden naar voren geschoven om dit probleem te ondervangen en werden toegepast doorheen de studies gerapporteerd in dit proefschrift. Het proces, de output en de interpretaties van dergelijke analyses worden grondig besproken in hoofdstuk 4.

De eerste onderzoeksvraag situeert zich in de medische setting. Er wordt nagegaan of de introductie van rollen een significante impact heeft op de kennisconstructie in de discussiegroepen. Verder wordt onderzocht of er verschillen in sociale kennisconstructie zijn tussen groepen (1) met een student versus een docent als moderator en groepen (2) met of zonder alternatiefzoeker. Een contentanalyse gebaseerd op het model van Gunawardena e.a. werd uitgevoerd en multilevel logit analyses werden toegepast. De resultaten tonen aan dat er een significant verschil in kennisconstructie is tussen de condities met een student als moderator en die met een docent als moderator, maar enkel wanneer een alternatiefzoeker aanwezig was. We kunnen dan ook concluderen dat de kans dat de bijdragen van studenten een hoger niveau van kennis reflecteren significant groter is in discussiegroepen waarbij zowel de rol van moderator als de rol van alternatiefzoeker werden toegekend aan een student.

De tweede onderzoeksvraag exploreert of er verschillende niveaus van kennisconstructie worden gevonden in bijdragen van studenten met een rol vergeleken met de berichten van studenten die geen rol uitoefenden. De resultaten in hoofdstuk 3 tonen aan dat de berichten van studenten met de rol van moderator significant hogere niveaus van kennisconstructie vertonen vergeleken met de berichten van studenten zonder rol. Wat betreft de rol van alternatiefzoeker werden er geen verschillen vastgesteld.

De derde onderzoeksvraag gaat na of de eerstejaarsstudenten in de pedagogische setting hun rollen accuraat uitvoerden. Deze vraag werd bestudeerd vooraleer we de impact van het introduceren van rollen op kennisconstructie onderzochten omdat onderzoek aantoont dat studenten hun rollen niet altijd uitvoeren en omdat in dit geval eerstejaarsstudenten betrokken waren in de studie. In deze context onderzochten we in hoofdstuk 5 in hoeverre de starter, moderator, theoreticus, brononderzoeker en samenvatter hun rollen vervulden. De resultaten confirmeren dat alle rollen goed werden ingevuld.

Onderzoeksvraag vier bestudeert of de introductie van rollen een impact heeft op de kennisconstructie in de discussiegroepen in de pedagogische setting. In hoofdstuk 6 onderzoeken we specifiek of het invoeren van rollen een invloed heeft op het proces van samen kennis construeren en of het moment waarop de rollen worden ingevoerd daarbij een belangrijke factor is. De resultaten tonen aan dat groepen waarbij rollen bij de eerste discussiethema’s werden toegekend en later werden afgebouwd, hogere niveaus van kennisconstructie halen vergeleken met groepen waar de rollen pas later werden geïntroduceerd. Op basis daarvan kunnen we dan ook concluderen dat het tijdstip waarop de rollen geïntroduceerd worden een belangrijke factor is.

De vijfde onderzoeksvraag focust op discussiegroepen waarin rollen geïmplementeerd werden en peilt naar het verschil in kennisconstructie gereflecteerd in bijdragen van studenten met rollen vergeleken met studenten zonder rollen in de pedagogische setting. In het vierde hoofdstuk geven de resultaten aan dat enkel de rol van samenvatter een significant positief effect heeft op de kennisconstructie. Berichten van studenten met andere rollen (starter, moderator, theoreticus en brononderzoeker) verschillen niet significant van bijdragen van studenten zonder rollen wat betreft de niveaus van kennisconstructie.

Onderzoeksvraag zes onderzoekt de relatie tussen de kennisconstructie en de activiteiten, die beiden in die berichten gereflecteerd worden. Meer bepaald werden in hoofdstuk 4 verschillende activiteiten geïdentificeerd die gerelateerd zijn aan de rollen (zoals samenvatten, modereren, introduceren van nieuwe punten, bediscussiëren van theorie en nieuwe bronnen) met het oog op het bestuderen van hun impact op de kennisconstructie. De resultaten tonen aan dat berichten gericht op theorie, inhoudelijk modereren en samenvatten significant hogere niveaus van kennisconstructie reflecteren.

De zevende onderzoeksvraag controleert of de eerstejaarsstudenten in de pedagogische setting een adequate inschatting kunnen maken van hun eigen kennisconstructieprocessen. Naar analogie met de derde onderzoeksvraag, controleren we of de studenten in staat zijn om hun niveaus van kennisconstructie goed in te schatten door ze te vergelijken met de geanalyseerde niveaus van kennisconstructie. De resultaten vermeld in hoofdstuk 6 tonen in dit verband aan dat de studenten onderschatten hoe vaak ze informatie delen en vergelijken. Daarnaast overschatten ze het voorkomen van bijdragen die gericht zijn op het exploreren van onenigheid, het onderhandelen over betekenisgeving, het evalueren van samen geconstrueerde kennis en het bereiken van overeenstemming en toepassen van samen opgebouwde kennis.

De achtste onderzoeksvraag was gericht op het achterhalen van de toegevoegde impact van zelfevaluatie bovenop de introductie van rollen op de kennisconstructie in de discussiegroepen in de pedagogische setting. De conclusie in hoofdstuk 6 geeft aan dat de introductie van een aantal zelfevaluatiemomenten geen significante positieve impact op of toegevoegde waarde heeft bij de sociale kennisconstructie in de asynchrone discussiegroepen.

Hoofdstuk 7 bestaat uit een algemene discussie en conclusie waarin de resultaten die doorheen de vorige hoofdstukken werden gepresenteerd, kort samengevat en met elkaar in verband gebracht worden. Algemeen kunnen we concluderen dat de introductie van rollen een succesvolle aanpak is om discussiegroepen te structureren en om samenwerkend leren en het samen construeren van kennis te stimuleren. Niettemin wordt opgemerkt dat het doel van het structureren niet uit het oog mag worden verloren. Rollen mogen niet worden gebruikt met het doel om taken te verdelen zodat studenten individueel kunnen werken zonder met elkaar in interactie te treden. Integendeel, het doel moet net zijn om het samen kennis construeren te stimuleren.

Verder worden de beperkingen van de studies besproken en worden suggesties voor verder onderzoek geformuleerd. De beperkingen en suggesties zijn gerelateerd aan de specifieke settings, studenten en natuurlijke omgevingen, alsook aan het bestuderen van processen van kennisconstructie, de keuze voor contentanalyse en het model van Gunawardena e.a., en de methodologische technieken. Vervolgonderzoek kan verder ook meer op de groep focussen, andere vormen van structuur implementeren, rekening houden met individuele verschillen en de procedure voor zelfevaluatie optimaliseren.

Verder wordt een aantal praktische implicaties vermeld, verbonden aan de resultaten van het onderzoek gerapporteerd in dit proefschrift. Het hoofdstuk eindigt met de conclusie dat dit proefschrift een aantal belangrijke vragen over de impact van de introductie van rollen op kennisconstructie heeft beantwoord en dat de weg nu open ligt voor toekomstige onderzoeken en praktijken die verder zoeken naar optimale instructiestrategieën.